ESSAYS IN HEALTH ECONOMICS

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ESSAYS IN HEALTH ECONOMICS

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The first essay of this dissertation investigates the effect of macroeconomic fluctuations at school-leaving on men's health at age 40. I use macroeconomic fluctuations in the U.S. between 1976 and 1992 as a quasi-experiment to identify persistent health effects. I proxy macroeconomic fluctuations with the state unemployment rate. I draw data from the National Longitudinal Survey of Youth 1979 Cohort (NLSY79) Age 40 Health supplement. I examine three measures of health: physical and mental functioning and depressive symptoms. I find that men who leave school when the state unemployment rate is high have worse physical and mental health functioning, and more depressive symptoms at age 40 than men who left school when the state unemployment rate was low.

The second essay tests the persistent effect of macroeconomic fluctuations at leaving school on three markers of health behavior: smoking, binge drinking, and obesity. Data are drawn from the NLSY79. I exploit macroeconomic fluctuations at school leaving between 1976 and 1995 to identify effects. I proxy macroeconomic fluctuations with the state unemployment rate. I find that leaving school when the state unemployment rate is high leads to an increase in the probability of binge drinking and a decrease in the probability of obesity in middle age. Health behavior marker effects are concentrated among college educated men.

The third essay contributes to the literature on the labor market consequences of unhealthy behaviors by examining a previously underappreciated consequence of the rise in obesity in the U.S.: challenges for military recruitment. Specifically, this essay estimates the percent of the U.S. military-age population that exceeds the Army's current active duty enlistment standards for weight-for-height and percent body fat, using data from the full series of National Health and Nutrition Examination Surveys (1959-2008). This essay documents a substantial increase in the number and percent of military-age civilians who are ineligible to serve in the Army because they are overweight, finds disparities across race and education in exceeding the standards, and estimates the implications for military recruitment of future changes in the prevalence of obesity.

BIOGRAPHICAL SKETCH

Johanna Catherine Maclean has accepted an Assistant Professor of Medical Ethics and Health Policy position at the University of Pennsylvania Perelman School of Medicine. Catherine received her Ph.D. in economics at Cornell University in 2012. She holds an Undergraduate and Masters degree in economics from Dalhousie University in Halifax, Canada. While at Dalhousie, Catherine was awarded a Social Sciences and Humanities Research Council of Canadian Graduate Student Scholarship. Prior to arriving at Cornell University, Catherine worked as a Senior Research Associate in the Health Economics Research Group at the University of Miami in Coral Gables, Florida.

Catherine is an empirical health economist. She uses health and labor economic theory to explore the health effects of macroeconomic fluctuations, employment, and public policies. Catherine is also interested in the labor market; healthcare; and socioeconomic consequences of poor health and health behaviors. Her current work focuses on the health effects of leaving school in a bad economy; implications of rising obesity for the U.S. Armed Services; the effect of DSM Axis II personality disorders on physical health, health behaviors, and health care utilization; the persistent health effects of education; and health and consumer effects of smoking policies. Catherine's work has been published in *Health Economics*, *Health Services Research*, *Applied Economics*, *Industrial Relations,* and *American Journal of Health Promotion.*

To Doug and Babe.

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CHAPTER 1

THE HEALTH EFFECTS OF LEAVING SCHOOL IN A BAD ECONOMY

Johanna Catherine Maclean[1]

ABSTRACT

This study investigates the effect of leaving school in a bad economy, defined as a state unemployment rate of 9% or higher, on men's health at age 40. Three empirical patterns motivate this research: workers who leave school in a bad economy persistently earn lower wages and work in less prestigious careers, individuals' career outcomes are associated with health outcomes, and the macroeconomy affects health. I use macroeconomic fluctuations between 1976 and 1992, and variation across states, as a quasi-experiment to identify the persistent health effects. Three health outcomes are examined: physical functioning, mental functioning, and depressive symptoms. I draw data from the recently available National Longitudinal Survey of Youth 1979 Cohort Age 40 Health supplement. I find that men who leave school in a bad economy have worse health at age 40 than men who leave school in a stronger economy. The results are robust to various econometric specifications, including the use of instrumental variables to correct for the potential endogeneity of the timing and location of leaving school. Supplementary analysis sheds light on potential mechanisms. Factor analysis indicates that effects are concentrated in mental health

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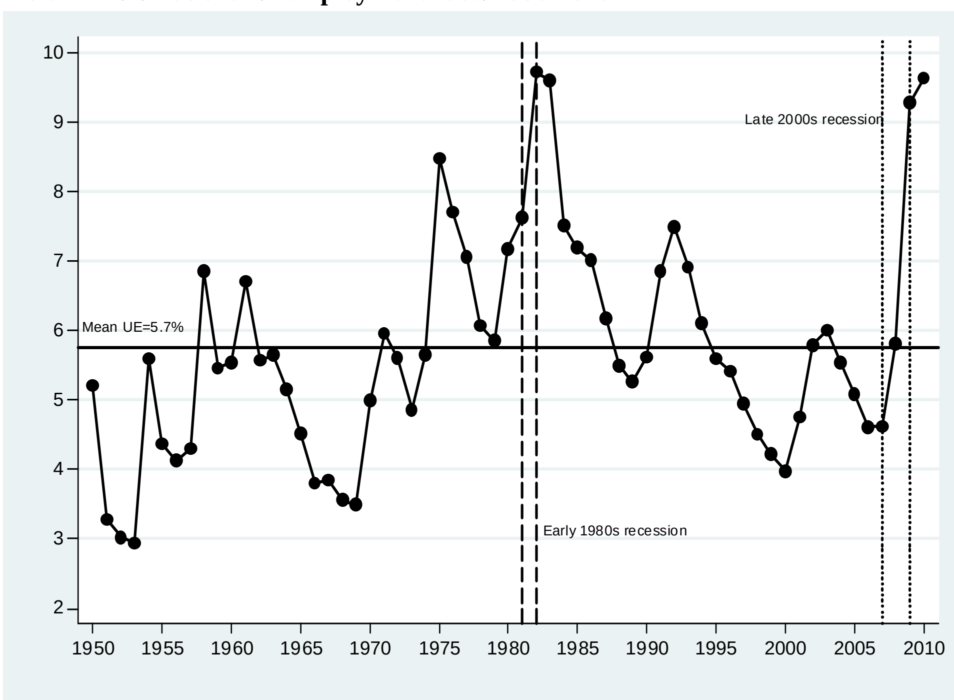
domains. This study provides the first published evidence on the persistent health effects of leaving school in a bad economy. The findings suggest that men who left school during the 2007-09 recession may experience persistently poor careers and health.

I. Introduction

This study investigates the persistent health effects of leaving school in a bad economy, defined as a state unemployment rate of 9% or higher. I compare the age 40 health of men who left school in a bad economy with the age 40 health of men who did not. Three empirical patterns motivate this study: leaving school in a bad economy has persistent and negative career effects; individual's career and health outcomes are correlated; and macroeconomic fluctuations affect health. My findings are timely as the U.S. is recovering from the 2007-09 recession. Figure 1.1 plots the national unemployment rate between 1950 and 2010. The high and persistent unemployment rates of the 2007-09 recession are apparent. The national unemployment rate was 8.2% in March 2012; this translates into 12.8 million unemployed persons (Bureau of Labor Statistics [BLS], 2012). 42.6% of the unemployed can be categorized as in long term unemployment, defined as an unemployment spell lasting 27 weeks or more. The rate of unemployment is particularly high among new labor market entrants: 13.8%, among those aged 20-24 (BLS, 2012). Rates of underemployment are estimated to be as high as 14.9% (BLS, 2012). Underemployment includes workers in part time jobs for economic reasons, discouraged workers, and persons marginally attached to the labor market. Research shows that new labor market entrants have suffered disproportionately in terms of employment outcomes in the 2007-09 recession (Bell & Blanchflower, 2009). Research implies the 2007-09 recession led to stress, food insecurity, morbidity, sedentary lifestyles, lower use of medical services, and loss of health insurance (Lusardi et al, 2010; Nord et al, 2009; Cawley et al, 2011; Colman & Dave, 2011; Currie & Telkin, 2011; Deaton, 2011; Holahan, 2011). These statistics imply that the current cohort of school-leavers may experience persistent, negative career and health effects as a result of entering a fragile labor market.

FIGURE 1.1. National unemployment rate: 1950-2010



Notes: Data are drawn from the Bureau of Labor Statistics Historical Unemployment Rate data series (series number LNS14000000). The early 1980s recession (July 1981-November 1982) is indicated with dashed lines and the late 2000s recession (December 2007- June 2009) is indicated with dotted lines.

Previous literature suggests that the link between leaving school in a bad economy and age 40 health may operate, at least partially, through career, marriage, and education outcomes. Leaving school in a bad economy leads to a higher probability of unemployment and a low-quality job (e.g., lower wage, less satisfying, less likely to offer health-related benefits, more harmful work environment) in the short run as there are few open jobs from which to choose. Labor studies show that labor market frictions limit the ability of workers to shift into better jobs as the economy rebounds, leaving workers persistently stuck in low-wage and low-quality jobs (e.g., Oyer 2006; 2008; Mansour, 2009; Genda et al, 2010; Kahn, 2010; Schoar & Zuo, 2011; Oreopolous et al, 2012). I employ a broad definition of labor market frictions: any deviation from perfect worker mobility between jobs. In a spot market only contemporary shocks affect career outcomes while frictions (e.g., imperfect information, signaling, implicit contracts, internal labor markets, human capital accumulation) suggest that leaving school when the state unemployment rate is high may persistently affect outcomes. See Baker et al (1994), Oyer (2006; 2008), or Kahn (2010) for a comprehensive review of labor market frictions. The career effects are economically meaningful. Kahn (2010), using the same data set that I analyze in this study, finds that among white male college graduates a 1 percentage point increase in the state unemployment rate at school-leaving is associated with an annual wage loss of 2.5-9% and a less prestigious career 15 years later. A robust health economics literature shows that income is positively associated with health; job attributes (benefits, satisfaction, hours worked, working conditions) affect health after conditioning on income; and job loss/unemployment negatively affects health beyond what is predicted by standard income effects. Additionally, leaving school in a bad economy may affect marriage and education by altering marriage market opportunities or the opportunity cost of attaining additional education.

I draw data from the recently available, geocoded National Longitudinal Survey of Youth 1979 Cohort (NLSY79) Age 40 Health supplement. The supplement is well-suited to my research objectives: it contains rich information on age 40 health, detailed educational and labor market histories, and comprehensive background information. I model age 40 health outcomes as a function of leaving school in a bad economy and use macroeconomic fluctuations between 1976 and 1992 as a quasi-experiment to identify health effects. The early 1980s recession lies in the middle of this period (July 1982-November 1983). My findings are may be informative to current policy makers because the early 1980s is arguably the most similar economic event in recent history to the 2007-09 recession.

My results suggest that men who leave school in a bad economy have worse health, particularly mental health, at age 40 than men who do not. The magnitude of the estimated effects is similar in absolute value to having a mother with a high school diploma relative to a mother who dropped out of high school. The results are robust to various econometric specifications, including the use of instrumental variables to correct for the potential endogeneity of the timing and location of leaving school. Health effects vary by race/ethnicity, family background, occupation, and skill. I identify career, marriage, fertility, education, and self-esteem outcomes as potential mechanisms.

This study contributes to several economic literatures. First, it adds to the labor literature on the effects of leaving school in a bad economy (e.g., Oyer, 2006;

Kahn, 2010; Oreopolous et al, 2012), as it identifies a previously unrecognized consequence: health. Second, it relates to the robust economics literature that documents the health effects of career outcomes (Duleep, 1986; Fletcher et al, 2010). Third, this study extends the active, although mixed, line of research that examines the health effects of macroeconomic fluctuations (Ruhm, 2000; Miller et al, 2009; Huff Stevens et al, 2011; Davalos et al, forthcoming). Fourth, this paper contributes to the growing interest in sensitive developmental periods (Heckman, 2007; Almond & Currie, 2011): neuroscience research documents that school-leaving age is an important period for emotional development (Dahl, 2004). While the literature has largely ignored the potential health effects of leaving school in a bad economy, it does suggest that a relationship may exist.

This paper is structured as follows. Section II reviews channels from leaving school in a bad economy to later health. Data and measures are described in Section III; Section IV reports the empirical model and results. Robustness checks are reported in Section V and Section VI concludes.

II. Conceptual Framework

Leaving school in a bad economy may have a persistent negative effect on health through several channels. Workers who leave school in a bad economy earn less than workers who do not. Empirical health studies document a positive association between income and health (Duleep, 1986; Deaton & Paxson, 1998; Deaton, 2002; Gardner & Oswald, 2007; Currie, 2009). Job displacement is associated with income loses, morbidity, unhealthy behaviors, suicide, and mortality

(Jacobson et al, 1993; Eliason & Storrie, 2009; Kuhn et al, 2009; Strully, 2009; Sullivan & von Wachter, 2009; Classen & Dunn, 2012; Davis & von Wachter, 2011; Deb et al, 2011). Job churning is correlated with poor health (Strully, 2009), workers with past unemployment spells have worse mental health than continuously employed workers (Knabe & Ratzel, 2009), and the unemployed have particularly poor health (Dooley et al, 1996). If mental health declines in bad economies (Ruhm, 2000), workers may be less productive and receive a low wage regardless of the number of jobs available (Ettner et al, 1997).

Low-quality jobs may lack benefits and provide unhealthy working conditions because working conditions are correlated within jobs (Kenkel & Supina, 1992). Workers who leave school in a bad economy work in less prestigious careers and are less likely to be promoted (Oyer, 2006; 2008; Kwon et al, 2010; Kahn, 2010). In the U.S. health insurance is highly tied to employment. If men who leave school in a bad economy systematically lack access to health insurance, they may experience health losses (Franks et al, 1993; Currie & Gruber, 1996). Unsafe and unpredictable work is linked with worse health, and cumulative exposure may be particularly harmful (Fletcher et al, 2007; Fletcher & Yamaguchi, 2010). Long work hours are associated with obesity (Courtemanche, 2009), repetitive tasks and work overload are correlated with sleep problems (Knudsen et al, 2007), and job satisfaction is associated with reporting good health (Fischer & Sousa-Poza, 2009).

Leaving school in a bad economy may affect health through marriage, fertility, and education. These outcomes are associated with good health (Grossman, 1972; Gardner & Oswald, 2004; Fuchs, 2004; Cutler & Lleras-Muney, 2008). Marriage and fertility decisions may be postponed or a worker may choose not to enter into these family arrangements. For example, a man who leaves school in a bad economy and obtains a low paying job may have poor marriage market opportunities. He may decide to delay or forego marriage and/or fertility. Similarly, workers who leave school in a bad economy may seek out education as lower wages reduce opportunity costs or alternatively they may be unable to finance education with lower earnings. Additionally, psychological research associates unmet expectations with poor health (Aron & Aron, 1987). If men who leave school in a bad economy are unable to achieve expectations they may experience poor health.

Health shocks received during the school-leaving period may have persistent effects absent labor market frictions. Economists are increasingly interested in sensitive periods of development: some skills or traits are most easily acquired at specific stages (Heckman, 2007). Although much of this line of research has focused on early childhood (Almond & Currie, 2011), neuroscience research shows that typical school-leaving age (late-teens to mid-20s) is an important period for prefrontal cortex development. This region of the brain governs emotion and self-regulation (Dahl, 2004).[2]

Several surprising studies call to question whether leaving school in a bad economy will hurt health. Work by Ruhm (1995; 2000; 2003; 2005) and others (e.g., Dehejia & Lleras-Muney, 2004; Dave & Rashad-Kelly, 2010) shows that physical health and health behaviors improve while mortality declines as the unemployment

[2] The prefrontal cortex region of the brain has been implicated in planning complex cognitive behaviors, personality expression, decision making, and moderating social behavior. The primary activity of the prefrontal cortex region is development of thoughts and actions that meet internal objectives.

rate rises. Several studies that use the Social Security Notch, Earned Income Tax Credit, or inheritances as exogenous sources of variation in income show no, or a negative, relationship between income and health (Snyder & Evans, 2006; Schmeiser, 2009; Cawley et al, 2010; Kim & Ruhm, 2012). The RAND health insurance experiment, a large-scale experiment than randomized levels of health insurance across individuals, finds that large differences in co-payments lead to small differences in health outcomes (Newhouse, 1993). Recent quasi-experimental studies challenge the causal role of education in health production that is predicted by the Grossman model (Grossman, 1972; Albouy & Lequien, 2009; Clark & Royer, 2010; McCary & Royer, 2011). Taken together, these unexpected findings imply that leaving school in a bad economy may have no effect, or a positive effect, on later health. Thus, whether, or by how much, leaving school in a bad economy hurts health is an empirical question.

III. Empirical Model and Data

This study takes a standard health production function as a starting point (Rosenzweig & Schultz, 1983). Health is produced using market (e.g., medical care) and non-market (e.g., exercise) inputs. Consumers are endowed with a health stock and value health and other goods. They make consumption decisions to maximize utility given preferences, prices, the budget set, and the health production function. I choose covariates to proxy for these factors. Recently, economists have extended the Rosenzweig & Schultz (1983) framework by building in sensitive developmental periods: health shocks received during such periods persistently affect health

(Heckman, 2007; Almond & Currie, 2011). These extensions capture the developmental importance of school-leaving age (Dahl, 2004). Features of these models provide my conceptual framework and guide my empirical analysis.

I take a reduced form approach rather than estimate a full structural model that specifies all causal pathways from leaving school in a bad economy to health at age 40. I exploit a quasi-experiment, macroeconomic fluctuations between 1976 and 1992 and variation across states, to identify net health effects. My primary objective is to estimate the total effect of leaving school in a bad economy on health, not the partial effect after conditioning on career outcomes, marital status, and other endogenous health determinants. In the core models, I control only for exogenous and predetermined variables. One interpretation of the parameter estimates is the health effect after men make endogenous decisions about employment, marriage, and other health determinants. In a later section I investigate potential mechanisms to shed light on how the net relationship may operate.

I estimate the following health production to model age 40 health as a function of leaving school in a bad economy:

$$H\_40_{is} = \alpha_0 + \alpha_1 U_{is} + X_{is}\alpha_2 + S_i\alpha_3 + D_i\alpha_4 + \varepsilon_{is} \qquad (1)$$

H_40_{is} is an age 40 health outcome for individual i in school-leaving state s. The key explanatory is U_{is}, an indicator for leaving school in a bad economy. I compare the age 40 health of men who left school in a bad economy with the age 40 health of men who did not. X_{is} is a vector of personal characteristics for individual i in school-leaving state s. S_i and D_i are school-leaving state and year fixed effects. ε_{is} is the error term. Inclusion of school-leaving state fixed effects implies that within school-leaving state variation in unemployment rates is used to identify health effects while school-leaving year fixed effects capture national trends in the macroeconomy. The key identifying assumption is presented in Equation (2):

$$Cov(U_{is}, \varepsilon_{is} | X_{is}, S_i, D_i) = 0 \qquad (2)$$

In words, the bad economy indicator is uncorrelated with the error term after conditioning on personal characteristics and various fixed effects. Equations are estimated with least squares. [3] For interpretation I take log transformations of the functioning scales, parameter estimates have the interpretation of demi-elasticities. Results are robust if I use the raw scales. I use sample weights that account for survey design and attrition, and I cluster standard errors by the school-leaving state.[4]

I draw data from the recently available, geocoded National Longitudinal Survey of Youth 1979 Cohort Age 40 Health supplement. Respondents were administered the supplement once between 1998 and 2006 at or about age 40. The original sample consisted of 12,686 youth 14 to 22 in 1979. Excluding subsamples dropped by the NLSY79 for financial reasons (military sample in 1984 and low income white sample in 1991) leaves 9,964 eligible respondents. 8,465 respondents (85% of the eligible sample) completed the supplement, including 4,169 men. 4,161 men have valid school-leaving information. 14 men with missing instrumental variable information (described later) are excluded. I focus on the persistent effects of leaving school in a bad economy and retain men who left school 15 years or more

[3] Results are consistent, and more precisely estimated, if a count data model (e.g., Poisson, negative binomial) is used to estimate the depressive symptom equation.
[4] Unweighted results are consistent with the weighted results. Similarly, clustering at the school-leaving state/year level provides consistent standard error estimates as reported in this study. Results are available on request.

prior to the supplement (*n*=4,047). I exclude men who left school before 1976 (*n*=273) as state-level unemployment rates from the BLS are available beginning in this year. The analysis sample includes 3,774 men (Table 1.1) who left school between 1976 and 1992. Results are robust to alternative sample exclusion rules and are available on request.

TABLE 1.1 NLSY79 analysis sample

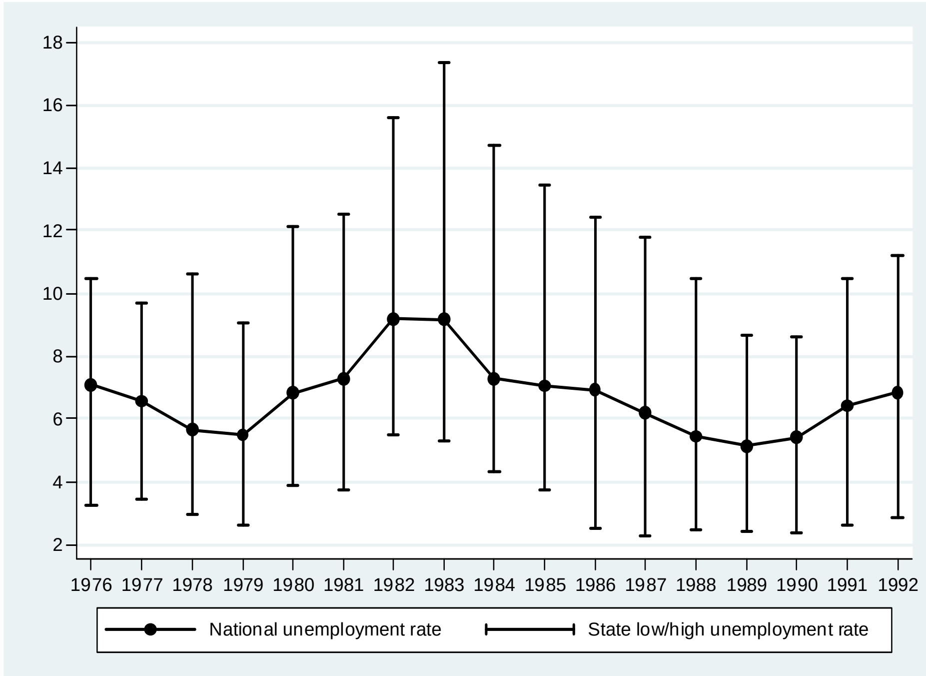
Sample	Observations
Original NLSY79 sample	12686
Sample remaining after NLSY dropped samples [1]	9964
Completed Age 40 Health supplement	8465
Men who completed Age 40 Health supplement	4169
Men with valid school-leaving information	4161
Men with valid instrumental variable information	4147
Men out of school 15+ years at supplement	4047
Men who left school 1976 and onwards	3774

[1] 1079 members of the military (*n*=1208) and white low income (*n*=1643) subsamples were not followed after 1984 and 1991 respectively.

The supplement is well suited to my research objectives. The timing and content permit investigation of persistent effects on multiple health outcomes. The education history and geocodes allow me to locate the exact state, month, and year of school-leaving and take advantage of monthly variation in economic conditions. The NLSY79 is a longitudinal survey and offers a substantial advantage over cross-sectional surveys: cross-sectional data typically do not include school-leaving time or location. Researchers must impute this information, introducing measurement error (Genda et al, 2010). The detailed labor market and demographic histories allow me to analyze potential mechanisms. The rich personal information allows me to control for a comprehensive set of covariates. The NLSY79 has several notable limitations: a small sample size, respondents complete the supplement only once, age 40 may be too young to observe health effects, and health outcomes are self-reports rather than objective measurements.

Figure 1.2 presents the quasi-experiment: the seasonally adjusted national unemployment rate is plotted between 1976 and 1992 (the years in which my sample left school). This period covers more than a full business cycle and provides substantial variation in economic conditions to identify the health effects of leaving school in a bad economy. The U.S. experienced high inflation (late 1970s); three recessions (a mild recession in 1980, a severe recession between July 1982 and November 1983, and a moderate recession between July 1990 and March 1991); and a period of economic growth (late-1980s). States were differentially impacted by these events: bars indicate the yearly minimum and maximum state unemployment rates. Because the early 1980s recession lies in the middle of the quasi-experiment, my findings are potentially useful for current policy makers. Although the U.S. has undergone substantial economic and demographic changes in the last 30 years, the early 1980s recession is arguably the most informative economic event for anticipating the persistent impact of the 2007-09 recession. Both recessions were long contractions (16 and 18 months, the average recession between 1945 and 2000 lasted 11 months [NBER, 2011]) and generated high, sustained unemployment. There are differences between these two contractions. For example, the early 1980s recession was concentrated in the manufacturing sector while the 2007-09 recession was more broadly experienced.

FIGURE 1.2. National and high/low state unemployment rate: 1976-1992



Notes: Data are drawn from the Bureau of Labor Statistics Historical Unemployment Rate data series (series number LNS14000000).

The dependent variables in this study are three health outcomes.[5] The Short Form 12 physical score ("physical functioning") ranges from 0 to 100 and is calibrated such that 50 is the average score (Quality Metric, 2011). The score is calculated from 12 questions on physical functioning from the individual's perspective (see Table 1.2 for questions). The Center for Epidemiologic Studies Depression score ("depressive symptoms") measures depressive symptoms experienced in the past week (Radloff, 1977). Scores are based on 7 items and range from 0 to 24; higher scores indicate worse health (see Table 1.3 for questions). Weighted summary statistics are reported in Table 1.4. Sample means for physical functioning, mental functioning, and depressive symptoms are 53.1, 54.0, and 2.63. These statistics suggest that the sample

[5] In unreported analyses I have analyzed self-reported health and chronic conditions. Results are robust and available upon request.

is in good health, not surprising as respondents are approximately 40 years old at the time of the supplement.

TABLE 1.2 SF12 items

Number	Question wording
1	In general, would you say your health is ....
	The following items are activities you might do during a typical day. Does your health limit you in these activities?
2	......Moderate activities, such as moving a table, pushing a vacuum cleaner, bowling or playing golf?
3	......Climbing several flights of stairs?
	During the past 4 weeks, have you had any of the following problems with your work or other regular daily activities as a result of your physical health?
4	..... Accomplished less than you would like?
5	.... Were limited in the kind of work or other activities?
	During the past 4 weeks, have you had any of the following problems with your work or other regular daily activities as a result of any emotional problems (such as feeling depressed or anxious)? (Please answer YES or NO for each question.)
6	.... Accomplished less than you would like?
7	.... Didn't do work or other activities as carefully as usual?
8	During the past 4 weeks, how much did pain interfere with your normal work (including both work outside of the home and housework)?
	The next questions are about how you feel and how things have been with you during the past 4 weeks. for each question, please give the one answer that comes closest to the way you have been feeling. How often during the past 4 weeks....
9	.... Have you felt calm and peaceful?
10	.... Did you have a lot of energy?
11	.... Have you felt down-hearted and blue?
12	During the past 4 weeks, how much of the time has your physical health or emotional problems interfered with your social activities (like visiting with friends, relatives, etc.)?

TABLE 1.3. Center for Epidemiologic Depression Studies items

Number	Wording
	Now I am going to read a list of the ways that you might have felt or behaved recently. After each statement, please tell me how often you felt this way during the past week.
1	I did not feel like eating; my appetite was poor.
1A	I felt that I could not shake off the blues, even with help from my family or friends.
2	I had trouble keeping my mind on what I was doing.
3	I felt depressed.
4	I felt that everything I did was an effort.
5	My sleep was restless.
5A	I felt lonely.
6	I felt sad.
7	I could not get "going".

TABLE 1.4. Weighted health outcomes

	N	Mean	SD	Min	Max
Physical functioning	3742	53.1	6.78	11.6	68.4
Mental functioning	3742	54.0	7.34	10.1	72.0
Depressive symptoms	3717	2.63	3.61	0	21

The key covariate is an indicator for leaving school with a state unemployment rate of 9% or higher ("bad economy"). I focus on the first period of school-leaving, this occurs only once for each respondent. I include both graduates and drop outs in the school-leaving definition. I first use responses to survey items asked between 1979 and 1998 on education history to identify the first time the respondent left school (i.e., exact month and year): respondents are allowed to return to school and remain in the sample.[6] Next, I use the geocodes to determine the state of school-leaving.[7] Respondents who left school between 1976 and 1978 are assigned the 1979 interview state. This imputation assumes that individuals do not move across state lines between school-leaving and 1979 and arguably does not introduce substantial measurement error: only 5.9% of school-leaving age men (13 to 28 years) report a between state move in the past year. The interview state is assigned to respondents who left school in 1979 and thereafter. The sample average school-leaving state unemployment rate is 7.48, and 19.7% of my sample left school in a bad economy.

Although no there is no single measure of economic activity, the unemployment rate provides a reasonable proxy. It is one of the variables used by the

[6] Non-enrolled respondents were asked "When were you last enrolled in regular school? What was the month and year?" I require that respondents remain out of school for at least two years. I locate the period of school-leaving using current enrollment items for respondents who do not provide school-leaving month and year (*n*=235). I define the period of school-leaving for these respondents as the first period they report enrollment in t-1, non-enrollment in t, and non-enrollment in t+1. I exclude respondents who report never being enrolled in school.

[7] In a robustness check I replace the state of residence with the college state for college attenders. Results are consistent.

NBER Business Cycle Dating Committee (2010).[8] The unemployment rate is easily understood, as the rate increases fewer people are employed, and is commonly used to measure economic activity in empirical research (Beaudry & DiNardo, 1991; Ruhm, 2000; Kahn, 2010). Monthly state unemployment data are available from the BLS. The bad economy indicator parallels the current economic climate: the national unemployment rate was 8.2% in March 2012; thus findings are relevant for current school-leavers.

The regression models include school-leaving state and year fixed effects; time since school-leaving; demographics (race/ethnicity, foreign birth, school-leaving age and education); age 14 characteristics (parental education; access to newspapers, magazines, or a library card; living with biological parents; number of siblings; rural residence; residence in the South); a proxy for health endowment (mother or father experiencing a major health problem by the Age 40 Health supplement); a proxy for baseline health (height in inches[9]); and a proxy for ability (age-standardized 1980 Armed Forces Qualification Test (AFQT) score[10]). I include indicators for missing

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[8] The NBER Business Cycle Dating Committee considers GDP, GDI, manufacturing and trade sales, industrial production, income, hours worked, and employment (NBER, 2010). Many of these measures are not available by state. Measuring school-leaving economic conditions with per capita income, male unemployment rate, employment growth rates, and employment-to-population rates produced consistent results. In a sensitivity check I replace the interview state with the college state, when different, for college attenders. Results are consistent.

[9] I use height from the 1981 round, the first year height information is collected. If height is missing in 1981, I assign the 1982 value. Height in the NLSY79 is self-reported. I calculate predicted height based on race, ethnicity, and age following equations developed by Cawley & Burkhauser (2006). Results are robust if I use self-reported height.

[10] The AFQT is a multiple-choice test that measures arithmetic reasoning, mathematics knowledge, paragraph comprehension, and word knowledge used to determine eligibility for enlistment in the U.S. Armed Forces. 94% of the sample completed the AFQT in 1980. Missing AFQT scores were imputed using race/ethnicity, and birth year and month fixed effects. The AFQT is age-standardized as respondents completed the test at different ages (15 to 23). Age-standardized AFQT=(AFQT-[mean AFQT for age])/(AFQT SD for age). Results are unchanged if the raw score is used.

covariates and assign missing observations the sample mean (continuous) or mode (binary).

IV. Results

Table 1.5 reports regression results. Leaving school in a bad economy is associated with 1.8% lower physical functioning, 1.2% lower mental functioning, and 0.333 more depressive symptoms at age 40. These parameter estimates imply 1.2% to 12.6% reductions in health and are similar in absolute value as having a mother with a high school diploma relative to a mother with less than high school. I report results from a short specification (covariates include school-leaving state and year fixed effects). Results generated in the short specification are nearly identical to the core results. This finding is consistent with the assumption that men who leave school in a bad economy are not systematically different from men who leave school in stronger economies.

TABLE 1.5. Effect of leaving school in a bad economy on health at age 40: Core regression results

	Log(physical functioning)	Log(mental functioning)	Depressive symptoms
Mean	53.1	54.0	2.63
Full specification	-0.018*	-0.012*	0.333*
	(0.010)	(0.007)	(0.186)
Short specification	-0.018*	-0.016**	0.333*
	(0.010)	(0.007)	(0.175)
N	3742	3742	3717

Notes: Standard errors are clustered by school-leaving state and reported in parentheses. ***; **; * = statistically significant at the 1%; 5%; 10% level.

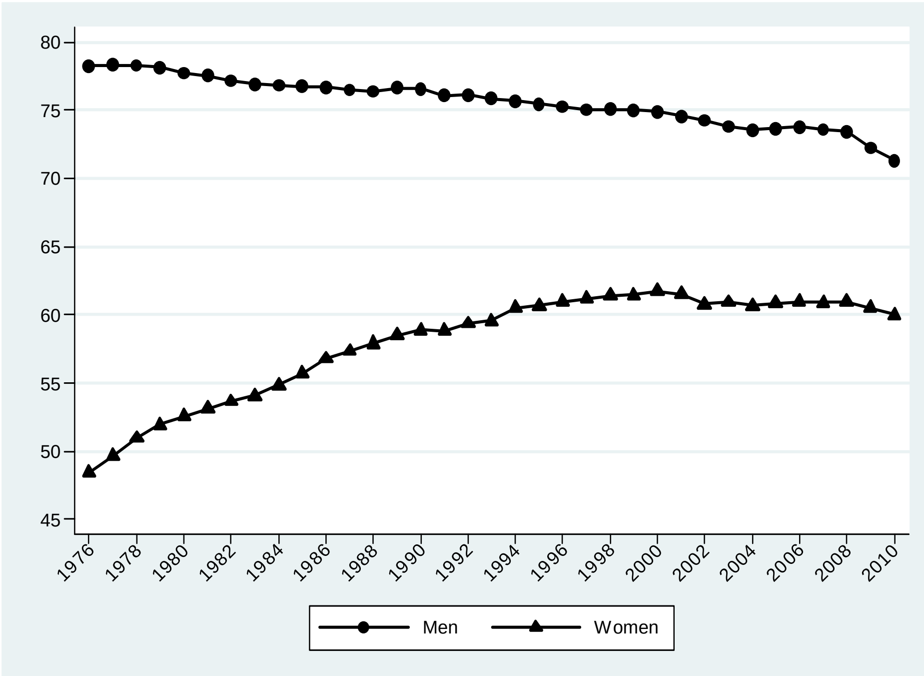
Table 1.6 reports results for women. The parameter estimates suggest that women are largely unaffected by leaving school in a bad economy, at least as measured by the health outcomes I investigate. Leaving school in a bad economy is hypothesized to operate partially through career and marriage outcomes. Historically, women are less likely to participate in the labor market than men. Figure 1.3 plots labor force participation rates by sex between 1976 and 2010. In all years women have a lower probability of participating in the labor market than men: in 1976 48% of women participated in the labor market while 78% of men participated. Leaving school in a bad economy may not have a substantial effect on women's careers as women have less to lose than men. Economic theories of marriage predict that career outcomes are stronger marriage determinants for men than women (Becker, 1981). Labor market participation patterns and economic theory are consistent with studies that document no robust associations between economic conditions at school-leaving and employment or marriage among women (Kondo, 2008; Hershbien, 2012). I focus on men in the remainder of this study, although examining the relationship between leaving school in a bad economy and women's health is an interesting direction for future research.

TABLE 1.6. Effect of leaving school in a bad economy on health at age 40 among women

	Log(physical functioning)	Log(mental functioning)	Depressive symptoms
Mean/proportion	51.8	52.0	3.68
Estimate	-0.007	-0.013	-0.094
	(0.015)	(0.018)	(0.349)
N	3844	3844	3827

Notes: Estimate is parameter estimate on bad economy indicator. Standard errors are clustered by school-leaving state and reported in parentheses. ***; **; * = statistically significant at the 1%; 5%; 10% level.

FIGURE 1.3. Labor force participation by sex: 1976-2010



Notes: Data are drawn from a special request by the author from the Bureau of Labor Statistics (Data on Employment Status by State and Demographic Group).

In Table 1.7 I report results using indicators for school-leaving state unemployment rates of 5 to < 6%; 6 to < 7%; 7 to <8%; 8 to <9%; 9 to <10%; 10 to <11%; and 11% + with <5% as the omitted category to motivate the bad economy indicator. Negative health effects generally do not emerge at lower levels of unemployment (less than 8%) but become evident at higher levels (8-9% +). Results are robust if the linear state unemployment rate is used. Defining a bad economy as a school-leaving state unemployment rate of 10% or higher generally implies larger effects than those estimated in the core model. For parsimony, I report results using the 9% bad economy indicator.

TABLE 1.7. Effect of leaving school in a bad economy on health at age 40: Various measures of a bad economy

	Log(physical functioning)	Log(mental functioning)	Depressive symptoms
Mean	53.1	54.0	2.63
Indicators			
5 - <6%	-0.007	-0.013	0.094
	(0.011)	(0.018)	(0.347)
6 - <7%	-0.006	-0.009	0.171
	(0.012)	(0.015)	(0.305)
7 - <8%	-0.012	-0.001	-0.289
	(0.014)	(0.015)	(0.305)
8 - <9%	-0.003	-0.025	0.050
	(0.016)	(0.017)	(0.316)
9 - <10%	-0.022	-0.016	-0.099
	(0.017)	(0.016)	(0.356)
10 - <11%	-0.017	-0.029	0.320
	(0.021)	(0.024)	(0.502)
11% +	-0.028	-0.031	0.389
	(0.021)	(0.018)	(0.368)
Unemployment rate	-0.004**	-0.003*	0.019
	(0.002)	(0.002)	(0.043)
Unemployment rate >10%	-0.013	-0.020	0.544***
	(0.011)	(0.011)	(0.192)
N	3742	3742	3717

Notes: Standard errors are clustered by school-leaving state and reported in parentheses. Omitted category in indicator school-leaving unemployment rate regression is a school-leaving state unemployment rate less than 5%. ***; **; * = statistically significant at the 1%; 5%; 10% level.

Tables 1.8 through 1.11 report health effects by race/ethnicity (non-white vs. white), family background (proxied by father's education: less than high school vs. high school or more), expected occupation (blue collar vs. white collar[11]), and skill at school-leaving (no college degree vs. college graduate). Labor studies document that career effects are largest among white and high skill workers. First, I stratify the sample by race/ethnicity. Interesting heterogeneity emerges. Non-white men who leave school in a bad economy may experience better physical functioning than non-white men who leave school in a stronger economy. However, they have lower

[11] In 1979 respondents were asked what they expected to be doing at age 35. One response was "working." Those who reported working were asked their expected occupation. I code managerial, professional, or technical sales as white collar.

mental functioning and more depressive symptoms by age 40. White men who leave school in a bad economy have worse health across all domains than white men who do not. These results imply that physical health effects are concentrated among white men while mental health effects are experienced by all men, but the effect may be largest among non-whites. Stratifying the sample by family background, occupation, or skill suggests that negative health effects are generally concentrated among men with more high skill fathers, men who expect a white collar job, and men with a college degree. My findings are broadly consistent with labor studies that identify the largest career effects among high skill men, although the mental health results by race/ethnicity are somewhat different (e.g., Kondo, 2007; Oyer, 2006; Kahn, 2010).

TABLE 1.8. Effect of leaving school on health at age 40 by race/ethnicity

	Non-white			*White*		
	N	Mean	Estimate	N	Mean	Estimate
Log(physical functioning)	1859	52.21	0.022 (0.017)	1883	53.32	-0.026** (0.012)
Log(mental functioning)	1859	54.22	-0.023 (0.015)	1883	53.96	-0.009 (0.010)
Depressive symptoms	1842	3.10	0.806* (0.413)	1875	2.51	0.213 (0.187)

Notes: Standard errors are clustered by school-leaving state and reported in parentheses. ***; **; * = statistically significant at the 1%; 5%; 10% level.

TABLE 1.9. Effect of leaving school on health at age 40 by family background

	Father less than high school			*Father high school or higher*		
	N	Mean	Estimate	N	Mean	Estimate
Log(physical functioning)	2932	52.69	-0.014 (0.016)	810	54.03	-0.025 (0.019)
Log(mental functioning)	2932	54.00	-0.010 (0.009)	810	54.05	-0.024 (0.015)
Depressive symptoms	2910	2.83	0.224 (0.265)	807	2.16	0.775** (0.333)

Notes: Standard errors are clustered by school-leaving state and reported in parentheses. ***; **; * = statistically significant at the 1%; 5%; 10% level.

TABLE 1.10. Effect of leaving school on health at age 40 by expected occupation

	Do not expect white collar			*Expect white collar*		
	N	Mean	Estimate	N	Mean	Estimate
Log(physical functioning)	1406	52.36	0.008 (0.013)	1802	53.68	-0.021 (0.014)
Log(mental functioning)	1406	53.74	0.027** (0.013)	1802	54.11	-0.026* (0.015)
Depressive symptoms	1393	3.05	0.091 (0.430)	1789	2.35	0.518* (0.298)

Notes: Standard errors are clustered by school-leaving state and reported in parentheses. ***; **; * = statistically significant at the 1%; 5%; 10% level.

TABLE 1.11. Effect of leaving school on health at age 40 by skill

	Less than college			*College graduate*		
	N	Mean	Estimate	N	Mean	Estimate
Log(physical functioning)	3187	52.63	-0.018 (0.012)	555	54.97	-0.009 (0.015)
Log(mental functioning)	3187	53.92	-0.008 (0.007)	555	54.37	-0.025 (0.017)
Depressive symptoms	3164	2.86	0.281 (0.211)	553	1.70	0.530 (0.469)

Notes: Standard errors are clustered by school-leaving state and reported in parentheses. ***; **; * = statistically significant at the 1%; 5%; 10% level.

The second objective of this study is to shed light on potential mechanisms for the net relationship between leaving school in a bad economy and health at age 40. The net relationship is hypothesized to operate, at least partially, through career outcomes, marriage, fertility, education, and unmet expectations. I investigate potential mechanisms in this section. Potential mechanisms (measured at the supplement) including labor supply (full time employment, weeks worked per year, hours worked per week), income (hourly wage, poverty), job attributes (white collar job, satisfaction, health insurance, visiting a doctor in the past year, shift work), job churning (number of jobs across the career, tenure), marital status (married, divorced, never married), fertility (any children), education obtained after school-leaving, and self-esteem are constructed.[12] Self-esteem is measured using the Rosenberg (1965) scale. The scale is based on 10 items and higher scores indicate higher levels of self esteem. Table 1.12 reports the list of scale items.

TABLE 1.12. Rosenberg (1965) self-esteem scale questions

Number	Wording
	Now I'm going to read a list of opinions people have about themselves. After I read each statement, please tell me how much you strongly agree, agree, disagree or strongly disagree with these opinions.
1	I feel that I'm a person of worth, at least on equal basis with others.
2	I feel that I have a number of good qualities.
3	All in all, I am inclined to feel that I am a failure.
4	I am able to do things as well as most other people.
5	I feel I do not have much to be proud of.
6	I take a positive attitude toward myself.
7	On the whole, I am satisfied with myself.
8	I wish I could have more respect for myself.
9	I certainly feel useless at times
10	At times I think I am no good at all

Mechanisms are 1) regressed on the bad economy indicator in separate regressions and 2) are entered into the health production function as additional regressors. If these outcomes are mechanisms they should be predicted by the bad economy indicator and health effects should decline after their inclusion in the health production function.

Tables 1.13 and 1.14 report results from the first exercise. Men who leave school in a bad economy are less likely to work full time, work fewer hours per week, are more likely to live in poverty, are more likely to work an irregular shift, exhibit evidence of higher job churning (lower tenure at the current job, more jobs across the

[12] Full time employment is defined as working 35+ hours per week. Annual weeks worked, weekly hours, and total number of jobs across the career relate to all jobs. Wage, occupation (professional, managerial, or technical sales), job satisfaction, health insurance, shift work, and tenure pertain to the primary job. The CPI is used to convert hourly wages into 2008 dollars. Wages less (more) than $1 ($1000) are excluded. Additional schooling is the difference between years of school-leaving at the supplement and school-leaving.

career), and are less likely to be married (this effect operates through foregone marriage). Such men may work fewer weeks per year, earn lower wages, be less likely to work in a white collar job, work in less satisfying jobs, have less access to employ-sponsored health insurance, use fewer medical services, be less likely to have children, be less likely to attain additional schooling, and have lower self-esteem; but these relationships are imprecisely estimated.

TABLE 1.13. Effect of leaving school on labor market outcomes at age 40

	N	Mean/proportion	Estimate
Full time employment	3768	0.80	-0.042** (0.017)
Annual weeks worked	3433	49.31	-0.119 (0.296)
Weekly hours	3768	41.28	-2.144* (1.129)
Log(hourly wage)	3467	22.77	-0.015 (0.041)
Poverty	3475	0.09	0.044*** (0.014)
White collar job	3370	0.50	-0.008 (0.026)
Satisfied with job	3534	0.49	-0.003 (0.034)
Health insurance	3165	0.84	-0.015 (0.023)
Visit doctor in the past year	3475	0.58	-0.020 (0.039)
Irregular shift	3354	0.21	0.042** (0.020)
Number of jobs	3774	11.33	1.078** (0.423)
Tenure (weeks)	3500.	383.16	-39.730* (20.315)

Notes: Standard errors are clustered by school-leaving state and reported in parentheses. ***; **; * = statistically significant at the 1%; 5%; 10% level.

TABLE 1.14. Effect of leaving school on marriage, fertility, education, and self-esteem outcomes at age 40

	N	Mean/proportion	Estimate
Married	3774	0.64	-0.062** (0.029)
Never married	3774	0.17	0.043* (0.022)
Divorced	3774	0.19	0.020 (0.023)
Children	3774	0.75	-0.029 (0.023)
Additional education	3774	0.34	-0.015 (0.026)
Self-esteem scale	3280	23.84	-0.505 (0.311)

Notes: Standard errors are clustered by school-leaving state and reported in parentheses. ***; **; * = statistically significant at the 1%; 5%; 10% level.

Results from the second exercise are reported in Table 1.15: mechanisms are entered into the core model as additional regressors. Parameter estimates generated in these models may not have a causal interpretation: the mechanisms are determined by the bad economy indicator ("bad controls"); inclusion of bad controls in a regression model can lead to biased estimates (Angrist & Pischke, 2009). These mechanisms explain some, but not all, of the association between leaving school in a bad economy and health at age 40: estimates decline by 44% to 67%. These findings suggest that the net relationship operates at least partially through career, marriage, fertility, education, and self-esteem.

TABLE 1.15. Effect of leaving school on health at age 40, augmented health production function

	N	Mean	Core	+Mechanisms	% $\Delta\beta$
Log(physical functioning)	3742	53.1	-0.018* (0.010)	-0.010 (0.011)	-44.44
Log(mental functioning)	3742	54.0	-0.012* (0.007)	-0.004 (0.009)	-66.67
Depressive symptoms	3717	2.63	0.333* (0.186)	0.114 (0.197)	-65.77

Notes: Standard errors are clustered by school-leaving state and reported in parentheses. % $\Delta\beta$ $=(\beta_M-\beta_C)/(\beta_C)*100$. ***; **; * = statistically significant at the 1%; 5%; 10% level.

V. Robustness Checks

This section reports results from a series of robustness checks. An obvious concern is that the time or location of school-leaving is endongeous to the contemporaneous unemployment rate. School-leavers may engage in endogenous timing (enrolling in additional schooling, dropping out, forced out for financial reasons) or migration (moving to a stronger labor market). The intuition for the sign of the potential bias is as follows. School-leavers who avoid bad economies have characteristics (ability, financial resources, forethought) that permit avoidance behavior. These characteristics are arguably positively correlated with age 40 health. The rich background information contained in the NLSY79 allows me to control, at least partially, for these characteristics. To the extent that characteristics remain unobservable, failure to account for them is expected to bias least squares estimates away from zero.[13] Classical measurement error in the school-leaving variables, a familiar feature of survey data, will attenuate least squares estimates towards zero. If measurement error is non-classical, the direction of the bias is ambiguous (Bound et al, 2001). It is not clear *a priori* which effect will dominate.

Table 1.16 reports a basic test for endogenous timing and migration. The sample is split between men who left school in a bad economy and men who did not. If school-leavers are avoiding bad economies, differences in observable characteristics should exist between men who leave school in a bad economy and men who do not.

[13] Assume the true model takes the following form: $H\_40_{is}=\alpha_0 + \alpha_1 U_{is} + \alpha_2 C_{is}$; $\alpha_1<0; \alpha_2>0$. C_{is} is scalar that captures characteristics that allow avoidance behavior and are positively associated with age 40 health. The estimated model can be written as $H\_40_{is}=\beta_0 + \beta_1 U_{is}$; $\beta_1 <0$. The association between omitted and included regressor takes the form $C_{is}=\gamma_0 + \gamma_1 U_{is}$; $\gamma_1<0$. The omitted variable formula implies $\beta_1 = \alpha_1 + \gamma_1 * \alpha_2$; $\gamma_1 * \alpha_2 <0$: least squares estimates are biased away from zero.

However, these groups of men are broadly similar in terms of their observable characteristics and there are few statistically significant differences. Differences may be an artifact of the early 1980s recession: this recession was concentrated in northern states with relatively high prevalence of whites and relatively low prevalence of Hispanics (e.g., Michigan). The Appendix reports an exploratory analysis into endogenous timing and migration using proxies for these behaviors contained in the NLSY79. The results suggest that endogenous behavior is not driving the findings.

TABLE 1.16. Test of covariate balance

	School-leaving UE<9%	School-leaving UE>=9%	Difference
Unemployment rate at school-leaving	6.56	11.2	-4.64*
Time since school-leaving	22.4	22.1	0.3
School-leaving year	1980.2	1981.4	-1.2
Age at school-leaving	19.0	19.2	-0.2
White	0.78	0.83	-0.05*
Black	0.14	0.13	0.01
Hispanic	0.070	0.041	0.029*
Foreign born	0.042	0.037	0.005
Less than high school at school-leaving	0.19	0.13	0.06*
High school at school-leaving	0.47	0.47	0
Some college at school-leaving	0.15	0.17	-0.02
College graduate at school-leaving	0.19	0.22	-0.03
Father’s years of schooling	12.0	11.9	0.1
Father’s years of schooling missing	0.100	0.085	0.015
Mother’s years of schooling	11.7	11.8	-0.1
Mother’s years of schooling missing	0.048	0.060	-0.012
Magazines age 14	0.67	0.71	-0.04
Magazines age 14 missing	0.0079	0.0045	0.0034
Newspaper age 14	0.84	0.87	-0.03
Newspaper age 14 missing	0.0012	0.0045	-0.0033
Library card age 14	0.75	0.71	0.04
Library card age 14 missing	0.0021	0.0051	-0.003
Live with biological parents age 14	0.76	0.76	0
Live with biological parents age 14 missing	0.0026	0.00040	0.0022
Number of siblings	3.28	3.18	0.1
Number of siblings missing	0.00038	0	0.00038
Rural residence at age 14	0.22	0.24	-0.02
Rural residence at age 14 missing	0.0026	0.0029	-0.0003
Reside in South at age 14	0.31	0.25	0.06*
Reside in South at age 14 missing	0.028	0.018	0.01
Father major health problem	0.39	0.36	0.03
Father major health problem missing	0.028	0.034	-0.006
Mother major health problem	0.41	0.40	0.01
Mother major health problem missing	0.071	0.071	0
Height in 1981	69.8	69.6	0.2
Height in 1981 missing	0.0090	0.0081	0.0009
AFQT score standardized	0.28	0.36	-0.08
Observations	3083	691	

Notes: *Statistically different from zero at 1% confidence interval.

I use two-stage least squares to address remaining endogeneity concerns and measurement error in the school-leaving variables.[14] Two variables are used to

[14] Results are consistent if a two-step residual inclusion (2RSI) estimator is employed. Terza et al (2008) argue that the 2SRI estimator is more appropriate if the potentially endogenous variable is binary as in my model. Angrist (2001) contends that two stage least squares can generate consistent estimates of causal effects in the presence of a binary endogenous variable.

instrument for leaving school in a bad economy: 1) on-time state unemployment rates and 2) respondent-expected state unemployment rates. I create on-time state unemployment rates using birth date, state of residence at age 14, and education at school-leaving.[15] Respondents are assigned the state unemployment rate they would face if they left school on time. For example, I assign a college graduate the June (modal school-leaving month in my sample) unemployment rate in the year he turned 22 (modal school-leaving age for college graduates in my sample) in the state of residence at age 14. State of residence at age 14 is used as it is arguably exogenous to the school-leaver while the school-leaving state is suspect. I make similar assignments for all educational levels. I construct respondent-expected[16] state unemployment rates using birth date, reported educational expectations in 1979, and state of residence at age 14. In 1979 respondents were asked "What level of education do you expect to attain?" The respondent-expected state unemployment rate is the unemployment rate the respondent would have faced had he left school at his expected time. For example, I assign a respondent who reported that he expected to complete high school the June unemployment rate in the year he turns 18 in state of residence at age 14. I make similar assignments for all levels of expected education. The compliers are men who form an educational plan and do not deviate in response to contemporaneous macroeconomic fluctuations. The time since school-leaving is also potentially endogenous. I instrument time since school-leaving with the on-time and respondent-

[15] I use 1965 compulsory schooling laws to calculate school start dates (see Appendix Table 1 in Cascio & Lewis, 2006).

[16] I would like to thank David Card for suggesting this instrumental variable.

expected time since school-leaving variables.[17] The school-leaving state and year fixed effects are replaced with age 14 state fixed effects and on-time and respondent-expected year fixed effects. Standard errors are clustered by the age 14 state of residence.

The key identifying assumption in this model is, after conditioning on personal characteristics and various fixed effects, the IVs are correctly excludable from the health production function. The IVs must predict the endogenous regressor to consistently estimate a local average treatment effect for the compliers. Table 1.17 presents results from first-stage regressions: in separate equations I regress the bad economy indicator on the IV and covariates using a linear probability model. The IVs are strong, with *F*-statistics well above 10 (Stock et al, 2002): 99.83 and 82.23. A 1 percentage point increase in the on-time and respondent-expected state unemployment rate is associated with a 10.5 and 8.4 percentage point increase in the probability of leaving school in a bad economy. By construction there is less variation in the instrumented probability of leaving school in a bad economy than in the bad economy indicator: on-time and respondent-expected school-leaving occurs in June, while monthly variation is used to construct the bad economy indicator. Thus, the IV parameters may be less precisely estimated than the core model parameters.[18]

[17] I define the on-time since school-leaving as the supplement year minus the on-time school-leaving year; I define respondent-expected time since school-leaving analogously.
[18] Instrumental variable estimators typically use less variation than used by the least squares estimator to estimate effects. The former set of estimators relies on variation in the potentially endogenous regressor induced by the instrumental variable. Alternatively, the least squares estimator uses all variation in the potentially endogenous variable.

TABLE 1.17. Effect of instrumental variables on the probability of leaving school in a bad economy

	On-time	Respondent-expected
Proportion	0.197	0.197
IV	0.105***	0.084***
	(0.011)	(0.009)
F-statistic	99.83	82.23
Observations	3774	3774

Notes: Standard errors are clustered by age 14 state and reported in parentheses. ***; **; * = statistically significant at the 1%; 5%; 10% level.

The IV, reported in Table 1.18, results are consistent with the core results (Table 1.5). IV estimates imply that leaving school in a bad economy leads to 3.3% lower physical functioning and 0.429 more depressive symptoms. Surprisingly, leaving school in a bad economy leads to a 0.5% increase in mental functioning; although the wide confidence interval contains zero and cannot rule out a negative effect consistent with the core results. Results are robust if I estimate just-identified models. Table 1.19 reports results from an intent-to-treat model. Parameter estimates represent an averaged effect between compliers who are fully affected by leaving school in a bad economy and non-compliers who are unaffected. Results are consistent with the core models: by age 40 men who left school in a bad economy have worse physical functioning, mental functioning, and depressive symptomatology.

TABLE 1.18. Effect of leaving school on health at age 40: IV model

	N	Mean	Core model	IV model
Log(physical functioning)	3742	53.1	-0.018*	-0.033
			(0.010)	(0.024)
Log(mental functioning)	3742	54.0	-0.012*	0.005
			(0.007)	(0.015)
Depressive symptoms	3717	2.63	0.333*	0.429
			(0.186)	(0.428)

Notes: Standard errors are clustered by age 14 state and reported in parentheses. ***; **; * = statistically significant at the 1%; 5%; 10% level.

TABLE 1.19. Effect of leaving school on health at age 40: Intent-to-treat model

	N	Mean	Core model	On time	Respondent expected
Log(physical functioning)	3742	53.1	-0.018*	-0.013	-0.008
			(0.010)	(0.010)	(0.008)
Log(mental functioning)	3742	54.0	-0.012*	-0.0003	-0.002
			(0.007)	(0.010)	(0.009)
Depressive symptoms	3717	2.63	0.333*	0.051	0.099
			(0.186)	(0.210)	(0.246)

Notes: Standard errors are clustered by age 14 state and reported in parentheses. ***; **; * = statistically significant at the 1%; 5%; 10% level.

Next, I use a family fixed effect estimator to assess persistent health effects of leaving school in a bad economy. This estimator controls for all family-invariant characteristics that are correlated with leaving school in a bad economy and age 40 health; thus the family fixed estimator may better control for individual heterogeneity than the core model. Variation is generated by siblings who face different economic conditions at school-leaving: I compare the age 40 health of siblings who left school in a bad economy with the age 40 health of siblings who did not. The sibling sample includes 1,137 male, biological siblings from 526 families with 2 to 5 male children identified in the 1979 roster. Results, reported in Table 1.20, are consistent with the core findings (Table 1.5). I present results generated in the sibling sample with and without the family fixed effect, results are broadly consistent across the specifications although estimated effects are larger after including the family fixed effect. In the preferred specifications that include a family fixed effect, men who leave school in a bad economy have 4.1% lower physical functioning, 6.8% lower mental functioning, and 0.942 more depressive symptoms than siblings who leave school in a stronger economy. These results are consistent with the core findings.

TABLE 1.20. Effect of leaving school on health at age 40: Family FE model

	Core model			*Family fixed effect model*			
	N	Mean	Estimate	N	Mean	No FE	FE
Log(physical functioning)	3742	53.1	-0.018* (0.010)	1128	53.35	-0.012 (0.022)	-0.041 (0.042)
Log(mental functioning)	3742	54.0	-0.012* (0.007)	1128	54.19	-0.051*** (0.019)	-0.068* (0.034)
Depressive symptoms	3717	2.63	0.333* (0.186)	1124	2.60	0.609 (0.374)	0.942 (0.812)

Notes: Standard errors are clustered by school-leaving state and reported in parentheses. ***; **; * = statistically significant at the 1%; 5%; 10% level.

Table 1.21 reports results from models that use the school-leaving region unemployment rate to define a bad economy at school-leaving. These models permit endogenous migration within the region. School-leaving region fixed effects replace state fixed effects and robust standard errors are reported; covariates are unchanged. Results are broadly consistent with the core results: men who leave school in a bad economy have 1.0% lower physical functioning, 0.6% lower mental functioning, and 0.215 more depressive symptoms at age 40 than men who left school in a stronger economy. The estimates are imprecise, not surprising as I rely on within region variation to identify health effects.

TABLE 1.21. Effect of leaving school on health at age 40: Regional unemployment rates

	N	Mean	Core model	Region UE rate
Log(physical functioning)	3742	53.1	-0.018* (0.010)	-0.010 (0.011)
Log(mental functioning)	3742	54.0	-0.012* (0.007)	-0.006 (0.012)
Depressive symptoms	3717	2.63	0.333* (0.186)	0.215 (0.270)

Notes: Robust standard errors reported in parentheses. ***; **; * = statistically significant at the 1%; 5%; 10% level.

An important source of bias is between school-leaving state differences in difficult to observe characteristics that are correlated with leaving school in a bad economy and age 40 health. The core model includes school-leaving state fixed effects and controls for time invariant differences. My sample left school between 1976 and 1992, and state characteristics may have changed over this period. In this section I first estimate the core model without school-leaving state fixed effects and second augment the core model with school-leaving state-specific linear time trends. The former specification uses variation between school-leaving states and variation within school-leaving state over time to identify health effects. The latter specification uses variation off a school-leaving state linear time trend and controls for time-varying between school-leaving state differences; this specification is more demanding on the data than the core model. Results, reported in Table 1.22, are consistent with the core results regardless of how I model between state differences.[19] One interpretation of these results is that the core findings are not driven by difficult-to-observe between state differences.

TABLE 1.22. Effect of leaving school on health at age 40: School-leaving state unobservable characteristics

	N	Mean	Core model	No state fixed effect	State-specific time trend
Log(physical functioning)	3742	53.1	-0.018* (0.010)	-0.014* (0.007)	-0.011 (0.011)
Log(mental functioning)	3742	54.0	-0.012* (0.007)	-0.006 (0.007)	-0.009 (0.008)
Depressive symptoms	3717	2.63	0.333* (0.186)	0.177 (0.159)	0.306 (0.195)

Notes: Estimate is parameter estimate on bad economy indicator. Standard errors are clustered by school-leaving state and reported in parentheses. ***; **; * = statistically significant at the 1%; 5%; 10% level.

[19] School-leaving state-specific time trends soak up much of the variation in school-leaving economic conditions. Variance inflation factors, a common metric for testing collinearity, are often above 10. This is a sign of problematic collinearity and ill-conditioning (Anderson & Wells, 2007). These data limitations can lead to inflated standard errors.

I next perform a series of falsification tests. I select two outcomes that should not be predicted by leaving school in a bad economy: natural blond hair and blue eyes (coded one for blond hair or blue eyes; zero otherwise). 13% of the sample has blond hair and 29% have blue eyes. Results (Table 1.23) suggest no relationship between leaving school in a bad economy and these outcomes: parameter estimates are small and indistinguishable from zero.

TABLE 1.23. Effect of leaving school in a bad economy on hair and eye color

	Blond hair	Blue eyes
Proportion	0.13	0.28
Bad economy	-0.019	0.006
	(0.020)	(0.024)
Observations	3643	3645

Notes: Standard errors are clustered by school-leaving state and reported in parentheses. ***; **; * = statistically significant at the 1%; 5%; 10% level.

This section tests whether bias from non-random attrition is driving the findings. In 2006, the last year the supplement was fielded, the NLSY79 retention rate was 77% and 85% of eligible respondents completed the supplement. I use sample weights, which correct for attrition, in all analyses. To test whether attrition remains a concern, I compare demographics of completers and attritors; regress the probability of attriting on the bad economy indicator; and re-estimate the core model assigning attritors 1) a healthy outcome and 2) an unhealthy outcome (bounding exercise). Healthy outcomes are physical and mental functioning scores at the 90th percentile, and depressive symptoms set to zero. I define unhealthy outcomes symmetrically: physical and mental functioning (depressive symptoms) at the 10th (90th) percentile. Table 15 reports the comparison of observable characteristics by attrition status. I do not include respondents dropped by the NLSY79 for financial reasons or respondents I exclude from the sample due to missing variables, time since school-leaving, or school-leaving year. These groups are broadly similar in terms of observable characteristics (Table 1.24). Results reported in Tables 1.25 and 1.26 imply that leaving school in a bad economy does not strongly predict attrition and results are robust to the bounding exercise. One reason for a non-interview is mortality. Interestingly, men who leave school in a bad economy may be a higher risk of all-cause mortality than men who leave school in a stronger economy. The parameter estimate is imprecise, but I can rule out a zero effect. This relationship may explain the modest association between leaving school in a bad economy and the probability of attrition.

TABLE 1.24. Observable characteristics by attrition status

	Complete (n=3774)	Attrite (n=761)	Difference
White	0.79	0.81	-0.02
Black	0.15	0.13	0.02
Hispanic	0.064	0.060	0.004
Foreign born	0.041	0.054	-0.013
Father’s education	12.1	12.1	0
Father’s education missing	0.094	0.11	-0.016
Mother’s education	11.8	11.8	0
Mother’s education missing	0.050	0.053	-0.003
Magazines age 14	0.68	0.67	0.01
Magazines age 14 missing	0.0070	0.0061	0.0009
Newspaper age 14	0.85	0.86	-0.01
Newspaper age 14 missing	0.0020	0.0034	-0.0014
Library card age 14	0.74	0.77	-0.03
Library card age 14 missing	0.0029	0.0028	0.0001
Live with biological parents age 14	0.76	0.76	0
Live with biological parents age 14 missing	0.0023	0.0030	-0.0007
Rural residence at age 14	0.22	0.20	0.02
Rural residence at age 14 missing	0.0028	0.0020	0.0008
Reside in South at age 14	0.30	0.25	0.05*
Reside in South at age 14 missing	0.024	0.026	-0.002
Height in 1981	69.8	69.5	0.3
Height in 1981 missing	0.0084	0.060	-0.0516*
Age-standardized AFQT score	0.31	0.31	0

Notes:*=statistically different from zero at the 1% level.

TABLE 1.25. Effect of leaving school in a bad economy on probability of attrition and all-cause mortality at age 40

	Attrite	Mortality
Proportion	0.18	0.04
Bad economy	0.023	0.019
	(0.019)	(0.013)
Observations	4535	4535

Notes: Standard errors are clustered by school-leaving state and reported in parentheses. ***; **; * = statistically significant at the 1%; 5%; 10% level.

TABLE 1.26. Effect of leaving school on health at age 40: Bounding exercise

	N	Mean	Core	N	Healthy outcome	Unhealthy outcome
Log(physical functioning)	3742	53.1	-0.018*	4535	-0.010	-0.023**
			(0.010)		(0.011)	(0.010)
Log(mental functioning)	3742	54.0	-0.012*	4535	-0.006	-0.017*
			(0.007)		(0.012)	(0.009)
Depressive symptoms	3717	2.63	0.333*	4535	0.215	0.450**
			(0.186)		(0.270)	(0.217)

Notes: Standard errors are clustered by school-leaving state and reported in parentheses. ***; **; * = statistically significant at the 1%; 5%; 10% level.

In this section I report results from a factor analysis. Variation in my three selected health outcomes may be driven by a smaller set of latent variables. Factor analysis models these latent variables as a linear combination of my three observed health outcomes. I use the principal components method to analyze the correlation matrix between my three health outcomes. I retain two factors. Factor loadings, which report correlations between the factors and health outcomes, are reported in Table 1.27. Factor 1 loads most heavily on mental functioning and depressive symptoms. Factor 2 loads most heavily on physical functioning. Results (Table 1.28) indicate that men who leave school in a bad economy have lower measures of latent health, particularly as measured by Factor 1 which captures dimensions of mental health, by age 40 than men who do not.

TABLE 1.27. Factor loadings

Health outcome	Factor 1	Factor 2
Physical functioning	0.079	0.219
Mental functioning	0.388	-0.105
Depressive symptoms	-0.473	-0.154

TABLE 1.28. Effect of leaving school on health at age 40: Factor analysis

	Factor 1	Factor 2
Mean	0.026	0.023
Estimate	-0.077**	-0.023
	(0.034)	(0.015)
Observations	3696	3696

Notes: Estimate is parameter estimate on bad economy indicator. Standard errors are clustered by school-leaving state and reported in parentheses. ***; **; * = statistically significant at the 1%; 5%; 10% level.

VII. Discussion

This study provides the first published evidence on the persistent health effects of leaving school in a bad economy. Findings contribute to the labor literature examining career effects of leaving school in a bad economy; literatures on the health effects of employment and the macroeconomy; and the growing health literature that investigates important development periods. My results suggest that by age 40 men who left school in a bad economy have worse health, particularly mental health, than men who did not. The effect sizes are similar in absolute value as having a mother with a high school diploma relative to a mother who dropped out of high school. Health effects vary by race/ethnicity, family background, occupation, and skill. Supplementary analyses suggest career, marriage, fertility, education, and self-esteem outcomes as mechanisms. Results are robust to various econometric specifications, including the use of instrumental variables to correct for the potential endogeneity of the school-leaving variables. Factor analysis suggests that effects may be concentrated among mental health domains. The current findings imply that labor studies underestimate the full cost of leaving school in a bad economy: consequences extend beyond the career and into the health domain.

Recent work on avoidance behavior suggests that individuals respond to health shocks in ways that minimize health damage (Niedell, 2009; Moretti & Niedell, 2011). Failure to account for such avoidance behavior can lead to underestimates of the true effect of a health shock. For example, men who are initially placed in an unhealthy job because they left school in a bad economy may undertake actions (diet, exercise, stress management) to offset health effects. The avoidance literature implies that the parameter estimates have the interpretation of lower bounds and the true health effects of leaving school in a bad economy are larger than those estimated in this study.[20]

Policy makers may find my results useful. There is general concern for the economic well-being of the current cohort of school-leavers (e.g., von Wachter, 2010). My findings suggest that the full effects of leaving school extend beyond career outcomes. Government policies should take into account the magnitude and persistence of health effects associated with leaving school in a bad economy: effects potentially represent substantial health losses (the core estimates imply a 1.2% to 12.6% reduction in health outcomes relative to sample means, and the avoidance literature suggests that these underestimate the true health effects) that are evident more than 20 years after school-leaving. Health policy can be packaged with career

[20] Following Moretti and Niedell (2011) a standard health production function can be augmented to allow avoidance behavior: $H=H(S*A,X)$ where H is health, S is a health shock, A is avoidance behavior, and X is all other health determinants. To observe the impact of avoidance behavior, one can take the derivative with respect to the shock: $\partial H/\partial S = \partial H/\partial S + \partial H/\partial A * \partial A/\partial S$. The first term is the biological effect and the second term is the avoidance term. If $\partial H/\partial S>0$, then $\partial H/\partial A*\partial A/\partial S$ is likely > 0 (individuals undertake action to minimize damage imposed by a health shock). Failing to account for the second term will lead to an underestimate of the health effect.

re-orientation policies (von Wachter, 2010). For example, general information on how long a recovery period may last, health effects of a low-quality job, steps individuals can take to offset negative effects, and access to health programs (e.g. stress management) can be provided to labor market entrants. Locating health information at unemployment centers my increase awareness.

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APPENDIX: EXPLORATORY ANALYSIS OF SCHOOL-LEAVING TIME AND LOCATION

School-leavers may avoid leaving school in a bad economy through endogenous timing (enrollment, dropping out of school to take a job, leaving school for financial reasons) and migration (moving across state lines). In this section I first review the published U.S. literature on endogenous behavior. Second, I report an analysis of these behaviors using proxies contained in the NLSY79.

The empirical evidence in the U.S. suggests that delaying school-leaving through enrollment is not common. Corman (1983) shows that the state unemployment rate is not a strong correlate of college or vocational school attendance among men. Betts and McFarland (1995) find that a 1% increase in the state unemployment rate is associated with a 0.5% increase in full-time attendance at community colleges among recent high school graduates. Genda et al (2010) identify little correlation between the state unemployment rate and enrollment among men in the Current Population Survey. Card and Lemieux (2000) show that the state unemployment rate at age 18 is a modest predictor of high school completion, but not college outcomes, among young men. Kahn (2010) finds that the state unemployment rate at age 18 is a weak predictor of college completion in the NLSY79. Students may decide to drop out of school to take advantage of a strong economy or may be forced out of school during a bad economy if they cannot afford education costs. Published evidence suggests the former dominates: the probability of dropping out increases modestly as the unemployment rate declines (Rumberger, 1983; Rees & Mocan, 1997). School-leavers may move from a weak to a strong labor market at school-leaving. In 2000 42 million Americans moved. 11% reported moving because of a new job or to look for work, while 51.6% moved for housing-related reasons (U.S. Census, 2001). These statistics suggest that a minority of movers move for work-related reasons.

The NLSY79 contains proxies for endogenous timing and migration. Table 1.29 reports results from regressing an indicator for each behavior (enrollment, leaving school to take a job, leaving school for financial reasons, and moving across state lines) on an indicator for a current state unemployment rate of 9% or higher among school-leaving age men (13 to 28 years). Results are consistent if a lagged indicator for a bad economy is used. No statistically significant relationships emerge. An exception is moving: men are *less* likely to move across state lines when the unemployment rate is high (17% less likely relative to the sample mean). School-leaving cohort (men who left school in the same year) size is compared with the national unemployment rate. If school-leavers are avoiding bad economies through endogenous timing cohorts should be large in low unemployment years. Table 1.30 suggests this is not the case: two of the largest cohorts occurred in the highest unemployment rate years (1982, 1983). 36% of the sample left school in recessions of the early 1980s while 8.6% left in the low employment years of the late 1980s (1985-1989). Regressing school-leaving cohort size on the national unemployment rate reveals a positive relationship (beta=48.96, robust se=33.89): cohort size *increases* as the national unemployment rate rises. Economic conditions at age 14 are uncorrelated with education or age at school-leaving (see Table 1.31), suggesting that economic conditions experience during youth are not strong predictors of age or educational attainment at school-leaving.

TABLE 1.29. Effect of a bad economy on enrollment, dropping out, leaving school for financial reasons, and migration

	Currently Enrolled	Drop out	Financial difficulty	Move across state lines
Proportion	0.24	0.08	0.07	0.06
Bad economy	0.002	-0.003	0.014	-0.010**
	(0.007)	(0.013)	(0.016)	(0.004)
Sample	Full	Left school	Left school	Full
Observations	58193	5687	5687	60903

Notes: All models estimated with a linear probability model and control for personal characteristics and state and year fixed effects. Full sample includes all men of school-leaving age (13 to 28 years); left school sample includes men who left school since last interview. Standard errors clustered by state and reported in parentheses. ***;**;*= statistically significant at the 1%; 5%; 10% confidence level.

TABLE 1.30. School-leaving cohort size and the national unemployment rate

Year	School-leaving cohort size	National unemployment rate
1976	258	7.09
1977	342	6.57
1978	459	5.64
1979	543	5.49
1980	452	6.81
1981	473	7.28
1982	426	9.18
1983	301	9.16
1984	182	7.27
1985	121	7.05
1986	89	6.92
1987	55	6.18
1988	32	5.44
1989	30	5.13
1990	9	5.41
1991	0	6.42
1992	2	6.84

Notes: A school-leaving cohort is a sample of men who left school in the same year.

TABLE 1.31. Effect of a bad economy at age 14 on school-leaving age and years of education

	School-leaving age	School-leaving years of education
Mean	19.04	12.77
Bad economy	0.131	-0.025
	(0.138)	(0.103)
N	3774	3774

Notes: Standard errors are clustered by school-leaving state and reported in parentheses. ***; **; * = statistically significant at the 1%; 5%; 10% level.

Taken together the published literature and analysis using the NLSY79 suggests that U.S. school-leaving men in the mid-1970s to late 1980s did not substantially alter school-leaving time or location through enrollment, dropping out, or moving. Nor were these men forced out of school in bad economies. Interestingly, these men were *less* likely to move and school-leaving cohort sizes were *larger* when the unemployment rate was high.

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CHAPTER 2

DOES LEAVING SCHOOL IN A BAD ECONOMY AFFECT HEALTH BEHAVIOR MARKERS?

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ABSTRACT

This study tests the persistent effect of macroeconomic fluctuations at leaving school on three markers of health behavior: smoking, binge drinking, and obesity. Data are drawn from the geocoded National Longitudinal Survey of Youth 1979 Cohort. I exploit macroeconomic fluctuations at school leaving between 1976 and 1995 to identify effects. I proxy macroeconomic fluctuations with the state unemployment rate. I find that leaving school when the state unemployment rate is high leads to an increase in the probability of binge drinking and a decrease in the probability of obesity in middle age. Health behavior marker effects are concentrated among college educated men. Supplementary analyses document career and marriage outcomes as potential mechanisms. These findings suggest an unanticipated consequence of the 2007-09 recession: increased binge drinking and lower body weight among the current cohort of school leaving men.

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I. Introduction

This study estimates the effect of macroeconomic fluctuations at school leaving on three markers of health behavior: smoking, binge drinking, and obesity. Several empirical patterns motivate this study: leaving school when the unemployment rate is high has negative career and health effects; individual career outcomes and health are correlated; and macroeconomic fluctuations affect health. I proxy macroeconomic fluctuations at school leaving with the state unemployment rate. I compare health behavior markers at middle age of those who left school when the unemployment rate was high with those who left school when the unemployment rate is low. I use macroeconomic fluctuations between 1976 and 1995 to identify persistent health behavior marker effects.

Despite receiving substantial research and policy attention, rates of smoking, binge drinking, and obesity remain above nationally stated objectives (USHHS, 2010). As documented in Table 2.1, these health behavior markers are associated with 631,000 deaths and $236 billion (2008 dollars) in health care costs annually. 21.8% of Americans smoke[22] (MMWR, 2010) and smoking is the leading cause of preventable death and disease in the United States (MMWR, 2010; USHHS, 2010). 14.3% of adults report binge drinking[23] in the past 30 days (Naimi, et al, 2003). Binge drinking is defined by the National Institute on Alcohol Abuse and Alcoholism (NIAAA) as a pattern of drinking that brings an individual's blood alcohol concentration to 0.08 gram percent or more (NIAAA, 2004). Consuming five [four] or more alcoholic

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[22] Smokers are defined as adults aged >=18 who reported having smoked >=100 cigarettes in their lifetime and now smoke every day or some days (MMWR, 2010).
[23] Drinking 5 [4] or more drinks in one drinking session for men [women].

drinks within two hours for men [women] generates this level of blood alcohol concentration for the average adult. Binge drinking is associated with injuries, alcohol poisoning, sexually transmitted diseases, cardiovascular diseases, liver disease, unintended pregnancies, and impaired driving (Naimi, et al, 2003). Recent data suggests that 35.5% of men and 35.8% of women are obese[24] (Flegal et al, 2012). Obesity is associated with morbidity, mortality, poor labor market outcomes, and increased health care costs (Cawley, 2004; Malnick & Knobler, 2006; Flegal et al, 2007; Dixon, 2010; Cawley & Meyerhoefer, 2012). Understanding determinants of smoking, binge drinking, and obesity is important for effective health policy, containing future health care costs, and improving population health.

TABLE 2.1. Deaths and health care costs attributable to health behavior markers

Health behavior marker	Annual deaths	Annual health care costs (2008 dollars)
Smoking	443,000[1]	$79 B[4]
Binge drinking	76,000[2]	$10 B[5]
Obesity	112,000[3]	$147B[6]

[1]Adhikari et al (2008); [2]Midanik et al (2004); [3]Flegal et al (2005); [4]Miller et al (1999); [5]USDHHS (2000); [6]Finkelstein et al (2009).

My findings imply that leaving school when the state unemployment rate is high increases the probability of binge drinking and decreases the probability of obesity in middle age. Consistent with labor studies that document large, negative career effects for high skill (college graduates, MBAs, PhDs) men, health behavior marker effects are concentrated among college educated men. My preferred specification implies that a 1 percentage point increase in the state unemployment rate at school leaving leads to a 2.8 percentage point increase in the probability of binge

[24] Obesity is defined as a Body Mass Index (BMI) of 30 or more. BMI=(weight in pounds)*703/(height in inches)^2.

drinking and a 5.1 percentage point decrease in the probability of obesity at middle age among college educated men. This affect is observed 17 to 33 years after leaving school when men are 43 to 51 years old. I find no evidence that the state unemployment rate at school leaving affects women's health behavior markers. This non-result is consistent with labor studies that document no association between macroeconomic fluctuations at school leaving and career outcomes among women (Kondo, 2007; Hershbein, 2012). Supplementary analyses suggest that the net effect may operate through career and marriage outcomes. Men that leave school when the state unemployment rate is high work fewer weeks per year, are less likely to be satisfied with their job, are less likely to have flexible work hours, and are less likely to be married in middle age than their counterparts who leave school when the state unemployment rate is low. Results are robust to various econometric techniques, including instrumental variables that account for the potential endogeneity of the time and location of school leaving. My findings suggest that college educated men in the current cohort of school-leavers are persistently more likely to binge drink, but less likely to be obese, in middle age than college educated men in adjacent cohorts.

This paper is structured as follows. Section II reports the conceptual framework. The empirical model and data are described in Section III and Section IV reports results. Robustness checks are reported in Section V and Section VI concludes.

II. Conceptual Framework

This section reviews several lines of research that link macroeconomic fluctuations at school leaving with health behavior markers. Labor studies document that workers who leave school in a bad economy have persistently worse career outcomes and effects are concentrated among high skill (college graduates, MBAs, PhDs) men (Oyer, 2006; 2008; Kahn, 2010; Genda et al, 2011; Oreopolous et al, 2012). Frictions in the labor market prevent workers from shifting to a better job when the economy rebounds. I employ a broad definition of labor market frictions: any deviation from perfect worker mobility between jobs. In a spot market only contemporary shocks affect career outcomes while frictions (e.g., imperfect information, signaling, implicit contracts, internal labor markets, human capital accumulation) suggest that leaving school when the state unemployment rate is high may persistently affect outcomes. See Baker et al (1994), Oyer (2006; 2008), or Kahn (2010) for a comprehensive review of labor market frictions. Kahn (2010), using the same data analyzed in the current paper (NLSY79), finds that a 1 percentage point increase in the school leaving unemployment rate leads to a 2.5-9% lower wage up to 15 years later among white male college graduates. Economic theory and empirical evidence imply that as income rises, all else equal, the demand for health will increase (Grossman, 1972; Duleep, 1986). Workers who leave school when the state unemployment rate is high are predicted to have worse health than their counterparts who leave when the state unemployment rate is low.

Low-quality jobs may lack benefits because working conditions are correlated within jobs. For example, small firms that do not offer health insurance are less likely to offer worksite health promotion [exercise, nutrition, blood pressure monitoring, off the job accident reduction] programs (Kenkel & Supina, 1992). Workers who leave school when the state unemployment rate is high may obtain jobs that provide fewer fringe benefits. Public health research implies that workplace health promotion programs can be effective in helping workers quit smoking, reduce problematic alcohol use, and lose weight (Anderson et al, 2009; Webb et al, 2009; Leeks et al, 2010). If workers who leave school when the state unemployment rate is high systematically lack access to workplace health promotion programs, they may experience worse health behavior markers. Although the results are not entirely consistent, the displaced worker literature highlights the health effects of job loss: in addition to lower earnings losing a job leads to mortality, smoking, binge drinking, and obesity (Jacobson et al, 1993; Gallo et al, 2000; Strully, 2009; Sullivan & von Wachter, 2009; Deb et al, 2011). Using administrative data, Sullivan and von Wachter (2009) find that job loss due to plant closure leads to loss in life expectancy of 1.0–1.5 years for a worker displaced at age 40. Features of employment are associated with health, even after conditioning on income. For example, Courtemarche (2009) links long work hours with high body weight, Fletcher et al (2010) find that cumulative exposure to physically demanding work in harmful working conditions leads to lower self-reported health, and Fischer and Sousa-Poza (2009) associate job satisfaction with self-reported health.

Leaving school in a when the state unemployment rate is high may affect health behavior markers through marriage and education. These outcomes are negatively associated with substance use (Gardner & Oswald, 2004; Fuchs, 2004;

Heinz et al, 2009; Cutler & Lleras-Muney, 2010; Cutler et al, 2011), although marriage may be positively associated with body weight (Averett et al, 2008). A worker who leaves school in when the state unemployment rate is high and obtains a low paying job may have poor marriage market opportunities. He may decide to delay or forego marriage. Becker (1981) shows that career outcomes are stronger determinants for male marriage market opportunities than for female opportunities, thus the marriage mechanism may be stronger for men than women. Workers who leave school when the state unemployment rate is high may seek out education as lower wages reduce the opportunity cost of education or alternatively they may be unable to finance education with lower earnings. Although health economics theory implies a causal relationship between education and health (Grossman, 1972), recent empirical research provides mixed support for an education-health relationship (de Walgue, 2007; Grimard & Parent; 2007; Clark & Royer, 2010; Etile & Jones, 2011).

Economists are increasingly interested in 'sensitive' periods of development: some skills or traits are most easily acquired at specific developmental stages (Knudsen et al, 2006; Heckman, 2007; Almond & Currie, 2011). Although much of the economics literature focuses on the importance of early childhood (0 to 5 years), neuroscience research shows that typical school leaving ages (mid-teens to mid-20s) may be a sensitive period for emotional and self-regulation development: prefrontal cortex development occurs at this stage and this region of the brain governs emotion and self-regulation (Dahl, 2004). Health shocks received during this period may have persistent effects.

Although much of the literature suggests that individuals who leave school when the unemployment rate is high are more likely to smoke, binge drink, and be obese, several studies with counter-intuitive findings call to question the direction of the relationship. An active line of research suggests that health behavior markers improve when the state unemployment rate rises (Ruhm, 2003; 2005; Ruhm & Black, 2002). Work by Ettner (1996) implies that income is positively associated with alcohol use. Studies that use the Social Security Notch, Earned Income Tax Credit, or inheritances as exogenous sources of variation in income show no, or a negative, relationship between income and health behavior markers (Schmeiser, 2009; Cawley et al, 2010; Kim & Ruhm, 2012). Bhattacharya & Sood (2005) note that if health insurance premiums do not risk adjust for body weight, access to health insurance may lead to increases in the prevalence of obesity. Thus, while the literature suggests leaving school in when the unemployment rate is high may lead to smoking, binge drinking, and obesity, the direction and magnitude of the relationship is an empirical question.

III. Empirical Model and Data

This study takes a standard health production function as a starting point (e.g., Rosenzweig & Schultz, 1983). Health is produced using market (e.g., medical care) and non-market (e.g., exercise) inputs. Consumers are endowed with a health stock and value health and other goods. They make consumption decisions to maximize utility given preferences, prices, the budget set, and the health production function. Recently, economists have extended this framework by building in sensitive developmental periods: health shocks received during such periods persistently affect health (Knudsen, et al, 2006; Heckman, 2007; Almond & Currie, 2011). These extensions capture the developmental importance of school leaving age identified by neuroscience research (Dahl, 2004). Features of these models guide my empirical analysis.

I take a reduced form approach rather than estimate a full structural model that specifies all causal pathways from macroeconomic fluctuations at school leaving to health behavior markers in middle age. I exploit a quasi-experiment, macroeconomic fluctuations between 1976 and 1995 and variation across states, to identify net effects. My primary objective is to estimate the total effect of macroeconomic fluctuations at leaving school on health behavior markers in middle age, not the partial effect after conditioning on career outcomes, marital status, and other endogenous health determinants. In the preferred specifications, I control only for arguably exogenous and predetermined variables. One interpretation of the parameter estimates is the effect after school-leavers make endogenous decisions about employment, marriage, education, and other health behavior marker determinants. In a later section I investigate potential mechanisms.

I estimate the following health production to model health behavior markers as a function of macroeconomic fluctuations at school leaving:

$$H_{it} = \alpha_0 + \alpha_1 U_i + X_{it}\alpha_2 + S_i\alpha_3 + D_i\alpha_4 + \varepsilon_{it} \qquad (1)$$

H_{it} is a health behavior marker (smoking, binge drinking, or obesity) for individual i in time t. The key explanatory variable is U_i, a measure of macroeconomic fluctuations at school leaving (proxied by the state unemployment rate). I compare the health behavior markers in middle age of respondents who left school when the state unemployment rate was high with those who left school when the state unemployment rate was low. X_{it} is a vector of personal characteristics for individual i in year t. S_i and D_i are school leaving state and year fixed effects. ε_{it} is the error term. Inclusion of state fixed effects implies that within state variation in the unemployment rate is used to identify effects while year fixed effects capture national trends in macroeconomic fluctuations. The key identifying assumption is presented in Equation (2):

$$Cov(U_i,\varepsilon_{it}|X_{it},S_i,D_i)=0 \qquad (2)$$

In words, the state unemployment rate at school leaving are uncorrelated with the error term in the structural equation after conditioning on personal characteristics and various fixed effects. I estimate the health behavior marker equations with weighted linear probability models and cluster standard errors by the school leaving state[25].

I draw data from the geocoded National Longitudinal Survey of Youth 1979 (NLSY79). The NLSY79 is a nationally representative sample consisting of 12,686 youth ages 14 to 22 in 1979. Excluding subsamples dropped by the NLSY79 (military sample in 1984 and low income white sample in 1991) leaves 9,964 eligible respondents. Respondents are interviewed annually between 1979 and 1994, and biennially from 1994 onwards. The most recently available round was fielded in 2008. To focus on the persistent effects of macroeconomic fluctuations at school leaving, I examine health behaviors in the 2008 round when respondents are middle

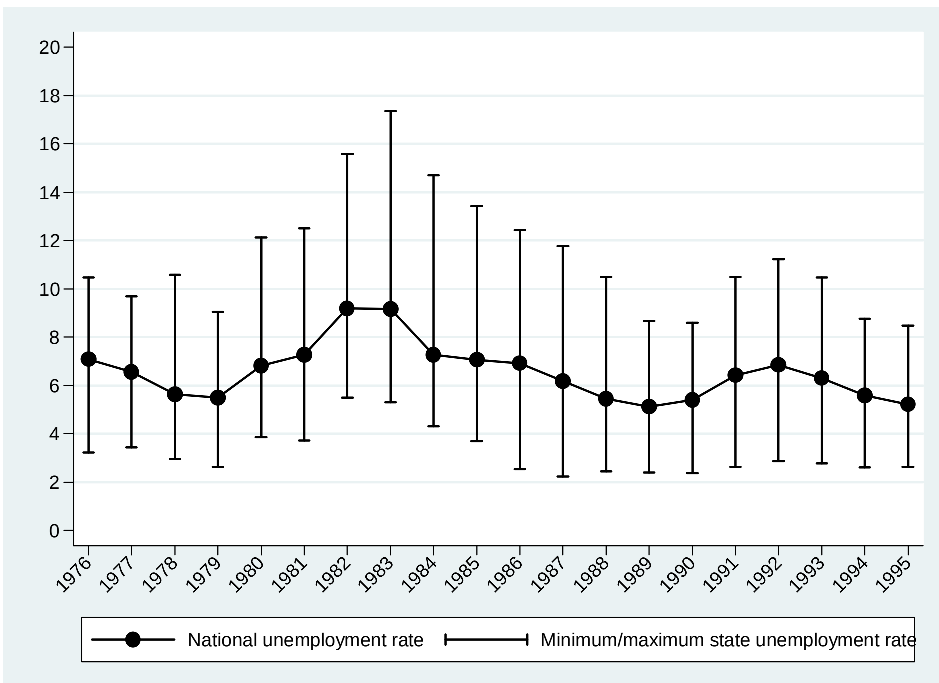
[25] Unweighted results are consistent with weighted results and are available upon request. Similarly, clustering at the school leaving state/year level produces consistent standard error estimates.

aged (43 to 51 years). I exclude observations with missing school leaving information or that were never enrolled in school. I retain observations that left school between age 15 and age 30. Because I use state unemployment rates from the BLS to proxy macroeconomic fluctuations at school leaving and these data are available from 1976 and onward, I exclude those who left school prior to 1976. The analysis sample includes 4000 men and 4132 women. Results are robust to alternative sample selection rules and are available on request.

The NLSY79 is well suited to my research objectives. I am able to examine three health behavior markers: smoking, binge drinking, and obesity. The timing of the NLSY79 allows me to estimate persistent effects; respondents are 43 to 51 years of age and have been out of school for 17 to 33 years in 2008. The education history and geocodes allow me to locate the exact state, month, and year of school leaving and take advantage of monthly variation in unemployment rates. The NLSY79 is a longitudinal survey and offers a substantial advantage over cross-sectional surveys: cross-sectional data typically do not include school leaving time or location. Researchers must impute this information, introducing measurement error (Genda et al, 2010). The detailed labor market and demographic histories allow me to analyze potential mechanisms. The rich personal information allows me to control for a comprehensive set of covariates. The NLSY79 has notable limitations: small sample size and self-reported health measures (Rowland, 1990; Brener et al, 2003).

Figure 2.1 presents the quasi-experiment: the seasonally adjusted national unemployment rate is plotted between 1976 and 1995. The school leaving period covers more than a full business cycle and provides substantial variation in macroeconomic fluctuations. The U.S. experienced three recessions (a mild recession in 1980, a severe recession between July 1982 and November 1983, and a moderate recession between July 1990 and March 1991) and two periods of economic growth (late-1980s and mid-1990s). States were differentially impacted by these events: bars indicate the annual minimum and maximum state unemployment rates. One interpretation of this figure is that the period between 1976 and 1995 provides sufficient variation in the macroeconomic fluctuations to identify effects.

FIGURE 2.1. National and high/low state unemployment rates: 1976-1995



Notes: Data are drawn from the Bureau of Labor Statistics Historical Unemployment Rate data series (series number LNS14000000).

The dependent variables in this study are past 30 day smoking, past 30 day binge drinking (6 or more alcoholic drinks in one drinking session)[26], and obesity (body mass index [BMI]≥30; BMI=[weight in pounds*703]/[height in inches]^2).

[26] The NLSY79 measure of binge drinking differs from the NIAAA definition: 6 or more drinks per drinking session vs 4 [5] drinks in 2 hours for men [women].

Height and weight information is self-reported in the NLSY79. Because such self-reports are known to contain substantial measurement error (Rowland, 1990), I construct predicted BMI from self-reported weight and height (Cawley, 2004; Cawley & Burkhauser, 2006). Results using self-reports are consistent and are available on request.

Although no there is no single best measure of economic activity, the state unemployment rate provides a reasonable proxy. It is one of the variables used by the NBER Business Cycle Dating Committee (2010) to date economic expansions and contractions.[27] The unemployment rate is easily understood, as the rate increases a smaller percentage of people are employed, and it is commonly used to measure economic activity in empirical research (e.g., Ruhm, 2003; Kahn, 2010). Monthly unemployment data at the state level are available from the BLS from 1976 onwards. To capture non-linearities in the relationship between economic conditions at school leaving and later health behavior markers, I create an indicator of a state unemployment rate of 9% or higher. Maclean (2012) finds that this level of unemployment is associated with particularly poor health. The sample average school leaving state unemployment rate is 7.52, and 19.7% of my sample left school in a bad economy.

I include both graduates and drop outs in the school leaving definition. I am interested in the first period of school leaving, this occurs once for each respondent. I

[27] The NBER Business Cycle Dating Committee considers GDP, GDI, manufacturing and trade sales, industrial production, income, hours worked, and employment (NBER, 2010). Many of these measures are not available by state. Measuring school leaving economic conditions with per capita income, male unemployment rate, employment growth rates, and employment-to-population rates produced consistent results. These results are available on request.

use responses to survey items asked between 1979 and 1998 on enrollment history to identify the month and year the respondent left school for the first time. Non-enrolled respondents were asked "When were you last enrolled in regular school? What was the month and year?" I use information contained in these two items to locate the time of school leaving. Respondents are allowed to return to school and remain in the sample. Next, I use the geocodes to determine the state of school leaving. Respondents who left school between 1976 and 1978 are assigned the 1979 interview state. This imputation assumes that individuals do not move across state lines between school leaving and 1979. Violation of this assumption induces measurement error, but only 5.6% of school leaving age respondents (ages 15 to 30 years) report a between state move in the past year in the NLSY79. The interview state is assigned to respondents who left school in 1979 and thereafter. In a sensitivity check I replace the interview state with the college state (when different) for college attenders. Results are consistent and available on request.

The regression models include measures of demographics (race/ethnicity, birth outside the U.S, school leaving age and highest grade completed); family background (parental education, access to cultural materials [magazines, newspapers, library cars], number of siblings); a proxy for ability (Armed Forces Qualification Test [AFQT] score), school leaving state and year fixed effects; and time since school leaving. I include indicators for missing covariates and assign missing observations the sample mean (continuous) or mode (binary).

Weighted summary statistics for men (women) are reported in Table 2.2 (Table 2.3). The prevalence of past 30 day smoking, past 30 day binge drinking, and obesity are 26%, 22%, and 36% among men. The prevalence rates among women are 25%, 8.7%, and 34%. Both men and women have been out of school an average of 28 years and on average left school at age 19.

TABLE 2.2. Weighted summary statistics, men

	Mean	SD	Minimum	Maximum
Smoke	0.26	0.44	0	1
Binge	0.22	0.41	0	1
Obese	0.36	0.48	0	1
School leaving UE rate	7.52	2.30	2.60	17.9
Time since school leaving	28.4	3.15	15	33
School leaving year	1980.6	3.15	1976	1994
School leaving age	19.2	2.60	15	30
Less than high school	0.16	0.36	0	1
High school	0.47	0.50	0	1
Some college	0.16	0.37	0	1
College graduate	0.21	0.41	0	1
White	0.81	0.39	0	1
Hispanic	0.056	0.23	0	1
Black	0.14	0.34	0	1
AFQT	50.1	28.9	1	99
Foreign born	0.033	0.18	0	1
Mother's education	11.8	2.57	0	20
Mother's education missing	0.049	0.22	0	1
Father's education	12.1	3.34	0	20
Father's education missing	0.092	0.29	0	1
Magazines	0.69	0.46	0	1
Magazines missing	0.0069	0.083	0	1
Library card	0.76	0.43	0	1
Library card missing	0.0028	0.053	0	1
Newspapers	0.86	0.35	0	1
Newspaper missing	0.0022	0.047	0	1
Siblings	3.16	2.22	0	22
Siblings missing	0.00032	0.018	0	1
Observations	4000			

Notes: Summary statistics are weighted using NLSY79 survey weights.

TABLE 2.3. Weighted summary statistics, women

	Mean	SD	Minimum	Maximum
Smoke	0.25	0.43	0	1
Binge	0.087	0.28	0	1
Obese	0.34	0.47	0	1
School leaving UE rate	7.50	2.30	2.10	17.9
Time since school leaving	28.6	3.08	14	33
School leaving year	1980.4	3.08	1976	1995
School leaving age	18.9	2.41	15	30
Less than high school	0.13	0.33	0	1
High school	0.46	0.50	0	1
Some college	0.21	0.41	0	1
College graduate	0.20	0.40	0	1
White	0.80	0.40	0	1
Hispanic	0.057	0.23	0	1
Black	0.14	0.35	0	1
AFQT	49.2	27.0	1	99
Foreign born	0.035	0.18	0	1
Mother's education	11.7	2.63	0	20
Mother's education missing	0.040	0.20	0	1
Father's education	11.9	3.37	0	20
Father's education missing	0.095	0.29	0	1
Magazines	0.68	0.46	0	1
Magazines missing	0.0048	0.069	0	1
Library card	0.79	0.41	0	1
Library card missing	0.0044	0.066	0	1
Newspapers	0.84	0.36	0	1
Newspaper missing	0.0039	0.063	0	1
Siblings	3.30	2.24	0	19
Siblings missing	0.0015	0.039	0	1
Observations	4132			

Notes: Summary statistics are weighted using NLSY79 survey weights.

IV. Results

My preferred results are reported in Tables 2.4 to 2.6. Table 2.4 reports results for the full sample. The top panel reports results for all men and the bottom panel reports results for all women. Each cell represents a parameter estimate from a separate regression. Models that proxy macroeconomic fluctuations at school leaving with the state unemployment rate and an indicator for a state unemployment rate of 9% or higher are estimated. In all regressions, the parameter estimates are small and indistinguishable from zero. This finding is not surprising: labor studies document career effects among high skill men. Combining men of different skill levels may mask relationships between macroeconomic fluctuations at school leaving and health behavior markers in middle age.

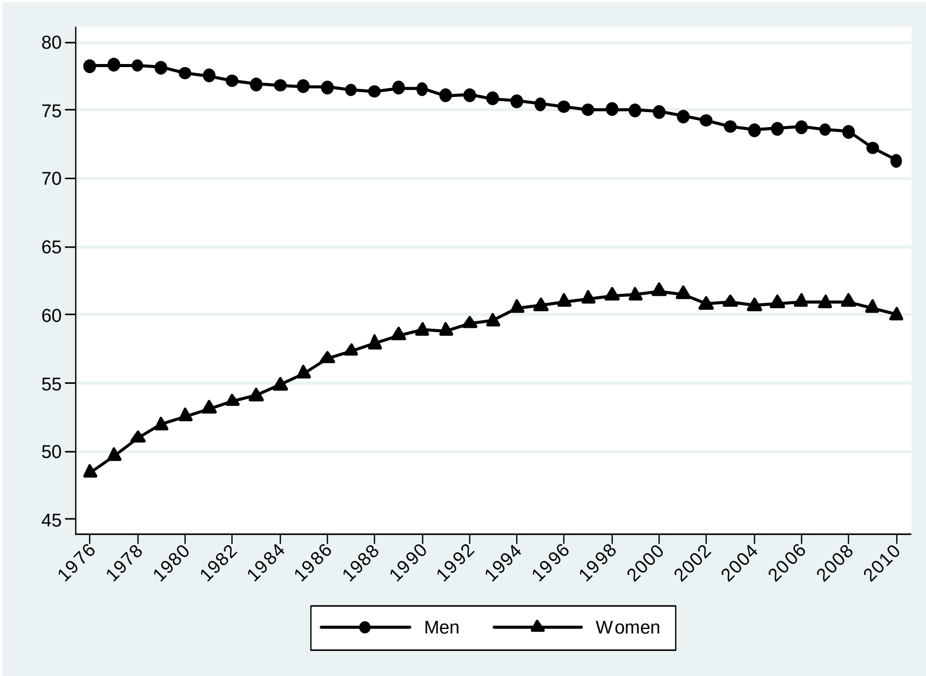
TABLE 2.4. Effect of school leaving unemployment rate on health behavior markers full sample

	Smoke	Binge	Obese
Men			
Proportion	0.26	0.22	0.36
Unemployment rate	0.0004	0.0022	-0.0093
	(0.0074)	(0.0056)	(0.0103)
Unemployment rate ≥ 9	0.0207	-0.0005	-0.0450
	(0.0272)	(0.0269)	(0.0359)
N	3072	3067	3058
Women			
Proportion	0.25	0.08	0.34
Unemployment rate	-0.0059	0.0027	-0.0065
	(0.0091)	(0.0047)	(0.0069)
Unemployment rate ≥ 9	-0.0223	0.0125	-0.0225
	(0.0324)	(0.0193)	(0.0216)
N	3358	3353	3232

Notes: All regressions estimated with a weighted linear probability model and control for demographics, family background, time since school leaving, school leaving year fixed effects, and school leaving state fixed effects. Standard errors are clustered around the school leaving state and are reported in parentheses. ***; **; and *=statistically different from zero at the 1%; 5%; and 10% confidence level.

Because I find no effects for women, I focus on men in the remainder of the paper. These non-results are consistent with studies that document no association between macroeconomic fluctuations at school leaving and career outcomes among women (Kondo, 2007; Hershbein, 2012). Women's labor market participation patterns are historically different from men's patterns. Figure 2.2 reports labor market participation for men and women between 1976 and 2010. In 1976, 48% of women ages 18 to 54 years participated in the labor market while 78% of men ages 18 to 54 years participated. Women in this cohort may have been less attached to the labor market than men and may have a different set of opportunities outside the labor market (e.g., home production, child rearing).

FIGURE 2.2. Labor force participation by sex: 1976-2010



Notes: Data are drawn from a special request by the author from the Bureau of Labor Statistics (Data on Employment Status by State and Demographic Group).

Table 2.5 reports regression results by skill level. I stratify men into "high skill" (a college degree or higher at school leaving) and "low skill" (less than a college degree at school leaving). Labor studies document that the career effects of leaving school when the state unemployment rate is high are concentrated among high skill (college graduates, MBAs, PhDs) men. Consistent with labor studies, I find that high skill men who leave school when the state unemployment rate is high are more likely to binge drink and less likely to be obese than their counter parts who leave school when the state unemployment rate is low in middle age. A 1 percentage point increase in the school state unemployment rate is associated with a 2.77 percentage point increase in the probability of binge drinking and a 5.7 percentage point decrease in the probability of obesity by middle age among college educated men. Relative to the sample mean, these parameter estimates imply a 17% increase in the probability of binge drinking and a 22.4% decrease in the probability of obesity. Results are consistent in specifications that include an indicator for a leaving school when the state unemployment rate is ≥ 9%. Table 2.5 reports results by race/ethnicity: white men vs. non-white men. No clear pattern between the state unemployment rate at school leaving and health behavior markers in middle age emerges. The parameter estimates are generally small and imprecisely estimated.

TABLE 2.5. Effect of school leaving unemployment rate on health behavior markers by skill

	Smoke	Binge	Obese
High skill men			
Proportion	0.07	0.16	0.25
Unemployment rate	-0.0086	0.0277*	-0.0513**
	(0.0113)	(0.0142)	(0.0218)
Unemployment rate ≥ 9	0.0759	0.0754	-0.1351
	(0.0533)	(0.0741)	(0.0820)
N	512	512	511
Low skill men			
Proportion	0.31	0.24	0.39
Unemployment rate	0.0052	-0.0034	-0.0021
	(0.0113)	(0.0070)	(0.0120)
Unemployment rate ≥ 9	0.0144	-0.0234	-0.0345
	(0.0312)	(0.0294)	(0.0381)
N	2560	2555	2547

Notes: All regressions estimated with a weighted linear probability model and control for demographics, family background, time since school leaving, school leaving year fixed effects, and school leaving state fixed effects. Standard errors are clustered around the school leaving state and are reported in parentheses. ***; **; and *=statistically different from zero at the 1%; 5%; and 10% confidence level.

TABLE 2.6. Effect of school leaving unemployment rate on health behavior markers by race/ethnicity

	Smoke	Binge	Obese
White men			
Proportion	0.24	0.23	0.35
Unemployment rate	0.0008	0.0021	-0.0114
	(0.0086)	(0.0068)	(0.0123)
Unemployment rate ≥ 9	0.0208	0.0008	-0.0665
	(0.0309)	(0.0312)	(0.0435)
N	1605	1604	1599
Non-white men			
Proportion	0.33	0.18	0.40
Unemployment rate	-0.0018	0.0015	0.0079
	(0.0118)	(0.0106)	(0.0116)
Unemployment rate ≥ 9	0.0108	-0.0097	0.0501
	(0.0477)	(0.0374)	(0.0442)
N	1467	1463	1459

Notes: All regressions estimated with a weighted linear probability model and control for demographics, family background, time since school leaving, school leaving year fixed effects, and school leaving state fixed effects. Standard errors are clustered around the school leaving state and are reported in parentheses. ***; **; and *=statistically different from zero at the 1%; 5%; and 10% confidence level.

To distinguish the importance of the state unemployment at school leaving from the contemporaneous effect of the state unemployment rate on health behavior markers (e.g., Ruhm, 2003, Dahve & Rashad-Kelly, 2010) I augment the preferred model with a lead and lag of the school leaving state unemployment rate. Results are reported in Tables 2.7 (all men), 2.8 (skill level), and 2.9 (race/ethnicity). The findings are broadly consistent with results generated in the preferred models. Binge drinking effects are stronger in the augmented models than in the preferred models: parameter estimates are larger and more likely to be statistically different from zero in the full sample, college educated sample, and white sample. The causal interpretation of the lead and lag state unemployment rate parameter estimates is not clear: I do not include lead or lag state and year fixed effects and the parameter estimates may suffer from omitted variable bias.

TABLE 2.7. Effect of school leaving unemployment rate on health behavior markers, lag and lead unemployment rate

	Smoke	Binge	Obese
Proportion	0.26	0.22	0.36
Lag unemployment rate	-0.0049	-0.0113	-0.0053
	(0.0091)	(0.0097)	(0.0089)
Unemployment rate	0.0023	0.0193**	-0.0096
	(0.0120)	(0.0088)	(0.0138)
Lead unemployment rate	0.0021	-0.0172**	0.0064
	(0.0107)	(0.0066)	(0.0103)
N	3072	3067	3058

Notes: All regressions estimated with a weighted linear probability model and control for demographics, family background, time since school leaving, school leaving year fixed effects, and school leaving state fixed effects. Standard errors are clustered around the school leaving state and are reported in parentheses. ***; **; and *=statistically different from zero at the 1%; 5%; and 10% confidence level.

TABLE 2.8. Effect of school leaving unemployment rate on health behavior markers by skill, lag and lead unemployment rate

	Smoke	Binge	Obese
High skill men			
Proportion	0.07	0.16	0.25
Lag unemployment rate	0.0004	-0.0112	-0.0421**
	(0.0114)	(0.0253)	(0.0204)
Unemployment rate	-0.0143	0.0457*	-0.0392
	(0.0180)	(0.0266)	(0.0298)
Lead unemployment rate	0.0146	-0.0299	0.0366**
	(0.0126)	(0.0195)	(0.0163)
N	512	512	511
High skill men			
Proportion	0.31	0.24	0.39
Lag unemployment rate	-0.0045	-0.0117	-0.0034
	(0.0109)	(0.0109)	(0.0105)
Unemployment rate	0.0085	0.0112	0.0022
	(0.0165)	(0.0105)	(0.0147)
Lead unemployment rate	-0.0010	-0.0126	-0.0038
	(0.0143)	(0.0090)	(0.0137)
N	2560	2555	2547

Notes: All regressions estimated with a weighted linear probability model and control for demographics, family background, time since school leaving, school leaving year fixed effects, and school leaving state fixed effects. Standard errors are clustered around the school leaving state and are reported in parentheses. ***; **; and *=statistically different from zero at the 1%; 5%; and 10% confidence level.

TABLE 2.9. Effect of school leaving unemployment rate on health behavior markers by race/ethnicity, lag and lead unemployment rate

	Smoke	Binge	Obese
White men			
Proportion	0.24	0.23	0.35
Lag unemployment rate	-0.0020	-0.0120	-0.0076
	(0.0108)	(0.0114)	(0.0109)
Unemployment rate	0.0026	0.0195*	-0.0091
	(0.0138)	(0.0105)	(0.0175)
Lead unemployment rate	-0.0010	-0.0169*	0.0047
	(0.0133)	(0.0094)	(0.0119)
N	1605	1604	1599
Non-white men			
Proportion	0.33	0.18	0.40
Lag unemployment rate	-0.0132	-0.0119	-0.0032
	(0.0086)	(0.0102)	(0.0181)
Unemployment rate	0.0007	0.0175	0.0002
	(0.0164)	(0.0135)	(0.0154)
Lead unemployment rate	0.0090	-0.0171*	0.0175
	(0.0140)	(0.0099)	(0.0157)
N	1467	1463	1459

Notes: All regressions estimated with a weighted linear probability model and control for demographics, family background, time since school leaving, school leaving year fixed effects, and school leaving state fixed effects. Standard errors are clustered around the school leaving state and are reported in parentheses. ***; **; and *=statistically different from zero at the 1%; 5%; and 10% confidence level.

The second objective of this paper is to shed light on potential mechanisms between the state unemployment rate at school leaving and health behavior markers in middle age. The net relationship is expected to operate, at least partially, through career outcomes, marriage, and education. I construct career (probability of employment, number of weeks worked in the past year, hourly wage, job satisfaction, flexible work hours[28]), marriage and fertility (marital status, presence of children), and education outcomes (difference between education at school leaving and survey date). In separate equations I model each potential mechanism as a function of the state unemployment rate at school leaving, demographics, family background, and school leaving state and year fixed effects. To preserve space I do not report results that

[28] Employment pertains to all jobs while hourly wage, job satisfaction, and flexible work hours pertain to the first listed job. A full description of the variables is available upon request.

proxy macroeconomic fluctuations at school leaving with an indicator for a state unemployment rate of 9% or higher. Results are consistent and are available on request. If these outcomes are potential mechanisms the outcomes should be predicted by the school leaving state unemployment rate. Results are reported in Table 2.10 (career outcomes) and Table 2.11 (marriage, fertility, and education outcomes).

TABLE 2.10. Effect of school leaving unemployment rate on labor market outcomes, various samples

	Employed	Weeks worked	Hourly wage	Satisfied with job	Flexible Work hours
Prop./mean	0.90	44.77	28.85	0.93	0.54
All men	-0.0031	-0.3512	-0.7181	-0.0087*	-0.0061
	(0.0050)	(0.2630)	(0.5342)	(0.0048)	(0.0078)
N	3049	3072	2642	2784	2366
Prop./mean	0.97	49.41	48.54	0.95	0.68
High skill	-0.0078	-0.9062**	2.3937	-0.0323**	-0.0619***
	(0.0082)	(0.4482)	(2.0443)	(0.0148)	(0.0193)
N	507	512	472	501	441
Prop./mean	0.89	43.49	23.13	0.92	0.49
Low skill	-0.0027	-0.2395	-0.8281*	-0.0020	-0.0034
	(0.0065)	(0.3199)	(0.4606)	(0.0044)	(0.0103)
N	2542	2560	2170	2283	1925
Prop./mean	0.93	46.35	30.52	0.93	0.54
White	0.0013	-0.1074	-0.5701	-0.0093*	-0.0085
	(0.0051)	(0.2857)	(0.5819)	(0.0052)	(0.0091)
N	1592	1605	1462	1522	1306
Prop./mean	0.81	38.33	21.08	0.93	0.51
Non-white	-0.0037	-0.4603	-1.3104**	-0.0106	0.0007
	(0.0109)	(0.5311)	(0.6105)	(0.0082)	(0.0194)
N	1457	1467	1180	1262	1060

Notes: All regressions estimated with a weighted linear probability model and control for demographics, family background, time since school leaving, school leaving year fixed effects, and school leaving state fixed effects. Standard errors are clustered around the school leaving state and are reported in parentheses. ***; **; and *=statistically different from zero at the 1%; 5%; and 10% confidence level.

TABLE 2.11. Effect of school leaving unemployment rate on social outcomes, various samples

	Married	Children	Additional schooling
Proportion/mean	0.64	1.60	0.36
All men	-0.0211**	-0.0256	-0.0005
	(0.0088)	(0.0184)	(0.0057)
N	3072	4000	4000
Proportion/mean	0.79	1.62	0.29
High skill men	0.0112	0.0273	-0.0106
	(0.0223)	(0.0784)	(0.0168)
N	512	647	647
Proportion/mean	0.60	1.60	0.38
Low skill men	-0.0255**	-0.0263	0.0015
	(0.0116)	(0.0161)	(0.0068)
N	2560	3353	3353
Proportion/mean	0.69	1.54	0.35
White men	-0.0157	-0.0032	-0.0049
	(0.0112)	(0.0288)	(0.0077)
N	1605	2121	2121
Proportion/mean	0.45	1.86	0.39
Non-white men	-0.0203*	-0.0726	0.0072
	(0.0110)	(0.0534)	(0.0108)
N	1467	1879	1879

Notes: All regressions estimated with a weighted linear probability model and control for demographics, family background, time since school leaving, school leaving year fixed effects, and school leaving state fixed effects. Standard errors are clustered around the school leaving state and are reported in parentheses. ***; **; and *=statistically different from zero at the 1%; 5%; and 10% confidence level.

The state unemployment rate at school leaving is associated with worse career and marriage, but not education, outcomes in middle age. Consistent with labor studies that document the largest career effects of leaving school when the state unemployment rate is high among high skill workers, I find the largest effects among college educated men. College educated men who leave school when the state unemployment rate is high work fewer weeks per year, are less likely to be satisfied with their job, and are less likely to have flexible work hours than their counterparts who leave school when the state unemployment rate is low by middle age. I find that men, and this effect is driven by low skill and non-white men, who leave school with the state unemployment rate is high are less likely to be married in middle age than their counterparts.

V. Robustness Checks

This section reports results from a series of robustness checks. An obvious concern is the endogeneity of school leaving. School-leavers may engage in endogenous timing (enrolling in additional schooling, dropping out, forced out for financial reasons) or migration (moving to a stronger labor market). I refer to these behaviors collectively as endogenous sorting. The intuition for the sign of the potential bias from endogenous sorting is as follows. School-leavers who avoid bad economies have characteristics (ability, financial resources, forethought) that permit avoidance behavior. These characteristics are arguably negatively correlated with smoking, binge drinking, and obesity. The rich background information contained in the NLSY79 allows me to control, at least partially, for these characteristics. To the extent that characteristics remain unobservable, failure to account for them is expected to bias least squares estimates away from zero.[29] Alternatively classical measurement error in the school leaving variables, a familiar feature of survey data, will attenuate least squares estimates towards zero. If measurement error is not classical, the sign of the bias is ambiguous. It is not clear *a priori* which effect will dominate.

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[29] Assume the true model takes the following form: $H\_40_{is}=\alpha_0 + \alpha_1 U_{is} + \alpha_2 C_{is}$; $\alpha_1<0$; $\alpha_2>0$. C_{is} is scalar that captures characteristics that allow avoidance behavior and are positively associated with age 40 health. The estimated model can be written as $H\_40_{is}=\beta_0 + \beta_1 U_{is}$; $\beta_1 <0$. The association between omitted and included regressor takes the form $C_{is}=\gamma_0 + \gamma_1 U_{is}$; $\gamma_1<0$. The omitted variable formula implies $\beta_1 = \alpha_1 + \gamma_1 * \alpha_2$; $\gamma_1 * \alpha_2 <0$: least squares estimates are biased away from zero.

Table 2.12 reports a basic test for endogenous sorting: covariate balance. The sample is split between men who left school with a state unemployment rate below or above the sample mean (7.52). If school-leavers are avoiding bad economies, differences in observable characteristics should exist between these two groups of men. *Ex ante*, we may expect that if positive sorting is present that observably more advantaged men will leave school when the unemployment rate is low. The test of covariate balance do not support this hypothesis: respondents in these two groups are broadly similar in terms of their observable characteristics.

TABLE 2.12. Test of covariate balance

	School leaving state unemployment rate ≤ sample mean	School leaving state unemployment rate > sample mean
Time since school leaving	28.8	27.9
School leaving year	1980.2	1981.1
School leaving age	19.1	19.2
Less than high school	0.18	0.12
High school	0.47	0.47
Some college	0.15	0.18
College graduate	0.20	0.23
White	0.80	0.81
Hispanic	0.063	0.046
Black	0.13	0.14
AFQT	50.4	49.8
Foreign born	0.034	0.033
Mother's education	11.8	11.9
Mother's education missing	0.045	0.055
Father's education	12.1	12.1
Father's education missing	0.090	0.094
Magazines	0.68	0.71
Magazines missing	0.0079	0.0056
Library card	0.77	0.75
Library card missing	0.0024	0.0035
Newspapers	0.85	0.86
Newspaper missing	0.0014	0.0033
Siblings	3.20	3.10
Siblings missing	0.00036	0.00025
Observations	2376	1624

I use two-stage least squares to address remaining endogeneity concerns and measurement error in the school leaving variables. I predict the state unemployment rate at school leaving using birth year, state of residence at age 14, and education at school leaving. This IV has been used previously to predict economic conditions at school leaving (Kahn, 2010; Oreopoulous et al, 2012). Men are assigned the state unemployment rate they would face if they left school on time (henceforth the on time state unemployment rate). For example, I assign a college graduate the June (modal school leaving month in my sample) unemployment rate in the year he turned 22 (modal school leaving age for college graduates in my sample) in the state of residence at age 14. State of residence at age 14 is used as it is arguably exogenous to the school-leaver while the school leaving state is suspect. I make similar assignments for all educational levels. The compliers are school-leavers who do not adjust their educational plans in response to the contemporaneous state unemployment rates. Because the time and location of school leaving is potentially endogenous, the time since school leaving is potentially endogenous. I instrument time since school leaving with the on time since school leaving variables: the survey year (2008) minus the on time school leaving year. The school leaving state and year fixed effects are replaced with age 14 state fixed effects and on time year fixed effects. Standard errors are clustered by the age 14 state of residence.

The key identifying assumption in this model is that, after conditioning on personal characteristics and various fixed effects, the IV is correctly excludable from the health production function. This assumption is difficult to test statistically. In unreported analyses, I regress the IV on all other covariates. The covariates are generally not strong predictors of the IV. One interpretation of this simple test is that the IV is uncorrelated with unobservables in the error term of the structural equation.

The IV must predict the endogenous regressor to consistently estimate a local average treatment effect for the compliers. Table 2.13 presents results from first-stage regressions: I regress the school leaving unemployment rate on the IV and covariates using least squares. To preserve space, I report regressions that measure macroeconomic fluctuations at school leaving with the state unemployment rate. Results using the indicator for a state unemployment rate of 9% or higher are consistent and available on request. The IV is strong: the *F*-statistics range from 51.80 to 350.13, well above the convention of 10 (Stock et al, 2002). A 1 percentage point increase in the on time state unemployment rate is associated with a 0.4552 to 0.6400 percentage point increase school leaving state unemployment rate.

TABLE 2.13. Effect of IV on state unemployment rate at school-leaving

	All	High skill	Low skill	White	Non-white
Mean	7.52	7.62	7.48	7.54	7.39
On time unemployment	0.5627***	0.6400***	0.5694***	0.6164***	0.4552***
rate	(0.0323)	(0.0889)	(0.0449)	(0.0329)	(0.0571)
F-statistic	303.64	51.80	160.90	350.13	63.567
N	3072	512	2560	1605	1467

Notes: All regressions estimated with weighted least squares and control for demographics, family background, time since school leaving, on time year fixed effects, and on time state fixed effects. Standard errors are clustered around the on time state and are reported in parentheses. ***; **; and *=statistically different from zero at the 1%; 5%; and 10% confidence level.

IV results are reported in Tables 2.14 (all men), 2.15 (skill level), and 2.16 (race/ethnicity). The IV results are smaller in magnitude and less likely to be statistically different from zero than the preferred specification results. The wide standard errors cannot rule out parameter estimates that are similar in magnitude to those estimated in the preferred specifications. The IV model uses less variation in unemployment rates than least squares, which may account for the reduced precision.

TABLE 2.14. Effect of school leaving unemployment rate on health behavior markers, IV model

	Smoke	Binge	Obese
Men			
Proportion	0.26	0.22	0.36
Unemployment rate	0.0157	0.0086	-0.0120
	(0.0211)	(0.0116)	(0.0106)
N	3072	3067	3058

Notes: All regressions estimated with weighted two-stage least squares and control for demographics, family background, time since school leaving, on time year fixed effects, and on time state fixed effects. Standard errors are clustered around the on time state and are reported in parentheses. ***; **; and *=statistically different from zero at the 1%; 5%; and 10% confidence level.

TABLE 2.15. Effect of school leaving unemployment rate on health behavior markers by skill, IV model

	Smoke	Binge	Obese
High skill men			
Proportion	0.07	0.16	0.25
Unemployment rate	-0.0310	0.0023	-0.0132
	(0.0201)	(0.0349)	(0.0261)
N	512	512	511
Low skill men			
Proportion	0.31	0.24	0.39
Unemployment rate	0.0144	0.0038	-0.0144
	(0.0134)	(0.0122)	(0.0140)
N	2560	2555	2547

Notes: All regressions estimated with weighted two-stage least squares and control for demographics, family background, time since school leaving, on time year fixed effects, and on time state fixed effects. Standard errors are clustered around the on time state and are reported in parentheses. ***; **; and *=statistically different from zero at the 1%; 5%; and 10% confidence level.

TABLE. 2.16. Effect of school leaving unemployment rate on health behavior markers by race/ethnicity, IV model

	Smoke	Binge	Obese
White men			
Proportion	0.24	0.23	0.35
Unemployment rate	0.0058	0.0117	-0.0122
	(0.0153)	(0.0138)	(0.0122)
N	1605	1604	1599
Non-white men			
Proportion	0.33	0.18	0.40
Unemployment rate	0.0008	0.0090	-0.0099
	(0.0324)	(0.0205)	(0.0246)
N	1467	1463	1459

Notes: All regressions estimated with weighted two-stage least squares and control for demographics, family background, time since school leaving, on time year fixed effects, and on time state fixed effects. Standard errors are clustered around the on time state and are reported in parentheses. ***; **; and *=statistically different from zero at the 1%; 5%; and 10% confidence level.

This section tests whether bias from non-random attrition is driving the findings. If attritors are systematically different than completers, my results may be biased. The NLSY79 retention rate was 77.8% in 2008 and I use sample weights which account for non-random attrition in all regressions. I compare demographics of completers and attritors and re-estimate the preferred model assigning attritors 1) a healthy outcome and 2) an unhealthy outcome (bounding exercise). Healthy outcomes are health behavior markers (smoking, binge drinking, and obesity) set to zero. I define unhealthy outcomes symmetrically: health behaviors markers set to one. Table 2.17 reports the comparison of observable characteristics by attrition status. I do not include respondents dropped by the NLSY79 for financial reasons or respondents I exclude from the sample due to missing variables, time since school leaving, or school leaving year. These groups are broadly similar in terms of observable characteristics. Results reported in Tables 2.18 through 2.20 imply that estimates are robust to various assumptions regarding the health behavior marker status of the attritors. One interpretation of these findings is that non-random attrition is not driving my results.

TABLE 2.17. Observable characteristics by attrition status

	Complete	Attrite
White	0.80	0.83
Hispanic	0.058	0.049
Black	0.14	0.12
AFQT	49.9	50.9
Foreign born	0.032	0.039
Mother's education	11.8	11.9
Mother's education missing	0.048	0.050
Father's education	12.1	12.1
Father's education missing	0.090	0.097
Magazines	0.70	0.67
Magazines missing	0.0076	0.0049
Library card	0.76	0.76
Library card missing	0.0032	0.0019
Newspapers	0.85	0.87
Newspaper missing	0.0021	0.0024
Siblings	3.14	3.19
Siblings missing	0.00028	0.00044
Observations	3092	908

TABLE 2.18. Effect of school leaving unemployment rate on health behavior markers, bounding exercise

	Smoke	Binge	Obese
Men			
Proportion	0.26	0.22	0.36
Good health	-0.0010	0.0008	-0.0083
	(0.0052)	(0.0047)	(0.0079)
Poor health	0.0011	0.0029	-0.0057
	(0.0076)	(0.0059)	(0.0088)
N	4000	4000	4000

Notes: All regressions estimated with a weighted linear probability model and control for demographics, family background, time since school leaving, school leaving year fixed effects, and school leaving state fixed effects. Standard errors are clustered around the school leaving state and are reported in parentheses. ***; **; and *=statistically different from zero at the 1%; 5%; and 10% confidence level.

TABLE 2.19. Effect of school leaving unemployment rate on health behavior markers by skill, bounding exercise

	Smoke	Binge	Obese
High skill men			
Proportion	0.07	0.16	0.25
Good health	-0.0062	0.0321***	-0.0332**
	(0.0079)	(0.0110)	(0.0164)
Poor health	-0.0387*	-0.0005	-0.0622***
	(0.0193)	(0.0180)	(0.0212)
N	647	647	647
Low skill men			
Proportion	0.31	0.24	0.39
Good health	0.0022	-0.0047	-0.0040
	(0.0080)	(0.0060)	(0.0090)
Poor health	0.0093	0.0025	0.0030
	(0.0116)	(0.0073)	(0.0097)
N	3353	3353	3353

Notes: All regressions estimated with a weighted linear probability model and control for demographics, family background, time since school leaving, school leaving year fixed effects, and school leaving state fixed effects. Standard errors are clustered around the school leaving state and are reported in parentheses. ***; **; and *=statistically different from zero at the 1%; 5%; and 10% confidence level.

TABLE 2.20. Effect of school leaving unemployment rate on health behavior markers by race/ethnicity, bounding exercise

	Smoke	Binge	Obese
White			
Proportion	0.24	0.23	0.35
Good health	-0.0027	-0.0001	-0.0109
	(0.0061)	(0.0054)	(0.0097)
Poor health	0.0016	0.0040	-0.0062
	(0.0093)	(0.0072)	(0.0099)
N	2121	2121	2121
Non-white			
Proportion	0.33	0.18	0.40
Good health	0.0013	0.0010	0.0048
	(0.0065)	(0.0077)	(0.0091)
Poor health	-0.0056	-0.0047	-0.0005
	(0.0139)	(0.0137)	(0.0116)
N	1879	1879	1879

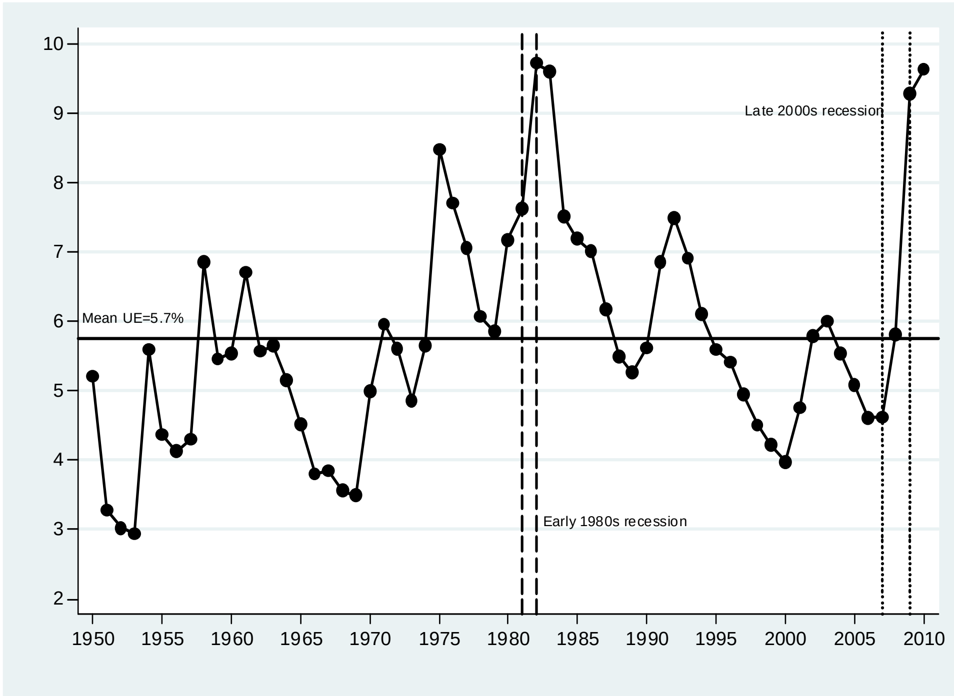
Notes: All regressions estimated with a weighted linear probability model and control for demographics, family background, time since school leaving, school leaving year fixed effects, and school leaving state fixed effects. Standard errors are clustered around the school leaving state and are reported in parentheses. ***; **; and *=statistically different from zero at the 1%; 5%; and 10% confidence level.

VI. Discussion

In this study I test the impact of macroeconomic fluctuations at leaving school on three health behavior markers in middle age: past 30 day smoking, past 30 day binge drinking, and obesity. I proxy macroeconomic fluctuations at school leaving with the state unemployment rate. My results imply that the state unemployment rate at school leaving is positively (negatively) associated with the probability of binge drinking (obesity) in middle age. Consistent with labor studies that document negative career effects of leaving school when the state unemployment rate is high, health behavior marker effects are concentrated among college educated men. My preferred specification implies that a 1 percentage point increase in the state unemployment rate at school leaving is leads to a 2.8 percentage point increase in the probability of binge drinking and a 5.1 percentage point decrease in the probability of obesity at middle age among college educated men. This affect is observed 17 to 33 years after leaving school when men are 43 to 51 years of age. Macroeconomic fluctuations at school leaving do not affect women's health behavior markers. These non-findings are consistent with labor studies that document no link between macroeconomic fluctuations at school leaving and career outcomes among women. Results are robust to various econometric specifications, including the use of instrumental variables to account for the potential endogeneity of the time and location of school leaving.

My findings are timely because the U.S. is recovering from the 2007-2009 recession. Figure 2.3 plots the national unemployment rate between 1950 and 2010. The high unemployment rates of, and slow recovery from, the 2007-09 recession are apparent. The national unemployment rate was 8.2% in March 2012; this translates into 12.8 million unemployed persons (Bureau of Labor Statistics [BLS], 2012). 42.6% of the unemployed can be categorized as in long term unemployment, defined as an unemployment spell lasting 27 weeks or more. The rate of unemployment is particularly high among new labor market entrants: 13.8%, among those aged 20-24 (BLS, 2012). Rates of underemployment are estimated to be as high as 14.9% (BLS, 2012). Underemployment includes workers in part time jobs for economic reasons, discouraged workers, and persons marginally attached to the labor market. Several recent economics studies find that the 2007-09 recession led to stress, food insecurity, morbidity, poor diet, sedentary lifestyles, lower use of medical services, and loss of health insurance (Nord et al, 2010; Dave & Kelly, 2010; Lusardi et al, 2010; Cawley et al, 2011; Colman & Dave, 2011; Currie & Telkin, 2011; Deaton, 2011; Holahan, 2011).

FIGURE 2.3. National unemployment rate: 1950-2010



Notes: Data are drawn from the Bureau of Labor Statistics Historical Unemployment Rate data series (series number LNS14000000). The early 1980s recession (July 1981- November 1982) is indicated with dashed lines and the late 2000s recession (December 2007- June 2009) is indicated with dotted lines.

Because the early 1980s recession lies in the middle of the quasi-experiment, my findings are potentially useful for current policy makers. Although the U.S. has undergone substantial economic and demographic changes in the last 30 years, the early 1980s recession is arguably the most comparable economic event for projecting the persistent impact of the 2007-09 recession. Both recessions were long contractions (16 and 18 months, the average recession between 1945 and 2000 lasted 11 months [NBER, 2011]) and generated high, sustained unemployment. There are differences between these two contractions. For example, the early 1980s recession was concentrated in the manufacturing sector while the 2007-09 recession was experienced more broadly and the recovery period from the 2007-09 recession is more sluggish than the early 1980s recession (Farber, 2011). These differences in the extent of the two recessions implies that effects of the 2007-09 recession may be larger than any effects identified using variation generated in the early 1980s recession.

This study contributes to several economic literatures. First, it adds to the literature on the effects of leaving school in a bad economy (Oyer, 2006; Kahn, 2010; Maclean, 2012; Oreopoulos et al, 2012; Schoar & Zuo, 2011), as it identifies a previously unrecognized consequence: health behavior markers. Second, this study contributes to the active line of research that examines the health effects of macroeconomic fluctuations (Ruhm, 2003; Arkes, 2007; Dave & Kelly, 2010; Colman & Dave, 2011; Davalos et al, forthcoming). Previous studies document that macroeconomic fluctuations have short run effects on health behavior markers. This line of research is active and decidedly mixed. My findings imply that macroeconomic fluctuations experienced at an important transition (school leaving) have a persistent effect on health behavior markers. My finding that leaving school when the state unemployment rate is high leads to an increase in the probability of binge drinking is consistent with recent work by Dávalos et al (forthcoming) that finds heavy drinking increases with the state unemployment rate but not the work of Ruhm (1995; 2002). Alternatively, my finding that a high state unemployment rate at school leaving leads to a decrease in the probability of obesity in middle age agrees with work by Ruhm (2003) and Dave & Rashad Kelly (2010). Understanding the effect of macroeconomic conditions on health is an important area for future research. Third, this paper contributes to the growing interest in sensitive developmental periods (Heckman, 2007; Almond & Currie, 2011): neuroscience research documents that school leaving age is an important period for emotional development (Dahl, 2004). This study highlights the importance of a particular shock: the macroeconomy at school leaving. Fourth, the findings in this study add to our understanding of health disparities between cohorts and the persistent health effects of the 2007-09 recession. My findings offer new information on the health effects of the macroeconomy and cohort level health disparities. Policy makers may consider timing health programs (e.g., access to low cost health promotion programs, income support) to active when the unemployment rate increases.

This study is a work in progress. I have made several simplifying assumptions that I will relax in future versions. For example, in future work I will explore in more depth potential mechanisms for the net effect identified in the preferred specification, examine the dynamics of the relationship between the macroeconomic fluctuations at school leaving and later health behavior markers, exploit the repeated information on health behavior markers rather than focusing solely on the persistent effects, update the data set to include the 2010 round of the NLSY79, investigate health behavior marker effects in the NLSY97, and examine the continuous smoking, drinking, and body weight measures. These extensions will hopefully provide more conclusive evidence on how macroeconomic fluctuations at school leaving affect the health behaviors examined in this study.

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CHAPTER 3

UNFIT FOR SERVICE: THE IMPLICATIONS OF RISING OBESITY FOR U.S. MILITARY RECRUITMENT SUB-HEADING ONE

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ABSTRACT

This paper contributes to the literature on the labor market consequences of unhealthy behaviors and poor health by examining a previously underappreciated consequence of the rise in obesity in the United States: challenges for military recruitment. Specifically, this paper estimates the percent of the U.S. military-age population that exceeds the U.S. Army's current active duty enlistment standards for weight-for-height and percent body fat, using data from the series of National Health and Nutrition Examination Surveys that spans 1959-2008. We calculate that the percentage of military-age adults ineligible for enlistment because they are overweight and overfat more than doubled for men and tripled for women during that time. As of 2007-08, 5.7 million men and 16.5 million women exceeded the Army's enlistment standards for weight and body fat. We document disparities across race and education in exceeding the standards, and estimate that a further rise of just 1% in weight and body fat would further reduce eligibility for military service by over 850,000 men and

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1.3 million women. The paper concludes with a discussion of the implications of these findings for military recruitment and defense policy.

I. Introduction

A substantial literature in economics studies the labor market and public health consequences of obesity. For example, several studies conclude that obesity lowers the probability of employment (e.g. Morris, 2007; Rooth, 2009) and lowers wages among the employed (e.g. Averett and Korenman, 1996; Cawley, 2004; Kline and Tobias, 2008). Other studies calculate the impact of obesity on U.S. health care costs, recent estimates of which are in the range of $147-$168 billion per year (Finkelstein et al., 2009; Cawley and Meyerhoefer, 2010). This paper focuses on a previously underappreciated labor market and public policy consequence of the obesity epidemic in the United States: substantial reductions in eligibility for military service.

Between 1959-62 and 2007-08, the age-adjusted prevalence of overweight (defined as a body mass index[32], or BMI, of 25 or higher) among adult males in the U.S. rose from 47.4% to 68.3% (Flegal et al., 1998; Flegal et al., 2002; Flegal et al., 2010). Over that same period, the prevalence of obesity (defined as a BMI of 30 or higher) among adult males in the U.S. tripled from 10.7% to 32.2% (Ibid). The prevalence of obesity defined using percent body fat (instead of BMI) has also increased dramatically in the past five decades (Burkhauser et al., 2009).

This paper examines the consequences of this rise in obesity for the largest employer in the United States: the Department of Defense or DoD (NRC, 2006). In

[32] Body mass index (BMI) is calculated as weight in kilograms divided by height in meters squared.

2009 there were over 1.4 million men and women on active duty in the U.S. military, with an additional 1.1 million men and women in the military reserves (U.S. Census Bureau, 2011). Currently, the DoD must recruit approximately 184,000 new military personnel every year to replace those who leave the service because of retirement or other reasons (U.S. Bureau Labor Statistics, 2009). Recruitment has become more challenging for the U.S. military since it initiated two major overseas operations: Operation Iraqi Freedom (March 20, 2003 – September 1, 2010), which transitioned into Operation New Dawn (September 1, 2010 – present), and Operation Enduring Freedom – Afghanistan (October 7, 2001 – present). These operations, which increased the military's demand for recruits (in particular, by the Army and Marine Corps) have also decreased the supply of applicants because they raise the risk of injury and death (Asch et al., 2010; Simon and Warner, 2007). In order to meet its recruiting targets, the U.S. Army was forced to substantially expand the availability and size of enlistment bonuses between 2004 and 2008 (Asch et al., 2010). The recession that began in late 2007 facilitated military recruitment by increasing the number applying to enlist.

Physical fitness in general, and body weight and body fat in particular, are highly relevant to military occupations (Institute of Medicine (IOM), 1990, 2004; Naghii, 2006). Militaries worldwide have long valued a physically fit appearance as an important signal of strength, discipline, and professionalism, and consider it important for morale and pride and thus effectiveness (IOM, 2004; Yamane, 2007; McLaughlin and Wittert, 2009). Moreover, military service often requires muscular and cardio-respiratory endurance, which can be hampered when body fat is excessive

(U.S. DoD, 2004). Several studies have found that heavier individuals, especially women, are more likely to fail basic training than healthy weight individuals (Jones et al., 1988; Knapik et al., 2001; Poston et al., 2002). Among Navy personnel, men and women with high weight-for-height are more likely to fail their semi-annual Physical Readiness Test (Bohnker et al., 2005). It is estimated that, among U.S. active duty military, overweight and obesity are responsible for 658,000 missed work days (absenteeism) and the equivalent of 17,000 missed work days due to lower productivity while at work (presenteeism), for a total productivity cost of $105.6 million per year (Dall et al., 2007). TRICARE, the U.S. military health insurance program, spends $1.1 billion annually treating obesity-related illness (Dall et al., 2007). For comparison, that is more than TRICARE spends annually treating illnesses related to tobacco use ($564 million) and alcohol consumption ($425 million) combined (Dall et al., 2007). The IOM has warned that obesity "threaten[s] the long-term welfare and readiness of U.S. military forces" (IOM, 2004, p.1) and an association of retired generals and admirals has declared that rising youth obesity threatens the future strength of the U.S. military and thus U.S. national security (Mission: Readiness, 2010).

Because of the importance of healthy body weight and composition for military readiness and effectiveness, the military imposes weight-for-height and percent body fat standards for enlistment. Thus, the high and rising prevalence of obesity in the U.S. civilian population makes it more difficult for the U.S. military to find acceptable numbers of quality recruits (Yamane, 2007; McLaughlin and Wittert, 2009). Excessive weight and body fat is now the most common reason for medical disqualification, leading to rejection of 23.3% of all applicants to the military (NRC, 2006). For comparison, the second most common reason is smoking marijuana, which leads to rejection of 12.6% of applicants (NRC, 2006). Roughly 15,000 applicants to the military are rejected each year for exceeding the standards for weight and body fat (Mission: Readiness, 2010).

The purpose of this paper is not simply to confirm that rising obesity has reduced eligibility for military service. Instead, our objective is to estimate more accurately than ever before the number and percentage of military-age civilians who exceed enlistment standards for weight-for-height and percent body fat. We document both current (2007-08) levels and trends over the period of rising obesity: 1959-2008. We also examine the personal characteristics (age, race, ethnicity, education, and marital status) associated with exceeding those enlistment standards. Finally, we simulate how future changes in weight and percent body fat would further affect eligibility for military service. For the sake of brevity we focus on results for the U.S. Army, but results for the Navy, Air Force, and Marine Corps are consistent and available upon request.

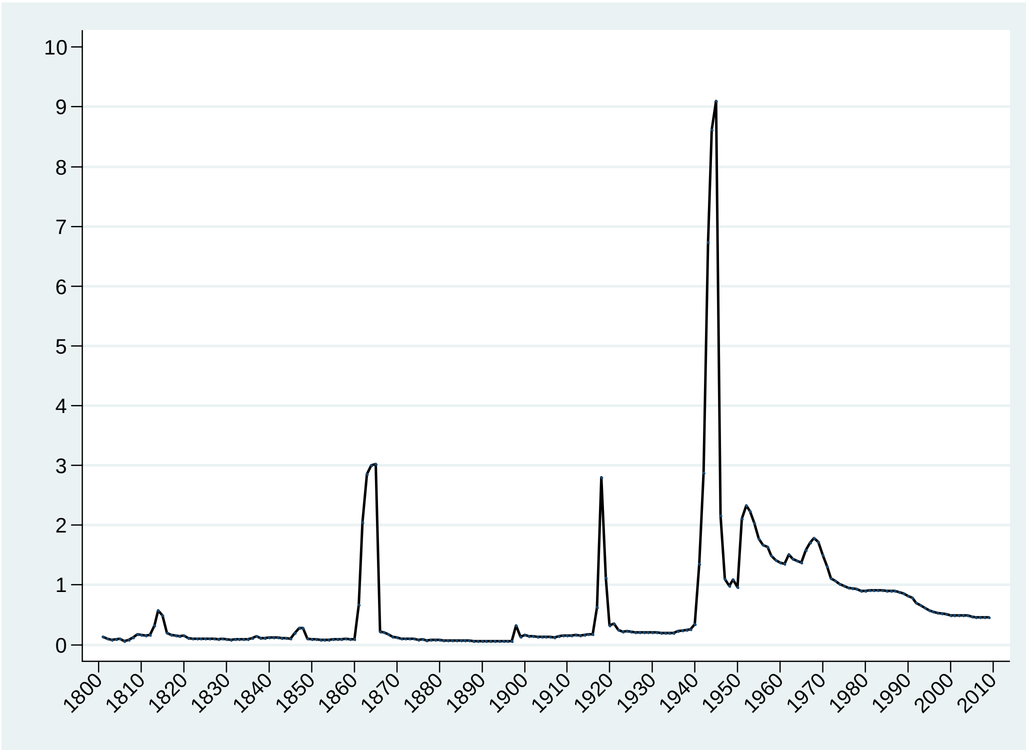
As of 2011, military service is less common than it was when the U.S. was engaged in large-scale wars.[33] Although in historical terms the U.S. military is currently small (as a percent of the U.S. population), that is misleading as to the potential threat that obesity-related disqualifications represent to future national security. Militaries must be able to expand greatly and rapidly to meet emerging national security threats. That is evident in Figure 3.1, which graphs the size of the

[33] For example, Figure 1 in Card and Lemieux (2001) illustrates the decline in the U.S. male veteran rate that began with birth cohorts in the early 1930s.

active-duty U.S. military as a percentage of the U.S. population.[34] This figure shows that the U.S. has commonly had to rapidly and dramatically increase the size of its military, most notably for World War II (1941-45) and the Civil War (1861-65), but large percentage increases in the size of the military occurred for every U.S. war, including the War of 1812, the Mexican-American War, World War I, the Korean conflict, and the Vietnam War. For example, the number of active-duty U.S. military personnel rose over 8,400% at the beginning of the Civil War (between 1859 and 1861), rose over 1,515% at the beginning of World War I (between 1916 and 1918), rose over 740% at the beginning of World War II (between 1940 and 1942), and more than doubled at the beginning of the Korean conflict (between 1950 and 1951). The U.S. has routinely found it necessary to multiply the size of its armed forces in times of crisis. As a result, one should not be misled by the size of the current military into underestimating the possible future implications for national security of large numbers of military-age civilians being ineligible for military service. Confirming evidence of this comes from an organization of retired senior military leaders, who have described youth obesity as "an epidemic that threatens national security" and are calling for public health policies to reduce youth obesity (Mission: Readiness, 2010, p. 2).

[34] The data in Figure 1 are taken from Historical Statistics of the United States (Carter, 2006), series Ed26 (military personnel on active duty) and Aa7 (resident population of the U.S.) for years 1795-1995, and from the Statistical Abstract of the United States (U.S. Census Bureau, various years) for years 1995-present. For the Civil War (1861-65), only Union forces are included while the population is for the combined Union and Confederacy.

FIGURE 3.1. Percent of U.S. Population in Active Duty Military: 1801-2009



Notes: Data: Historical Statistics of the United States (Carter, 2006), series Ed26 (military personnel on active duty) and Aa7 (resident population of the US) for years 1795-1995, and from the Statistical Abstract of the United States (U.S. Census Bureau, various years) for years 1995-present. For the Civil War (1861-65), only Union forces are included.

This paper relates to several previous studies. The first is the aforementioned report by retired generals and admirals, titled "Too Fat to Fight" (Mission: Readiness, 2010). That report lists the percentage of 18-24 year old Americans who were overweight or obese in 2006-2008, but did not examine the other ages eligible to enlist in the Army (25-42), and did not calculate what fraction met military enlistment standards for both weight-for-height and percent body fat. Moreover, the estimates of the prevalence of overweight and obese were based on self-reported weight and height, which tend to be substantially underreported (e.g. Rowland, 1974; Cawley and Burkhauser, 2006), potentially resulting in severe misclassification error (Nieto-Garcia et al., 1990). Other studies have used a subset of the data examined in this paper to calculate the percent of Americans meeting military weight-for-height standards in a narrow span of years; e.g. Nolte et al. (2002) examines 1988-94 and Yamane (2007) examines 2001-04. Those papers did not examine whether subjects also met the military standards for percent body fat.

This paper offers six improvements over the previous literature. First, we examine levels and trends over a much longer period: 1959-2008. Second, we examine not only whether civilians exceed the military enlistment standards for weight-for-height but also those for percent body fat. Third, weight and height are measured by medical professionals rather than self-reported. Fourth, we investigate which personal characteristics predict exceeding the standards. Fifth, we examine four sets of historic weight-for-height standards of the U.S. Army to determine how eligibility would differ if historic standards had remained in place. Sixth, we simulate how future changes in weight and body fat would affect future eligibility for enlistment.

This paper relates to several economic literatures. First, it contributes to the literature on the economics of obesity, as it documents a previously underappreciated labor market consequence of rising obesity. Second, the paper relates to the larger literature on the labor market consequences of risky health behaviors (e.g. Mullahy and Sindelar, 1993, 1996; vanOurs, 2004; Auld, 2005), some of which is published in this journal (e.g. McDonald and Shields, 2004; Johansson et al., 2007; Renna, 2007; Norton and Han, 2008). Third, the paper relates to the literature on defense economics. Defense economists have noted that there has been relatively little research on the economics of military manpower and human resource issues in the military (Sandler and Hartley, 1995).[35] This paper makes an important and timely contribution to defense economics, as "There is scant literature covering civilian obesity levels and military recruitment" (Yamane, 2007, p. 1160).

II. Military Standards for Weight-for-Height and Percent Body Fat

General physical standards for enlistment in the American military can be traced back to 1775, when Congress called for "able bodied" men to be formed into militia (Johnson, 1997). Weight-for-height standards for enlistment were first issued in 1887 for men and in the 1940s for women; initially their primary function was to exclude individuals who were underweight (Johnson, 1997), but in recent decades far more applicants are excluded for being overweight (NRC, 2006).[36] Exact standards for weight have evolved continuously since they were first implemented (Johnson, 1997).

Today, the DoD mandates that each military service enforce standards for recruiting that include maximum weight-for-height and percent body fat (U.S. DoD, 2004).[37] Historically, the military assessed only weight-for-height, not percent body fat. Weight-for-height has the advantage of being quick and easy to measure, but as a measure of fatness it is flawed because it ignores body composition. As a result, a maximum weight-for-height may not only exclude those who are fat, but also those

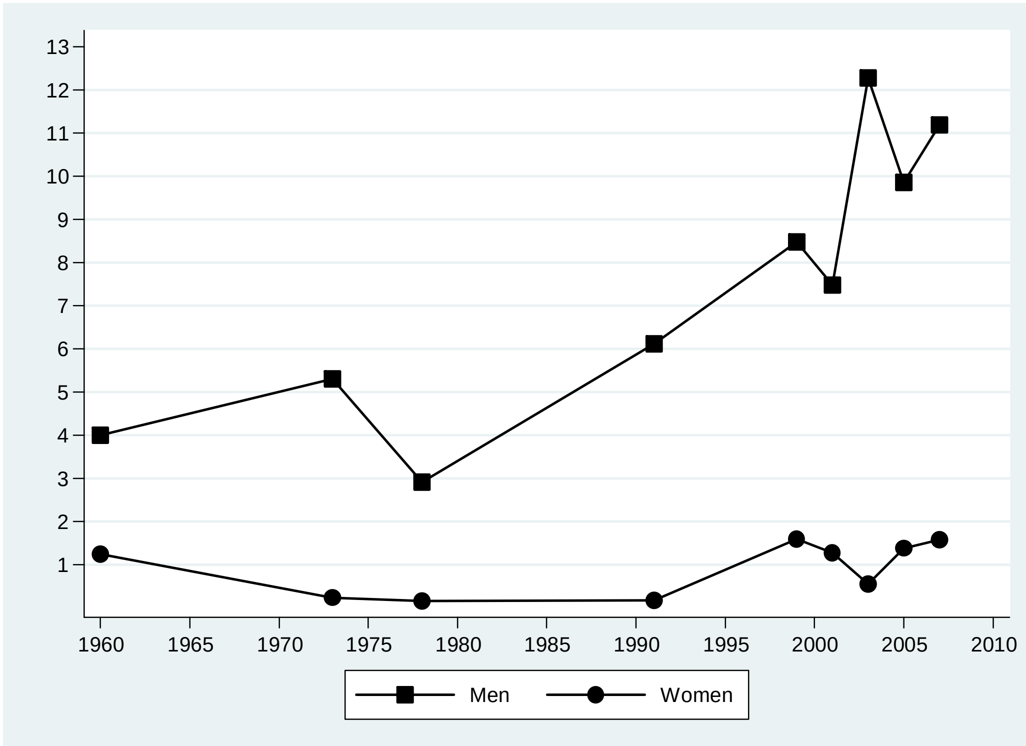
[35] Reviews of the research on the economics of military manpower are provided by Sandler and Hartley (1995), Warner and Asch (1995), and Asch et al. (2007).

[36] Economic historians have extensively studied the historic data on weight and height of conscripts and recruits, for example using them to track long-term trends in standards of living and health; see e.g. Komlos (1987, 2008) and Costa (1993, 2004).

[37] All military services also have a set of weight standards for those already in the service that are as strict as, or stricter than, those applied to new recruits (IOM, 2004).

who are muscular and thus particularly desirable recruits (see, e.g. Burkhauser and Cawley, 2008). This became more of a limitation in recent decades, as American men became more muscular. One way of measuring muscularity is to calculate the percentage of Americans who are obese by the standard of BMI (BMI>=30) but not obese by the standard of percent body fat (PBF>25% for men, PBF>30% for women). The trend in this proxy for muscularity is depicted in Figure 3.2, using data from the National Health and Nutrition Examination Surveys (which are explained in more detail in the Data section below). Figure 3.2 shows that muscularity rose dramatically for men; the percentage of men who are obese by BMI but not by PBF nearly tripled between 1960 and 2008 (rising from 4.0 to 11.2 percent). In contrast, muscularity among women remained relatively constant (between 0 and 2 percent) between 1960 and 2008.

FIGURE 3.2. Proxy for Muscularity: Percent Obese by BMI but not by Percent Body Fat



Notes: Data: NHES (1959-62), NHANES I (1971-75), NHANES II (1976-80), NHANES III (1988-94), and NHANES Continuous (1999-2000, 2001-02, 2003-04, 2005-06, and 2007-08). For NHES I and NHANES I, II, and III, points are located at the median year of the survey. For NHANES Continuous, points are placed at the first of the two years of the survey. Obesity definitions are: BMI>=30, percent body fat greater than 25% for men, greater than 30% for women.

Although the DoD provides general guidance, each service can determine its own minimum and maximum weight-for-height and percent body fat standards for enlistment (NRC, 2006; Yamane, 2007). The U.S. Army's current weight-for-height and percent body fat standards for active duty enlistment are listed in Table 3.1 for men and Table 3.2 for women. The weight-for-height standards of the Army vary with age (permitting older recruits to be heavier). Likewise, the maximum allowable percent body fat increases with age, from 26% to 30% for men and 32% to 36% for women.

TABLE 3.1. Current U.S. Army active duty enlistment standards for body weight and percent body fat, men

	Minimum weight(lbs)	***Maximum weight(lbs) by age***			
Height (inches)	**All**	**17-20**	**21-27**	**28-39**	**40+**
60	97	139	141	143	146
61	100	144	146	148	151
62	104	148	150	153	156
63	107	153	155	158	161
64	110	158	160	163	166
65	114	163	165	168	171
66	117	168	170	173	177
67	121	174	176	179	182
68	125	179	181	184	187
69	128	184	186	189	193
70	132	189	192	195	199
71	136	194	197	201	204
72	140	200	203	206	210
73	144	205	208	212	216
74	148	211	214	218	222
75	152	217	220	224	228
76	156	223	226	230	234
77	160	229	232	236	240
78	164	235	238	242	247
79	168	241	244	248	253
80	173	247	250	255	259
Maximum percent body fat	--	26	26	28	30

Notes: Source is Army Regulation 40-501 Table 2-1 and Table 2-2 (December, 2007). Eligible age range is 17-42 years.

TABLE 3.2. Current U.S. Army active duty enlistment standards for body weight and percent body fat, women

	Minimum weight(lbs)	***Maximum weight(lbs) by age***			
Height (inches)	**All**	**17-20**	**21-27**	**28-39**	**40+**
58	91	122	124	126	127
59	94	127	128	130	131
60	97	132	134	135	136
61	100	136	137	139	141
62	104	140	141	144	145
63	107	145	147	148	149
64	110	149	151	153	154
65	114	154	156	158	160
66	117	160	160	162	165
67	121	163	166	168	169
68	125	168	171	173	174
69	128	173	176	178	180
70	132	178	181	183	185
71	136	183	186	188	191
72	140	189	191	194	196
73	144	194	196	200	202
74	148	199	203	204	206
75	152	205	208	210	212
76	156	210	213	215	216
77	160	216	219	221	223
78	164	222	224	227	229
79	168	227	230	234	236
80	173	233	236	240	241
Maximum percent body fat	--	32	32	34	36

Notes: Source is Army Regulation 40-501 Table 2-1 and Table 2-2 (December,2007). Eligible age range is 17-42 years.

The standards in Tables 3.1 and 3.2 apply to the Army. The Navy, Air Force, and Marines have their own weight-for-height and body fat requirements. Despite the substantial differences in standards across services, the National Research Council notes that "There is no rationale given for this variability" (NRC, 2006, p. 117).

Applicants to the military receive medical examinations at military entrance processing stations (MEPS). A two-stage process is used to screen weight and body composition (NRC, 2006). The first stage is to measure weight and height; if the applicant is in the range of acceptable weight-for-height, then no further screening is required. If the applicant exceeds the maximum weight-for-height, then percent body fat is assessed using height and the circumferences of some combination of the abdomen, waist, hip, and neck. The measurement sites vary by service; the Army uses the abdomen and neck (U.S. Army, 2006). If the applicant's percent body fat is in the acceptable range, then the applicant is classified as meeting the requirements. Applicants who exceed both the weight-for-height and percent body fat thresholds are disqualified from enlisting and are encouraged to lose weight and then return to the MEPS for another assessment; under current regulations they must wait four days for every pound of weight to be lost (NRC, 2006). Disqualified applicants have the option of applying for a waiver; each service has its own policy on granting such waivers; see NRC (2006).

III. Data

This study utilizes the full series of nationally representative, cross-sectional health surveys sponsored by the National Center for Health Statistics of the Centers for Disease Control and Prevention. The National Health Examination Survey, Cycle I (NHES) was conducted during 1959-1962. The National Health and Nutrition Examination Surveys (NHANES) program began with NHANES I, which was conducted 1971-1975, and was followed by NHANES II (1976-1980), NHANES III (1988-1994), and NHANES Continuous (1999-2000, 2001-02, 2003-04, 2005-06, and 2007-08). For information on the sampling frame and methods of data collection in these surveys, see National Center for Health Statistics (1965; 1977; 1994; 2000) and McDowell et al. (1981). In each of these surveys, a nationally representative sample of the U.S. civilian non-institutionalized population was selected using a complex, stratified, multistage probability cluster sampling design. These are the best available data for estimating trends in the number and percent of U.S. military-age civilians who exceed the weight-for-height and percent body fat standards of the military, as the data are nationally representative, frequently collected over the past five decades, include demographic information such as age and gender, and, most importantly, contain measurements of weight, height, and other anthropometrics that can be used to calculate percent body fat.

Each NHES and NHANES survey included physical examinations conducted in a specially-designed and equipped mobile examination center where a scientific team including a physician and medical and health technicians measured weight, height, and skinfold thickness at the tricep and subscapular region (which is below the shoulder blade). Additional measures of fatness were recorded in certain surveys, but the only fatness measures that were collected consistently from NHES until NHANES 2007-08 are weight, height, and the two measures of skinfold thickness.

The maximum weight that could be measured was not binding in NHES, and was 400 pounds (182 kg) in NHANES I and II. In NHANES III it was again not binding and in NHANES Continuous it was 440 kg (968 pounds). The top-coding of weight does not affect our classification of individuals, as everyone with the maximum weight -- regardless of height -- is not weight eligible for enlistment in the military.[38]

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[38] The tallest height listed in any of the military standards is 86 inches and the maximum allowable weight for that height is 263 pounds, which is well below the top-coding of weight in the NHES or NHANES.

Skinfold thickness at the tricep and subscapular region were assessed using calipers. The NHES and NHANES medical technicians were trained in measuring skinfold thickness to ensure accuracy and reliability (National Center for Health Statistics, 2000). The NHANES III and NHANES Continuous noted when a skinfold exceeded the capacity of the calipers. We recode the skinfold thickness of such individuals to the maximum caliper size, but this top-coding does not affect estimates of eligibility for enlistment in the military because such individuals are not eligible whether their skinfold is set equal to the maximum caliper size or an even larger number.[39] In addition to recording whether the skinfold exceeded the maximum caliper size, the NHANES III and NHANES Continuous indicated if the examiner could not obtain a measurement (presumably for reasons other than the skinfold exceeding the maximum caliper size). When the skinfold could not be obtained, we impute it separately by sex using the other skinfold thickness (either tricep or subscapular), measured height and weight, age, age squared, race, and ethnicity; this prediction equation is based on respondents with complete information.[40] These regression models explain between 54.87% and 79.13% of the variance in skinfolds,

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[39] The percentage of our analysis sample with tricep skinfolds larger than the maximum caliper size is as follows: 1.20% in NHANES III and from 2.44% to 5.16% in each of the five surveys in NHANES Continuous. The percentage of our analysis sample with subscapular skinfolds larger than the maximum caliper size is as follows: 1.48% in NHANES III, 3.67% in NHANES 1999-2000, 1.22% in NHANES 2001-02, 1.60% in NHANES 2003-04, 1.62% in NHANES 2005-06, and 1.87% in NHANES 2007-08.

[40] The percentage of our analysis sample for whom tricep skinfold thickness could not be obtained was 1.81% in NHANES III, 5.53% in NHANES 1999-2000, 4.61% in NHANES 2001-02, 6.55% in NHANES 2003-04, 4.15% in NHANES 2005-06, and 3.32% in NHANES 2007-08. The percentage of our analysis sample for which subscapular skinfold thickness could not be obtained was 3.63% in NHANES III, 13.80% in NHANES 1999-2000, 13.80% in NHANES 2001-02, 13.25% in NHANES 2003-04, 14.54% in NHANES 2005-06, and 12.89% in NHANES 2007-08.

implying that the imputation procedure provides reasonable predictions for missing skinfolds.

Skinfold thicknesses at the tricep and subscapular region are used to calculate body density using the equations in Durnin and Womersley (1974). Body density is then used to calculate percent body fat (Siri, 1956; Durnin and Womersley, 1974).

We exclude women who were pregnant at the time of the interview (for each survey), and when the information is available (i.e. NHANES I, II, and III) women who were pregnant in the previous year. We examine only those civilians who are age-eligible to enlist in the Army; i.e. those aged 17-42 years. After excluding respondents that did not provide valid responses to all survey items of interest the final combined sample size is 35,337.[41]

IV. Methods

In order to estimate the number and percent of military-age Americans who exceed the U.S Army's enlistment standards for weight-for-height and percent body fat, we use the military's two-stage process. First, we compare the subject's measured weight and height to the active duty enlistment standards of the Army. If the subject's weight is between the minimum and maximum allowable for their height, the subject is classified as meeting the standard. If the subject's weight exceeds the maximum weight for their height, then the subject's percent body fat is compared to the maximum threshold. If the subject's percent body fat is less than or equal to the

[41] Final analysis sample sizes for each survey are: 3,414 for NHES; 6,545 for NHANES I; 5,464 for NHANES II; 7576 for NHANES III; 2,393 for NHANES 1999-2000; 2,628 for NHANES 2001-02; 2,446 for NHANES 2003-04; 2,484 for NHANES 2005-06; and 2,387 for NHANES 2007-08.

maximum allowable, then she is classified as meeting the standard. Subjects who exceed both the weight-for-height and percent body fat thresholds are coded as exceeding the standards.

Population sample weights for those who underwent medical examinations are used when estimating the number and percent of military-age respondents who exceed the U.S. Army's standards. We test the hypothesis of equality across surveys (and, therefore, across time) in the percentage of military-age civilians who exceed Army standards for weight-for-height and body fat.

We also examine which personal characteristics predict exceeding the current Army active duty enlistment standards for weight and body fat. Specifically, we estimate probit regressions in which the dependent variable is an indicator for exceeding the Army weight and body fat standards, using the most recent data, the NHANES Continuous (1999-2008). Regressors include: age (20-24; 25-29; 30-34; 35-39; and 40-42 with 17-19 as the omitted category), race/ethnicity[42] (African American, Hispanic, and other, with White as the omitted category), education (less than high school, some college, and college graduate, with high school graduate as the omitted category), marital status (divorced/widowed/separated and never married, with married as the omitted category), and survey fixed effects (NHANES 1999-2000 as the omitted category). We estimate the reduced-form body fatness production function in equation (1):

$$\text{(1)} \qquad \Pr(E_{it}=1)=\Phi(\alpha_0+\alpha_1^{'}X_{it}+\alpha_2^{'}D_t)$$

[42] NHES and NHANES I, II, and III race and ethnicity information is provided in four mutually exclusive categories: white, black, Hispanic, and other. For consistency we use these categories in all survey years. At the urging of referees, we exclude income from the set of regressors.

Where E_{it} is an indicator variable for individual *i* in survey *t* exceeding current active duty Army enlistment standards for weight-for-height and body fat, X_{it} is a vector of characteristics for individual *i* in survey *t*, D_t is a vector of survey fixed effects, and the α's are the parameters to be estimated. In all regressions, we use the sampling weights for those who underwent medical examinations. As recommended by the NHES and NHANES, standard errors are clustered around the primary sampling unit. For ease of interpretation, we calculate the marginal effect for each individual and report the average of those marginal effects.[43] We also report the probit coefficients and their standard errors. We estimate two specifications of the probit model: 1) one that controls for only exogenous variables (age, race, ethnicity); and 2) one that controls for a richer set of regressors (age, race, ethnicity, education, and marital status). Statistical analyses are conducted using Stata for Windows software version 11 (StataCorp, 2009).

V. Results

The percent of age-eligible U.S. civilians who exceed the U.S. Army's active duty enlistment standards for weight and body fat are listed in Table 3.3. Each row corresponds to a specific survey: NHES (conducted 1959-62), NHANES I (1971-75), NHANES II (1976-80), NHANES III (1988-94), and the various NHANES Continuous surveys (1999-2000, 2001-02, 2003-04, 2005-06, and 2007-08).

[43] We also calculated marginal effects for a hypothetical person with the average values of the regressors and found very similar results.

TABLE 3.3. Percent of age-eligible civilians who exceed current Army active duty enlistment standards for weight and percent body fat, by survey and gender

	(1)	(2)
Survey and Survey Years	**Men**	**Women**
NHES I: 1959-1962	5.548	11.464
	(0.918)	(0.919)
	[N=1637]	[N=1777]
NHANES I: 1971-1975	4.376	15.909
	(0.587)	(0.636)
	[N=2280]	[N=4265]
NHANES II: 1976-1980	6.155	18.589
	(0.495)	(0.892)
	[N=2828]	[N=2636]
NHANES III: 1988-1994	7.270	27.129
	(0.741)	(1.398)
	[N=3871]	[N=3705]
NHANES 1999-2000	11.703	31.511
	(1.359)	(2.294)
	[N=1230]	[N=1163]
NHANES 2001-2002	10.716	28.524
	(0.642)	(1.921)
	[N=1380]	[N=1248]
NHANES 2003-2004	10.395	32.957
	(1.214)	(2.510)
	[N=1295]	[N=1151]
NHANES 2005-2006	10.847	28.832
	(1.364)	(1.874)
	[N=1305]	[N=1179]
NHANES 2007-2008	11.701	34.645
	(1.311)	(2.107)
	[N=1219]	[N=1168]
Percentage Point Change Between NHES I and NHANES 07-08	6.153	23.181
Percent Change Between NHES I and NHANES 07-08	110.901	202.213
p-value[1]	0.0000	0.0000

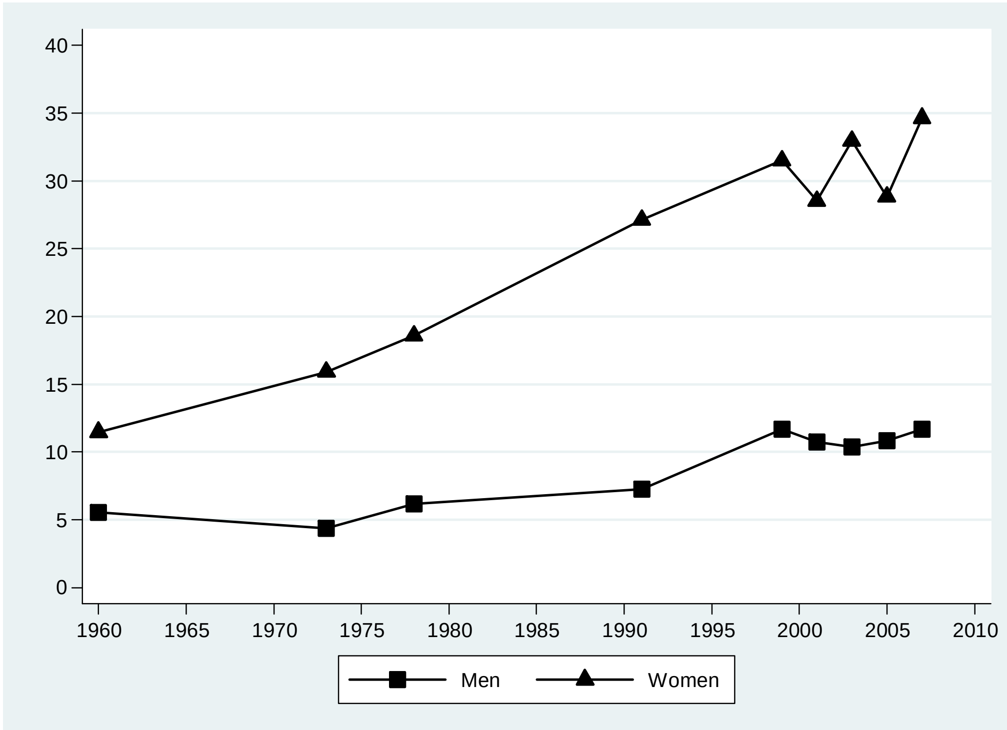
Notes: Percent exceeding standards is calculated by applying current Army weight standards to historical data. See Tables 1 and 2 for current Army enlistment weight standards. Sampling weights with adjustment for strata are used. Standard errors are reported in parentheses and unweighted sample sizes are reported in square brackets.
[1] *t*-test for difference in means between NHES I and NHANES 2007-2008.

For both men and women, the percent of military-age civilians who exceed the Army's weight and body fat requirements rose significantly between the earliest (1959-62) and the most recent (2007-08) surveys. Column 1 of Table 3.3 shows that the percentage of age-eligible (i.e. 17-42 years) male civilians who exceed the Army's weight and body fat limits rose from 5.55% in 1959-62 to 11.70% in 2007-08. This rise of 6.15 percentage points, or 110.90%, is statistically significant at less than a 1% level.

The percentage of the population that exceeds the Army enlistment standards for weight-for-height and percent body fat has risen more for women than men. Column 2 of Table 3.3 shows that the percentage of age-eligible (i.e. 17-42 years) female civilians who exceed the Army's weight-for-height and percent body fat requirements rose from 11.46% in 1959-62 to 34.65% in 2007-08. This rise of 23.18 percentage points, or 202.21%, is statistically significant at less than a 1% level. Figure 3.3 plots the increase over time in the percent of military-age civilian men and women who exceed the Army's enlistment requirements for weight-for-height and percent body fat.[44]

[44] In all Figures, data points are placed at the median year of the survey for NHES I and NHANES I, II, and III, and at the first of the two years of the survey for NHANES Continuous.

FIGURE 3.3. Percent of age-eligible civilians exceeding current Army active duty enlistment standards for weight and body fat



Notes: Data: NHES (1959-62), NHANES I (1971-75), NHANES II (1976-80), NHANES III (1988-94), and NHANES Continuous (1999-2000, 2001-02, 2003-04, 2005-06, and 2007-08). See Table 3 for survey-specific estimates. For NHES I and NHANES I, II, and III, points are located at the median year of the survey. For NHANES Continuous, points are placed at the first of the two years of the survey.

We also calculate the total number of military-age men and women who would be disqualified from enlisting in the Army for exceeding current weight and fat enlistment standards; results are listed in Table 3.4. In the most recent data (2007-08), 5.7 million age-eligible civilian men and 16.5 million age-eligible civilian women exceed both the weight-for-height and percent body fat enlistment standards of the Army.

TABLE 3.4. Total number of age-eligible civilians who exceed current Army active duty enlistment standards for weight and percent body fat, by survey and gender

	(1)	(2)
	Men	**Women**
NHES I: 1959-1962	1,463,445	3,159,992
NHANES I: 1971-1975	1,541,200	5,266,731
NHANES II: 1976-1980	2,490,037	6,869,053
NHANES III: 1988-1994	3,555,372	11,396,794
NHANES 1999-2000	6,088,302	15,182,625
NHANES 2001-2002	5,289,890	13,281,802
NHANES 2003-2004	5,132,264	15,485,703
NHANES 2005-2006	5,263,425	12,992,811
NHANES 2007-2008	5,743,082	16,464,419

Notes: Total number of Americans exceeding standards for enlistment is calculated by applying current Army weight standards to historical data. See Tables 1 and 2 for current Army enlistment weight standards.

We also investigate the correlates of exceeding current active duty enlistment standards for weight and body fat. Table 3.5 reports the results of probit regressions of exceeding the enlistment standards, estimated using data from the NHANES Continuous (1999-2008) for those who are age-eligible to enlist in the Army.[45] Each cell of the table lists the probit coefficient, the standard error (clustered by primary sampling unit) in parentheses, and the average marginal effect in square brackets.

[45] Observations with missing information on race, ethnicity, education, and marital status are dropped from the analysis sample; this sample is slightly smaller than the sample used in the estimation of percent and number eligible for military service.

TABLE 3.5. **Correlates of exceeding current Army active duty enlistment standards for weight and body fat, Continuous NHANES (1999-2008)**

	Men		Women	
	Model (1)	Model (2)	Model (1)	Model (2)
20-24 years	0.081	0.008	0.356***	0.403***
	(0.095)	(0.091)	(0.086)	(0.091)
	[0.015]	[0.001]	[0.122]	[0.136]
25-29 years	0.095	0.001	0.539***	0.683***
	(0.107)	(0.116)	(0.078)	(0.094)
	[0.018]	[0.000]	[0.185]	[0.231]
30-34 years	0.097	-0.001	0.531***	0.669***
	(0.102)	(0.114)	(0.065)	(0.087)
	[0.018]	[0.000]	[0.182]	[0.227]
35-39 years	0.197**	0.095	0.583***	0.703***
	(0.078)	(0.100)	(0.074)	(0.093)
	[0.038]	[0.018]	[0.200]	[0.238]
40-42 years	0.304***	0.197*	0.631***	0.767***
	(0.098)	(0.117)	(0.061)	(0.087)
	[0.058]	[0.038]	[0.217]	[0.260]
African American	0.154**	0.156**	0.563***	0.514***
	(0.067)	(0.067)	(0.056)	(0.057)
	[0.029]	[0.030]	[0.193]	[0.174]
Hispanic	-0.058	-0.061	0.187***	0.119*
	(0.071)	(0.074)	(0.059)	(0.063)
	[-0.011]	[-0.012]	[0.064]	[0.040]
Other race	-0.001	0.028	-0.180*	-0.147
	(0.124)	(0.123)	(0.091)	(0.089)
	[0.000]	[0.005]	[-0.062]	[-0.050]
Less than high school	--	-0.077	--	-0.013
		(0.074)		(0.067)
		[-0.015]		[-0.004]
Some college	--	0.059	--	-0.016
		(0.068)		(0.060)
		[0.011]		[-0.005]
College graduate	--	-0.190*	--	-0.483***
		(0.098)		(0.065)
		[-0.036]		[-0.164]
Divorced	--	-0.100	--	-0.042
		(0.131)		(0.077)
		[-0.019]		[-0.014]
Never married	--	-0.139*	--	0.006
		(0.072)		(0.063)
		[-0.026]		[0.002]
Un-weighted N	5792	5792	5376	5376

Notes: See Tables 1 and 2 for current Army enlistment weight standards. All models employ sampling weights with adjustment for strata and are estimated with a probit model. Each cell of the table lists the probit coefficient, the standard errors (clustered by primary sampling unit) in parentheses, and the average marginal effect in square brackets. All regressions also include survey fixed effects and an intercept. Reference categories are age 17-19 years, white, high school education, and married. Observations with missing information and pregnant women excluded from the analysis sample.
***;**;*=statistically different from zero at 1%; 5%;10% confidence level.

For each gender, Table 3.5 first presents the results of a parsimonious model (Model (1)) that includes only the exogenous regressors age and race/ethnicity. These results indicate that African-Americans are more likely to exceed the weight and fat standards of the Army. Specifically, African-American males are 2.9 percentage points more likely than white males to exceed the standards, and African American females are 19.3 percentage points more likely than white females to exceed the standards. In addition, Hispanic females are 6.4 percentage points more likely than white females to exceed the standards (the difference for Hispanic men is not statistically significant and of the opposite sign).

Older applicants are allowed higher maximum weights for a given height, as well as a higher maximum percent body fat (see Table 3.1 for men and Table 3.2 for women). Still, Table 3.5 indicates that men aged 35-39 and 40-42 are more likely to exceed the enlistment standards for weight and body fat. The same is true for women, among whom the association of age with probability of exceeding the standards is almost monotonic: the point estimates rise consistently with age.

Table 3.5 also presents, for each gender, the results of a model that adds education and marital status to the set of regressors (Model (2)). The addition of these regressors reduces the marginal effects of age for men, but increases the marginal effects of age for women. African-Americans remain significantly and substantially more likely than whites to exceed the standards: 3.0 percentage points more likely for men and 17.4 percentage points more likely for women.

The college-educated are significantly less likely to exceed the standards (3.6 percentage points less likely for men, and 16.4 percentage points less likely for women). In addition, never-married men are 2.6 percentage points less likely to exceed the enlistment standards for weight and body fat.

VI. Extension: Historic Army Standards

As an extension, we examine several historic sets of weight standards for the Army. We have located four historic sets of Army active duty enlistment standards for weight and body fat: those issued in 1961, 1968, 1976, and 1991 as well as the current standards issued in 2007 that are used earlier in this paper. The 1991 regulations were the first of which (we are aware) to include a percent body fat maximum; earlier regulations relied solely on weight-for-height. Figures 3.4 (men) and 3.5 (women) compare the percent of military-age civilians who exceed Army standards for weight and (if applicable) body fat. These figures reveal that weight-for-height standards became much more lenient in 1991. Figure 3.4 shows that, in 2007-08, roughly 12% of military-age American males exceed the 2007 (current) and 1991 Army standards, but that percentage would be roughly 20% if the 1961, 1968, or 1976 weight-for-height standards had remained in place. Likewise, Figure 3.5 shows that, in 2007-08, roughly 35% of military-age American females exceed the 2007 (current) and 1991 Army standards, but that percentage would be over 50% if the 1968 or 1976 standards had remained in place. In brief, the increase over time in ineligibility would have been even greater had the military not relaxed its standards in 1991.[46]

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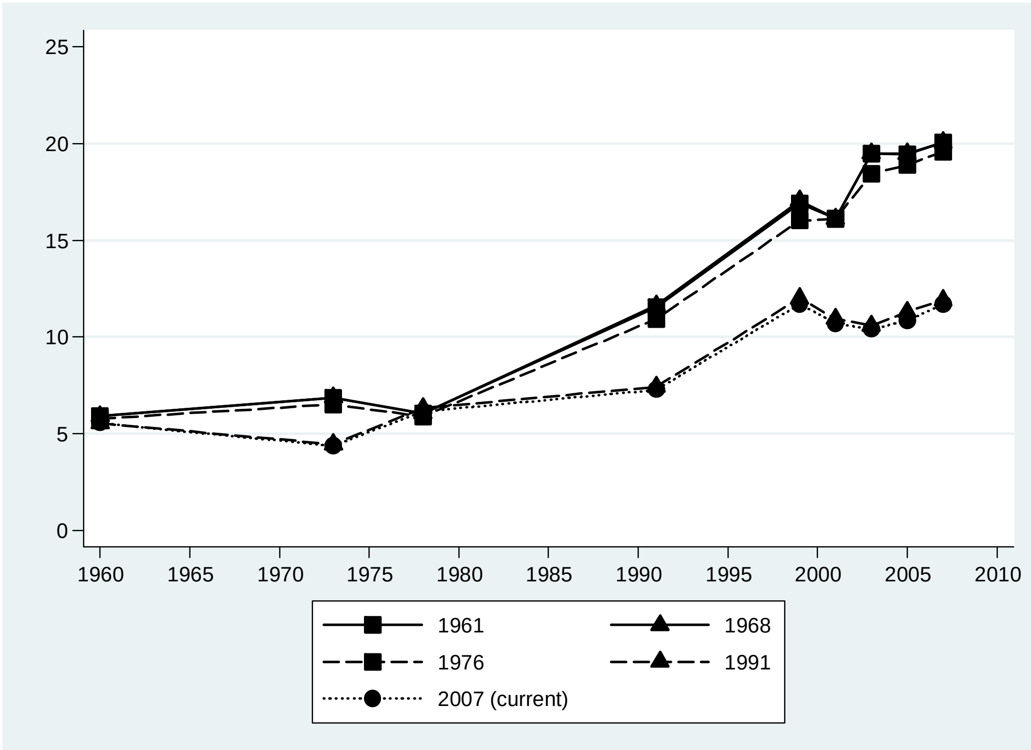
[46] Interestingly, the 1991 regulations are both more lenient, in the sense that they allow an applicant to exceed the maximum weight-for-height as long as he is below the maximum percent body fat, and stricter, in that the maximum weight in pounds for each height was reduced. On net, however, they are more lenient: a substantially higher percentage of Americans satisfy the 1991 regulations than the preceding 1976 regulations. The 1991 regulations are also arguably more accurate or appropriate than

FIGURE 3.4. **Percent of age-eligible male civilians exceeding historic Army active duty enlistment standards for weight and body fat**



Notes: Data: NHES (1959-62), NHANES I (1971-75), NHANES II (1976-80), NHANES III (1988-94), and NHANES Continuous (1999-2000, 2001-02, 2003-04, 2005-06, and 2007-08). For NHES I and NHANES I, II, and III, points are located at the median year of the survey. For NHANES Continuous, points are placed at the first of the two years of the survey. Current Army-age for enlistment is 17-42 years.

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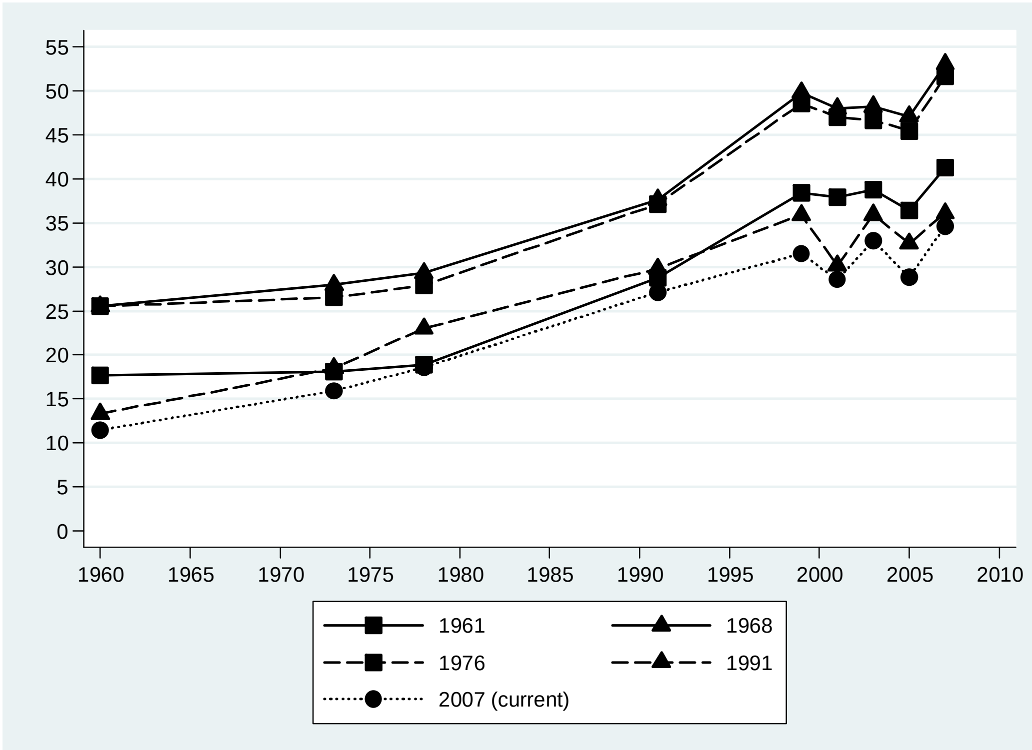
preceding regulations, in that the 1991 regulations permit more muscular individuals and reject fatter individuals at each height.

FIGURE 3.5. Percent of age-eligible female civilians exceeding historic Army active duty enlistment standards for weight and body fat



Notes: Data: NHES (1959-62), NHANES I (1971-75), NHANES II (1976-80), NHANES III (1988-94), and NHANES Continuous (1999-2000, 2001-02, 2003-04, 2005-06, and 2007-08). For NHES I and NHANES I, II, and III, points are located at the median year of the survey. For NHANES Continuous, points are placed at the first of the two years of the survey. Current Army-age for enlistment is 17-42 years.

VII. Extension: Simulation of Future Changes in Weight and Body Fat

As an additional extension, we estimate how future changes in weight and body fat would affect eligibility for military service. This is useful for understanding how a continuation of the rise in obesity would impact the military in the future. More optimistically, it is also useful for estimating the benefit of a reversal of the obesity epidemic (e.g. due to effective public health policies).

In Tables 3.6 (males) and 3.7 (females), we estimate the impact of changes in weight and body fat of 1%, 2%, and 3%, on the number and percent of Americans who would exceed Army standards for weight and body fat. The impact of gains and losses will not necessarily be symmetric, as the additional people pushed over the maximum by a given gain is not necessarily equal to the additional people pushed under the maximum by a given loss (i.e. the mass around the maximum may not be symmetric). To estimate these effects, we examine respondents to the Continuous NHANES (1999-2008), and add or subtract a given percentage (1%, 2%, or 3%) to their weight and percent body fat, then recalculate the number and percentage that would exceed the Army's eligibility standards.

TABLE 3.6. Simulated changes in the number and percent of civilian men exceeding current Army enlistment standards for weight and body fat, men

Change	N exceeding	% exceeding	N change	% change
Lose 3% weight & PBF	3,240,535	6.524	-2,262,858	-41.118
Lose 2% weight & PBF	4,038,583	8.130	-1,464,809	-26.616
Lose 1% weight & PBF	4,781,310	9.626	-722,082	-13.121
No change	5,503,392	11.079	--	--
Gain 1% weight & PBF	6,356,113	12.796	852,721	15.494
Gain 2% weight & PBF	7,109,111	14.312	1,605,718	29.177
Gain 3% weight & PBF	7,978,377	16.062	2,474,985	44.972

Notes: Data: Continuous NHANES (1999-2008). See TABLE 3.1 for current Army enlistment weight standards for men

TABLE 3.7. Simulated changes in the number and percent of civilian women exceeding current Army enlistment standards for weight and body fat, women

Change	N exceeding	% exceeding	N change	% change
Lose 3% weight & PBF	12,065,615	25.746	-2,615,857	-17.817
Lose 2% weight & PBF	12,932,169	27.595	-1,749,303	-11.915
Lose 1% weight & PBF	13,791,576	29.429	-889,896	-6.061
No change	14,681,472	31.328	--	--
Gain 1% weight & PBF	15,962,709	34.062	1,281,237	8.727
Gain 2% weight & PBF	16,902,355	36.067	2,220,883	15.127
Gain 3% weight & PBF	17,944,518	38.290	3,263,046	22.226

Notes: Data: Continuous NHANES (1999-2008). See TABLE 3.2 for current Army enlistment weight standards for women.

Table 3.6 presents results for men. A gain of 1%, 2%, or 3% to both weight and body fat would raise the number of military-age men who exceed the Army's standards by 0.9 million, 1.6 million, or 2.5 million. Losses of 1%, 2%, and 3% in both weight and body fat would have less of an impact than the equivalent gain; such losses would reduce the number who fail the standards by 0.7 million, 1.5 million, and 2.3 million.

For women (Table 3.7), the asymmetry of impacts between gains and losses is even greater. A gain of 1%, 2%, or 3% to both weight and body fat would raise the number of military-age women who exceed the Army's standards by 1.3 million, 2.2 million, or 3.3 million. Losses of 1%, 2%, and 3% have far less of an impact than the equivalent gain. Losses of 1%, 2%, and 3% of weight and body fat would decrease the number who exceed the standards by 0.9 million, 1.7 million, and 2.6 million.

In summary, even small additional increases in weight and fat have the potential to greatly increase the number of military-age civilians who exceed the military's weight-for-height and body fat standards. Unfortunately, equivalent reductions in weight and body fat have smaller beneficial impacts, because (as one would expect with a normal distribution) the number of men and women just below the maximum weight threshold (who could be pushed over the maximum by a small gain) is greater than the number just above the threshold (who could be pushed below the maximum by a small loss).

VIII. Limitations

The limitations of this paper include the following. A recruit who fails to pass the weight-for-height and percent body fat standards can petition to be re-measured at a later date. We are unable to determine which overweight and overfat subjects in our sample might have been able to "make weight" at a later date. We estimate body fat using skinfold thicknesses at the tricep and subscapular regions, whereas the Army uses the circumference of the abdomen and neck (U.S. Army, 2006); however, each is considered an accurate measure of body fat (Heymsfield et al., 2004). We examine only the standards regarding weight-for-height and percent body fat, whereas many other factors, such as standardized test scores, criminal background check, and performance on tests of physical fitness determine whether a recruit is eligible for enlistment. Thus, our estimates of the number of civilians that exceed the standards for weight-for-height and percent body fat are potentially much lower than the number that would fail any of the military's enlistment criteria. However, the purpose of this paper is not to estimate the number of civilians who fail any, or pass all, of the military enlistment standards, but to document how rising obesity disqualifies increasing numbers of civilians from military enlistment.

IX. Discussion

The high and rising prevalence of obesity represents a substantial challenge for military recruitment. The percentage of civilian military-age men and women who exceed military enlistment standards for weight-for-height and percent body fat has risen considerably in the past five decades. Between 1959-62 and 2007-08, the percentage of civilians aged 17-42 years who exceed the Army's enlistment standards for weight and body fat more than doubled for men and tripled for women. As of 2007-08, there were 5.7 million men and 16.5 million women between the ages of 17 and 42 who exceed the Army's enlistment standards for weight and body fat. As a result, the rise in obesity among the civilian population "may pose significant problems for national defense" (Yamane, 2007, p. 1163).

The implications of the rise in obesity for military recruitment depend in part on the number of military recruits needed in the future. If the U.S. completes Operation New Dawn in Iraq and Operation Enduring Freedom in Afghanistan, downsizes its military, and avoids large-scale wars, the impact will be less than if an additional major threat or conflict arises that requires a substantial expansion of the military, in which case rising obesity will represent a substantial obstacle to recruiting a sufficient number of high quality candidates, particularly among females.

The problem would be particularly acute if the U.S. was forced by wartime demands to return to a system of conscription or draft that sought to enlist a high percentage of civilians. Under conscription, military enlistment standards and exemptions can have the unintended consequence of incentivizing certain behaviors in order to avoid military service. For example, the Vietnam-era draft, by exempting those who were attending college, increased college attendance by 4 to 6 percentage points (Card and Lemieux, 2001). Another example from the Vietnam war is that a removal of the draft exemption for married childless men but retention of the exemption for married men with children led to a spike in fertility (Kutinova, 2009). Johnson (1997) contends that, historically, some potential draftees sought to gain weight to disqualify themselves from military service. Yamane (2007) argues that the rise in weight in the civilian population implies that there is a large number of potential draftees for whom it would be relatively easy to intentionally gain a sufficient amount of weight to avoid military service.

The percentage of military-age civilians who exceed weight-for-height and body fat standards increased considerably more for women than men. Although women constitute the minority of each U.S. armed service, the percentages are nontrivial; women represent 6.2% of the Marine Corps, 13.4% of the Army, 14.8% of the Navy, and 19.4% of the Air Force (U.S. Census Bureau, 2010). However, that is subject to change. When engaged in wars that are intense or long in duration, nations tend to enlist individuals previously thought less suited to service. For example, prior to 1941, the U.S. military never seriously considered employing women to fly military planes. That changed with the manpower demands of World War II, and in 1943 the U.S. formed the Women's Airforce Service Pilots (WASPs), through which over 1,000 American women flew military aircraft for noncombat purposes (Campbell, 1996). Today, several nations (e.g. Israel) require mandatory military service of women (Poast, 2006). Future threats or conflicts could lead the U.S. to enlist large numbers of women in its armed forces. Thus, rising obesity among women, not just that among men, represents a concern for national security.

A simplistic response to the challenge presented by the rise in obesity is to relax the enlistment standards to allow heavier and fatter recruits into the military. However, high weight and body fat have been linked to worse job performance in military occupations (IOM, 1990, 2004; Naghii, 2006), and cost the military over $1.2 billion annually in higher health care spending and lower productivity (Dall et al., 2007). The IOM reports that, of the recruits who exceeded the weight-for-height standards but subsequently entered the military because they passed the standards later or received a waiver, 80% left the military before completing their first term of enlistment but after the expenditure of training costs (IOM, 2004). Thus, relaxing the standards could entail substantial costs. It is beyond the scope of this study to calculate the optimal weight standards for the military from a cost-benefit perspective, but that is an important direction for future research.

Our probit results indicate that in recent years (1999-2008), African American females are between 17.4 and 19.3 percentage points more likely than white females, and African-American males are roughly 3 percentage points more likely than white males, to exceed the weight and body fat standards of the Army. These disparities represent a substantial challenge for the U.S. military, which actively seeks to recruit a labor force that is representative of the nation but has recently experienced declining enlistments by minorities, especially African-Americans (Asch et al., 2009).

Collectively, the findings of this paper, and their implications for military recruitment, represent an underappreciated cost of the obesity epidemic, and thus represent an additional reason for the U.S. government to invest in prevention of obesity. Cost-effective school-based interventions to prevent childhood obesity have been identified (Wang et al., 2003; Brown et al., 2007; Cawley, 2007, 2010). In addition, the Federal and state governments can mandate that private health insurance plans cover cost-effective methods of preventing and treating youth obesity (Homer and Simpson, 2007; Cawley, 2010) and states can cover such treatments in their Medicaid programs.

There is a precedent for concerns about military readiness leading to government policies to reduce obesity. Singapore, which has universal male conscription, became concerned about rising obesity among military conscripts and in response implemented in 1992 a broad campaign to reduce youth obesity (Walsh, 2004). Even in the U.S. there is precedent for the military advocating policies to ensure healthy weight among youths; the Mission: Readiness (2010) report notes that, after World War II, General Lewis Hershey, the Director of the Selective Service, convinced Congress to pass the National School Lunch Act "…as a way to improve the nutrition of America's children, increase their height and weight, and ensure America's national security" (Mission: Readiness, 2010, p. 1). Ironically, the modern school lunch program has been identified as a contributing factor to childhood obesity (e.g., Schanzenbach, 2009). As a result, retired generals and admirals are now calling for the removal of high-calorie, low-nutrient foods from schools and for improving the quality of the school lunch program (Mission: Readiness, 2010). The need for effective obesity prevention is urgent, as our estimates indicate that an additional gain in weight and percent body fat of just 1% would disqualify an additional 853,000 men and 1.3 million women from serving in the Army.

The trends documented in this paper suggest that retaining already-fit members of the military may be increasingly cost-effective relative to recruiting civilians who satisfy military weight and body fat requirements. A direction for future research is to examine whether cost effectiveness considerations justify shifting resources away from recruitment and toward retention.

The trends documented in this paper also suggest that the military may need to increasingly engage in factor substitution. As obesity raises the cost of recruiting an additional soldier who meets military weight requirements (and lowers the marginal product of military labor), it may be cost-saving to substitute capital for labor. The military has recently engaged in such factor substitution, e.g. moving from manned to unmanned aerial vehicles (e.g. Predator drones); additional substitution of capital for labor could help the military deal with a shrinking pool of high-quality recruits.

Another possibility is to substitute one type of labor to another. During the War on Terror, the U.S. military has increasingly outsourced activities to private military companies, which can recruit from a broader, international, labor pool (Singer, 2003). Though perhaps repugnant to some (Roth, 2007), such outsourcing of military functions could alleviate the burden on the U.S. military to find a large number of fit military recruits.

An ongoing challenge for the military is how to accurately measure fitness for service. Initially the military used weight-for-height, in part because it is easy to assess, but it is a noisy measure of fatness (Burkhauser and Cawley, 2008), and had the undesirable consequence of excluding men with high muscle mass, so the military now admits applicants who exceed the weight-for-height standard as long as their percent body fat is under a certain threshold (Johnson, 1997). Moreover, the services have varying standards of weight-for-height and body fat with no clearly articulated rationale based on difference of needs (NRC, 2006). An important direction for future research is to determine the measure of fatness, and the enlistment standards based on that measure of fatness, that are optimal for each service.

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