THE SUPER SIZE OF AMERICA:

AN ECONOMIC ESTIMATION OF BODY MASS INDEX AND OBESITY IN ADULTS

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The drudgery of seeking subsistence has been supplanted for millions of people, not by abundance and indulgence, but rather by a new concept of what are necessities and needs. – George Katona, *The Mass Consumption Society* [1964, 6]

INTRODUCTION

The *New York Times* recently featured in its book review section a book by Greg Critser entitled *How Americans Became the Fattest People in the World,* further shedding light on the obesity epidemic that has been prominently featured in the media. While obesity is not a new problem, it has recently surged into public consciousness. For most individuals, being overweight, defined as having a body mass index of 25 kg/m^2 or higher, and being obese, defined as having a body mass index of 30 kg/m^2 or higher, result from a combination of excess caloric intake and inactivity [Koplan and Dietz, 1999; Public Health Service, 2001]. The majority of Americans are now overweight [Must et al., 1999; Flegal et al., 2002]. According to the USDA, Americans consumed 2,002 calories per day in 1994-1996, as opposed to 1,854 in 1977-1978 [Frazao, 1999]. While rates of overweight and obesity had remained steady until about 1980, since then overweight and obesity in the United States have escalated dramatically. This is an indication that genetics may not play such a large role in obesity, as genetic change does not occur so rapidly over time. According to Koplan and Dietz [1999], the gene pool in the US has not changed significantly between 1980 and 1994. A study using twins has indicated that perhaps there is a much larger environmental effect in determining body weight than previously believed [Segal and Allison, 2002].

Second only to tobacco as the leading cause of premature death [McGinnis and Foege, 1993], obesity and sedentary lifestyle are rapidly becoming the first. Obesity

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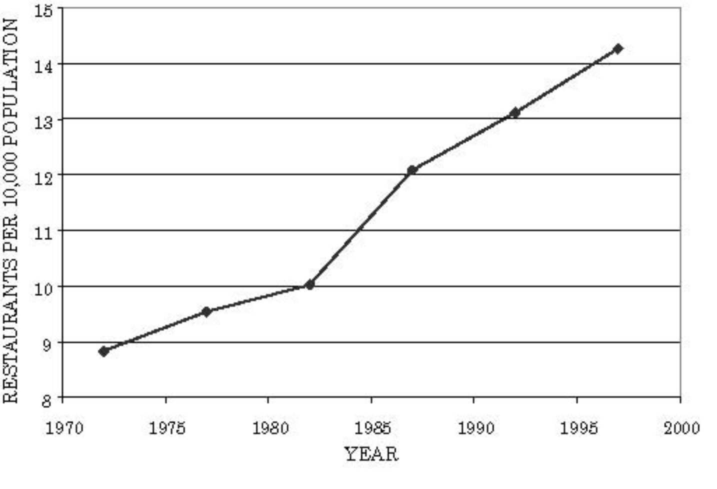
and sedentary lifestyles accounted for approximately 400,000 deaths in 2000, compared to 435,000 from cigarette smoking, 100,000 from alcohol abuse, and 20,000 from illegal drug use. They are related to such illnesses as coronary heart disease, stroke, high blood pressure, cancers of the colon, breast and prostate, and diabetes [Must et al., 1999; Mokdad et al., 2003]. Obesity has also been associated with high cholesterol, menstrual irregularities, pregnancy complications, and psychological disorders such as depression [NIDDKD, 1996]. Known to many as adult-onset diabetes, type II diabetes is now not uncommon among children as a result of the obesity epidemic [Freedman et al., 1999]. Obesity in adulthood has been shown to reduce life expectancy, most notably at younger ages [Peeters et al., 2003; Fontaine et al., 2003].

This paper investigates the idea that the recent rapid increase in obesity rates are due to economic changes that have in turn caused behavioral changes in the lives of Americans. These changes in the environment have changed habits and redefined social and cultural norms. Changes in the surrounding environment have been numerous. The per capita number of restaurants increased by 61 percent between 1972 and 1997 (see Figure 1). Since more women are in the labor force today than in the 1970s, eating out has become more common as families are encouraged to purchase food away from home.[1] We thus argue that this increase in female labor force participation operates through its effect on consumption of food away from home. Chou et al. [2001] control for predicted wages and predicted working hours when exploring the effect that restaurants potentially have on obesity, and find that this does not alter the significance or magnitude of the coefficient on the restaurants variable. Figure 2 shows the trend in female labor force participation in the US from 1970 to 2000. In 1971, 43 percent of women were in the labor force, a figure which increased to almost 60 percent by 1994. Technological changes have made for an easier lifestyle, and thus less physical activity is embedded into daily activities. Jobs have become more sedentary,

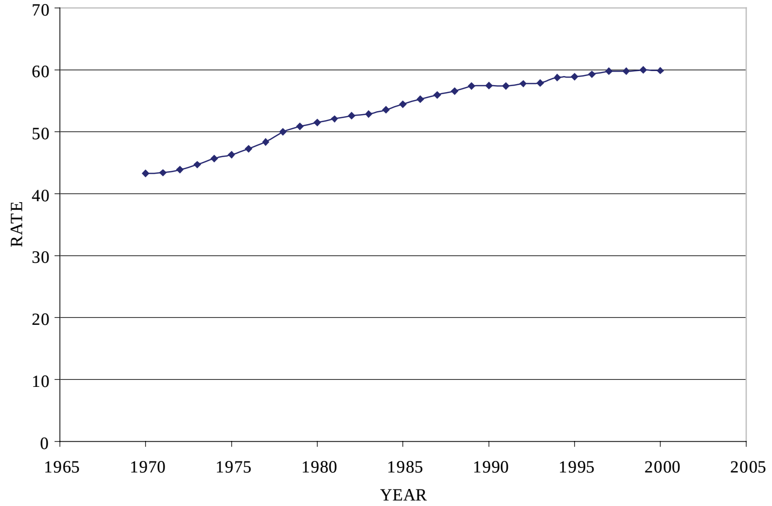
FIGURE 1
Restaurants per 10,000 population, 1972-1997



Source: Bureau of Labor Statistics

contributing to the lack of physical activity that many experience. Many must now stray from their daily routines and pay for gym memberships in order to be more physically active.

FIGURE 2
Female Labor Force Participation, Ages 16 and over, 1970-2000



Source: Bureau of Labor Statistics

To study the determinants of body mass index and obesity, we employ pooled micro-level data from the First, Second, and Third National Health and Nutrition Examination Surveys (NHANES I, NHANES II, and NHANES III). These data, described later in full, are what the Centers for Disease Control use to track changes in obesity over time, as they contain measures of weight and height based on actual physical examinations. We augment these data using state-level policy variables pertaining to the per capita number of restaurants, the gasoline tax, the cigarette tax, and clean indoor air laws. We find that the increase in the per capita number of restaurants in particular increases obesity, and that female body mass index is responsive to changes in the cigarette tax.

BACKGROUND AND LITERATURE REVIEW

The prevalence of morbid obesity, the most severe form of obesity defined by a body mass index of 40 kg/m^2 or higher, increased from 0.78 percent in 1990 to 2.2 percent in 2000 [Freedman et al., 2002].[2] The body mass index (BMI) is the most convenient measure available in assessing overweight and obesity, its limitations being that it might overestimate body fat in athletes who have a muscular build and underestimate body fat in older people who have lost muscle mass [NIDDKD, 1996].[3] Table 1 shows how average BMI and the percentage obese have changed over time in the four NHANES data sets.[4] The change between NHANES II and NHANES III is most notable, where a 57 percent increase occurs in the percentage of people who are obese. Average BMI goes up by 1.28 kg/m^2, or 5.1 percent, from 25.07 kg/m^2 to 26.35 kg/m^2. Table 2 shows differences across gender. This shows a 127 percent increase in the percentage of obese males between NHANES I and NHANES 99, and a 106 percent increase for females. The percentage of obese females, however, has remained consistently higher than the percentage of obese males.

TABLE 1
Trends in Body Mass Index and the Percentage of Obese, Persons 17 Years of Age and Older

Survey	Period	Body Mass Index	Percentage Obese
NHANES I	1971-1975	25.06	13.62
NHANES II	1976-1980	25.07	13.67
NHANES III	1988-1994	26.35	21.47
NHANES 99	1999-2000	27.77	29.19

Survey weights are employed in all computations.

TABLE 2
Trends in Body Mass Index and the Percentage of Obese, Persons 17 Years of Age and Older, By Gender

		Males		Females	
Survey	Period	Body Mass	Percentage	Body Mass	Percentage
	Index	Obese	Index	Obese	
NHANES I	1971-1975	25.33	11.31	24.81	15.71
NHANES II	1976-1980	25.22	11.36	24.94	15.78
NHANES III	1988-1994	26.41	18.86	26.29	23.85
NHANES 99	1999-2000	27.49	25.69	28.04	32.43

Survey weights are employed in all computations.

Part of the tremendous increase in the obesity rate over time has been attributed to reductions in job strenuousness [Philipson, 2001; Lakdawalla and Philipson, 2002]. Lakdawalla and Philipson use the National Health Interview Survey (1976-1994) and the National Longitudinal Survey of Youth (1982-1998) to show that decreases in job strenuousness over a long period of time are mainly responsible for increases in BMI over time. However, job strenuousness was relatively stable between the NHANES II and NHANES III time periods. The authors explain the rapid increase in the last two decades with changes in food prices. One disadvantage is that they are forced to use self-reported measures of weight and height rather than actual measures, yet they do attempt to correct for this.[5] Philipson [2001] points out that the American society has shifted from an agricultural one to a post-industrial one. This shift has been accompanied by innovations that economize on time spent in the household sector, such as convenience food for consumption. An increase in the variety of the food supply may contribute to the maintenance of obesity [Raynor and Epstein, 2001].

Cawley [1999] has presented evidence suggesting that caloric intake is addictive. This is in line with findings that high-density fast food might indeed be addictive [Naik and Moore, 1996; Schlosser, 2001]. Fat consumption in the US has increased [Ippolito and Mathios, 1995; Frazao, 1999]. Evidence has also been put forth suggesting that obesity is associated with lower wages for women [Averett and Korenman, 1996; Cawley, 2004]. The negative externalities that obese people impose on others has also been considered [Keeler et al., 1989].[6]

Chou, Grossman, and Saffer [2001, 2002, 2004] employ micro-level data from the 1984-1999 Behavioral Risk Factor Surveillance System to show the determinants of body mass index and obesity. They find large positive elasticities associated with the per capita number of restaurants, and at the same time, direct positive effects of labor market attachment on obesity. They theorize that perhaps labor market attachment has indirect effects on obesity that operate through restaurant availability. Ewing et al. [2003] have attributed part of the increase in obesity to the degree of urban sprawl. Urban sprawl measures the process through which the spread of development across the landscape outpaces population growth. Using a more comprehensive measure of urban sprawl, Smart Growth America has calculated a reliable measure of how conducive a city is to exercise. Those urban areas that offer more transportation choices, are more compact, and have a variety of stores and activity centers within reach have lower rates of obesity.

Global comparisons can be seen in Cutler et al. [2003], highlighting the leading role that the United States plays in the obesity epidemic. They stress a theory of increased obesity based on the division of labor in food preparation and thus reductions in the time cost of food. The mass preparation of food has allowed for the reduction of the marginal cost of preparing food by substituting capital for labor, leading to repeated food consumption of greater variety. They postulate that fattening meals at fast food restaurants have not made Americans obese as most of the increase in food consumption has been due to increased snacking.[7]

The magnitude of the obesity epidemic begs the question as to why the increase has been so rapid, as well as what policy changes might be done in order to reverse this trend. Part of this question has been answered by previous research. This paper uses comprehensive data rich in covariates with objective measures covering a long time period, 1971-1994. In addition, we consider gender groups separately.

EMPIRICAL METHODOLOGY

A household utility function such as that outlined by Becker [1965] provides a useful framework for assessing body mass index. While no one wishes to be obese, some people gain more utility out of consuming food than others. People combine the obtaining of goods and services in the market with their own time to achieve objects that enter their utility functions – such as health, entertainment, and the enjoyment of eating palatable food.

In this paper we use the National Health and Nutrition Examination Survey, which has an advantage over other data sets in that it has actual measures of body mass index rather than self-reported measures. We use pooled data from 1971 to 1994.

Obesity (O) is a function of caloric intake, caloric expenditure, smoking, and a vector of variables that are specific to an individual and reflect that individual's predisposition towards obesity. Demand functions for caloric intake, caloric expenditure, and smoking are generated that depend on a set of exogenous variables as follows:

$$O = O(R, t_c, indoor, t_g, E, A, G, S, H, M) \tag{1}$$

In equation (1), R represents restaurants, t_c is the cigarette tax, , *indoor* represents clean indoor air laws, t_g is the tax on gasoline, E represents ethnic and racial background, A is age, G is gender, S denotes years of formal schooling completed, H is household income, and M represents marital status. We translate equation (1) into an empirical one through the following equation:

$$\begin{aligned} O = {} & \alpha_0 + \alpha_1 R + \alpha_2 R^2 + \alpha_3 t_c + \alpha_4 t_c^{\,2} + \alpha_5 indoor + \alpha_6 t_g + \alpha_7 t_g^{\,2} + \\ & \alpha_8 black + \alpha_9 hispanic + \alpha_{10} other + \alpha_{11} A + \alpha_{12} A^2 + \alpha_{13} male + \\ & \alpha_{14} elem + \alpha_{15} somehigh + \alpha_{16} high + \alpha_{17} somecoll + \\ & \alpha_{18} college + \alpha_{19} H + \alpha_{20} H^2 + \alpha_{21} married + \alpha_{22} divorced + \\ & \alpha_{23} widowed + \overline{\alpha_{24}}(years) + \overline{\alpha_{25}}(states) + u \end{aligned} \tag{2}$$

Quadratic terms are included in equation (2) for the per capita number of restaurants, as well as for taxes, income, and age. This is to account for the likelihood that an additional value at higher levels will have less of an effect on the dependent variables as that of an additional value at lower levels.[8] *Black*, *Hispanic*, and *other* are dummy variables for race and ethnicity; *male* is a dummy variable for whether or not the respondent is male; *elem*, *somehigh*, *high*, *somecoll*, and *college* are dummy variables for years of schooling completed; *married*, *divorced*, and *widowed* are dummy variables for marital status; *years* and *states* represent indicators for year of survey and state of residence, respectively; α_{24} and α_{25} thus represent vectors.

MICRO-LEVEL DATA

To investigate the determinants of body mass index and obesity, we employ micro-level data from the First, Second, and Third National Health and Nutrition Examination Surveys (NHANES I, II, and III, respectively). These are national samples of the population of the US ages 6 months to 74 years (NHANES I and II), and ages 2 months and over (NHANES III) with some oversampling of preschool children and the elderly in all three surveys; low-income families in NHANES I and II; women of childbearing ages in NHANES I; and blacks and Mexican Americans in NHANES III. The oversampling of low-income families in NHANES I and II results in the presence of more blacks in these surveys than in a random sample of the population of the US. Similarly, the oversampling of blacks and Mexican Americans in NHANES III results in more low-income families than in a random sample. We focus in this paper on all adults 17 years of age and older. All three surveys were conducted by the National Center for Health Statistics (NCHS); NHANES I was conducted between 1971 and 1975; NHANES II was conducted between 1976 and 1980; and NHANES III was conducted between 1988 and 1994. Most states of the US are represented in each survey.

DEPENDENT VARIABLES

Body mass index (BMI), also termed Quetelet's index, is measured as weight in kilograms divided by height in meters squared, and is most commonly used in analyzing overweight and obesity. While there are various guidelines for defining overweight and obesity, we adopt the convention outlined by the National Institutes of Health in Clinical Guidelines [Public Health Service, 2001]. Following this method, an adult that is overweight is one with a BMI of 25 kg/m^2 or higher, while one that is obese has a BMI of 30 kg/m^2 or higher. Obesity characterized by a BMI in the range 30 - 34.9 is termed class 1 obesity, in the range 35-39.9 class 2 obesity, and that greater than 40 kg/m^2 class 3 obesity, or morbid obesity. The dependent variables that we use are body mass index and the probability of being obese, where an obese respondent is one with a BMI of 30 kg/m^2 or higher.

INDEPENDENT VARIABLES

The state-level variables included on the RHS of the equation pertain to the per capita number of restaurants, the cigarette tax, clean indoor air laws, and the gasoline tax. Including more state-level variables would cause the model to be plagued by multicollinearity. We must thus be partial to our results and generalize our conclusions to include effects of state-level variables that might be highly correlated with the ones that we include in our model.

The per capita state-level number of restaurants is taken from the Census of Retail Trade. Frequency of fast food restaurant use has been shown to be associated with higher fat intake and greater body weight [French et al., 2000; Rolls and Hammer, 1995; Public Health Service, 2001], as fast food restaurants serve especially large portions [Nielsen and Popkin, 2003]. The Census of Retail Trade is part of the Economic Census and is collected every five years. The data we use are from 1972, 1977, 1982, 1987, 1992, and 1997. Fast food restaurants correspond to the Census category *refreshment places* while full service restaurants correspond to the Census category *restaurants and lunchrooms*. In 1997 this classification system changed; refreshment places became *limited service restaurants*, and restaurants and lunchrooms became *full service restaurants*. Since these categories did not exactly overlap, a correction was used based on national data that the Census collected for both categories. This correction thus involved multiplying the 1997 state-level values for *limited service restaurants* by the ratio of nation-wide *refreshment places* to *limited service restaurants*. Similarly, 1997 state-level values for *full service restaurants* were altered by multiplying these values by the national ratio of *restaurants and lunchrooms* to *full service restaurants*. Data for years not covered are linearly interpolated and extrapolated. The distinction between fast food and full service restaurants in the Census of Retail Trade is not clear-cut; many full service restaurants serve the type of high-caloric, inexpensive food that fast food restaurants serve. Therefore, our restaurant variable takes the sum of fast food restaurants, where in general people pay before eating, and full service restaurants, which in general provide waiter/waitress service.

State taxes on gasoline are obtained from *Facts and Figures on Government Finance*. The interpretation of the effect that the gasoline tax has on obesity can be looked at from two angles. On the one hand increases in the gasoline tax could encourage people to walk and be more physically active. On the other hand increases could be a proxy for increases in the time cost associated with traveling in order to obtain healthy food. This could in turn encourage people to consume cheap, high-density convenience food.

Included among the RHS variables are state cigarette taxes and clean indoor air laws. The cigarette tax is taken from the Tax Burden on Tobacco. Clean indoor air laws are taken from the Centers for Disease Control and Prevention website (http://www.cdc.gov). The four indoor air laws pertaining to government workplaces, private workplaces, restaurants, and other places, are summed to form one variable. We expect cigarette taxes to be a positive function of BMI, as smoking has been used as a method of weight control [Fehily et al., 1984; Tomeo et al., 1999]. A combination of federal and state tax hikes, clean indoor air laws forbidding smoking in designated areas, and the anti-smoking campaign have caused people to smoke less over time. This may be part of the reason for the increase in BMI over time, an unintended consequence of the anti-smoking campaign.

Medical science has established the effects of caloric intake and physical activity on body mass index, and caloric intake and physical activity are poorly measured in NHANES.[9] We therefore estimate reduced form models. Our main concern in this paper is the effect that our state-level variables – in particular, the per capita number of restaurants – have on trends in our outcome variables, body mass index and obesity.

RESULTS

Table 3 shows means and standard deviations of the variables. Tables 4 and 5 show results where body mass index and obese are the dependent variables. Results are pooled as well as stratified by gender.[10] All regressions implement standard errors that cluster on state cells due to the aggregate nature of several of our RHS variables. The per capita number of restaurants affects females more than males in both BMI and obesity regressions. This is a poignant result, as it could reflect the increased cost of time, especially for women who are working more and have less time for meal preparation at home. An increase in the cigarette tax is shown to increase female BMI but not obesity. This is an expected result, as smoking would lower a person's BMI but not necessarily determine whether or not a person is obese. One can also think of smoking as being correlated with other unhealthy behavior, such as lack of exercise. Blacks, Hispanics, males, older people, and those who are married or widowed are more likely to have a higher BMI, while those with higher incomes and those with a college education are more likely to have a lower BMI. While males are more likely to have a higher BMI, they are less likely to be obese, reflecting the way BMI tends to overestimate overweight and obesity in people with more muscular mass.[11] Looking at results for males and females separately, however, reveals that black males do not significantly have a higher BMI, and males with higher incomes have a higher BMI.

TABLE 3

Definitions, Means, and Standard Deviations of Variables for Pooled Sample

Variable	Definition	Mean (Standard Deviation)
Body mass index	Weight in kilograms divided by height in meters squared	25.552 (5.262)
Obese	Dichotomous variable that equals 1 if body mass index is equal to or greater than 30	0.166 (0.372)
Black non-Hispanic	Dichotomous variable that equals 1 if respondent is black but not Hispanic	0.105 (0.307)
Hispanic	Dichotomous variable that equals 1 if respondent is Hispanic	0.063 (0.243)
Other race	Dichotomous variable if respondent's race is other than white or black	0.022 (0.147)
Male	Dichotomous variable that equals 1 if respondent is male	0.478 (0.500)
Elementary	Dichotomous variable that equals 1 if respondent completed at least 8 years of formal schooling	0.063 (0.243)
Some high school	Dichotomous variable that equals 1 if respondent completed at least 9 years but less than 12 years of formal schooling	0.168 (0.374)
High school graduate	Dichotomous variable that equals 1 if respondent completed exactly 12 years of formal schooling	0.352 (0.478)
Some college	Dichotomous variable that equals 1 if respondent completed at least 13 years but less than 16 years of formal schooling	0.173 (0.378)
College graduate	Dichotomous variable that equals 1 if respondent graduated from college	0.156 (0.363)
Married	Dichotomous variable that equals 1 if respondent is married	0.645 (0.478)
Divorced	Dichotomous variable that equals 1 if respondent is divorced or separated	0.085 (0.278)
Widowed	Dichotomous variable that equals 1 if respondent is widowed	0.058 (0.234)
Household income	Real household income in tens of thousands of 1982-84 dollars	2.907 (2.395)
Age	Age of respondent	41.243 (16.681)
Restaurants	Number of fast-food restaurants and full-service restaurants per ten thousand persons in respondent's state of residence	11.039 (2.270)
Cigarette tax	Real state cigarette tax in 1982-84 cents	22.581 (9.770)
Gas tax	Real state gasoline tax in 1982-84 cents per gallon	15.050 (3.837)
Indoor	Sum of indoor air law dichotomous variables (private+government+restaurant+other)	0.816 (1.318)

Standard deviation in parentheses. Sample size is 42,003. NHANES sample weights are used in calculating the mean and standard deviation.

Elasticities of BMI in Table 6 are computed at sample means using the coefficients from the models in Table 4. The elasticities of the state-level variables are indicative, as they are based on results which include time effects yet that nevertheless do not wipe out the effects of the policy variables. The restaurant elasticity implies that as the per capita number of restaurants increases by one percent, the average body mass index will rise by 0.09 percent, holding other covariates constant. Accordingly, if the per capita number of restaurants experiences a 100 percent increase, the average body mass index will rise by 2.25 kg/m^2 if the mean is at 25 kg/m^2.[12] The gas tax at first appeared to have a negative effect when viewing the coefficients in Tables 4 and 5, yet this switches signs at the mean, as seen in Table 6. This could mean that people do not travel as much to obtain healthier food, an added cost to preparing food at home.

TABLE 4
Body Mass Index Regressions, Persons 17 Years of Age and Older

Independent Variables	(1) Pooled	(2) Males	(3) Females
Restaurants	0.473	-0.006	0.893*
	(1.46)	(0.02)	(1.73)
Restaurants squared	-0.012	0.009	-0.031*
	(1.05)	(0.62)	(1.66)
Cigarette tax	0.058*	0.022	0.102*
	(1.81)	(0.56)	(1.95)
Cigarette tax squared	-0.001**	-0.001	-0.002**
	(2.46)	(0.87)	(2.47)
Indoor	-0.031	0.021	-0.077
	(0.44)	(0.22)	(0.96)
Gas tax	-0.143*	-0.119	-0.196
	(1.86)	(1.53)	(1.55)
Gas tax squared	0.005**	0.004**	0.007
	(2.05)	(2.01)	(1.61)
Black non-Hispanic	1.375***	0.223	2.346***
	(8.44)	(1.61)	(10.44)
Hispanic	0.865***	0.375	1.231***
	(3.71)	(1.22)	(5.74)
Other race	-1.384***	-1.791***	-1.093**
	(3.71)	(4.89)	(2.22)
Age	0.326***	0.268***	0.363***
	(19.98)	(18.34)	(14.44)
Age squared	-0.003***	-0.003***	-0.003***
	(18.07)	(17.64)	(12.53)
Male	0.434***		
	(4.20)		
Elementary	-0.327**	-0.235	-0.540**
	(2.12)	(1.03)	(2.07)
Some high school	-0.160	0.114	-0.661**
	(1.31)	(0.75)	(2.65)
High school graduate	-0.304**	0.378**	-1.163***
	(2.35)	(2.31)	(5.05)
Some college graduate	-0.655***	0.250*	-1.734***
	(4.12)	(1.83)	(5.61)
College graduate	-1.268***	-0.394***	-2.583***
	(7.83)	(2.59)	(8.20)
Household income	-0.164***	0.156**	-0.420***
	(3.19)	(2.32)	(7.48)
Household income squared	0.011**	-0.013**	0.029***
	(2.16)	(2.20)	(5.12)
Married	0.405**	0.874***	0.065
	(2.50)	(6.68)	(0.26)
Divorced	-0.163	-0.074	0.471*
	(0.81)	(0.33)	(1.70)

TABLE 4 (cont.)
Body Mass Index Regressions, Persons 17 Years of Age and Older

Independent Variables	(1) Pooled	(2) Males	(3) Females
Widowed	0.580**	0.629*	-0.258
	(2.45)	(2.02)	(0.86)
Constant	14.813***	18.573***	12.351***
	(6.10)	(6.93)	(3.55)
R-square	0.10	0.10	0.13
Sample size	42,003	18,707	23,296

Note: All regressions include state and year dummies. All regressions employ sample weights. Absolute values of t-ratios are reported in parentheses. Huber [1967] or robust standard errors on which they are based allow for state clustering.
* Significant at the 10 percent level.
** Significant at the 5 percent level.
*** Significant at the 1 percent level.

A possible source of concern is the potential endogeneity of the restaurant variable. Restaurants, for example, are not randomly distributed, as they might locate themselves in areas with higher BMIs, and/or be correlated with income. This can be overlooked somewhat when we see that the rise in restaurants per capita began before the rise in obesity (see Figure 1 and Table 1). We experimented with lagged restaurants per capita (lagged three years) and found that the positive and significant effect that the per capita restaurants had on BMI and obesity did not disappear.[13]

By comparing the observed change in body mass index and obesity over time (in our case, between 1971 and 1994) with the predicted change based on our model, we can determine how well we have predicted BMI. According to Table 7, our model accounts for about 27 percent of the actual change in body mass index for the pooled model, 79 percent for males, and only one percent for females. Clearly there is something going on with females that we have not been able to capture using this model. These values can be obtained by dividing the total predicted change with the observed change. The increase in the per capita number of restaurants makes the largest contribution to the body mass index outcome, accounting for 54 percent of the growth in body mass index in the pooled model. Unmeasured factors over time account for 73 percent of the growth in body mass index in the pooled model. In order to determine the impacts of selected factors in Table 7, we multiplied the coefficients from our samples in Table 4 with the change in that variable between 1971 and 1994, the initial and terminal years in our sample. Restaurants account for a sizeable amount of the change in BMI over time.

TABLE 5
Obese Regressions, Persons 17 Years of Age and Older

Independent Variables	(1) Pooled	(2) Males	(3) Females
Restaurants	0.049**	0.032	0.064**
	(2.57)	(1.34)	(2.04)
Restaurants squared	-0.001*	-0.000	-0.002
	(1.73)	(0.34))	(1.52)
Cigarette tax	0.004*	0.002	0.006
	(1.82)	(0.87)	(1.60)

TABLE 5 (cont.)
Obese Regressions, Persons 17 Years of Age and Older

Independent Variables	(1) Pooled	(2) Males	(3) Females
Cigarette tax squared	-0.000*	-0.000	-0.000*
	(1.85)	(0.57)	(1.83)
Indoor	-0.003	0.001	-0.008
	(0.76)	(0.23)	(1.46)
Gas tax	-0.009	-0.008	-0.012
	(1.63)	(1.42)	(1.42)
Gas tax squared	0.000*	0.000**	0.000
	(1.95)	(1.97)	(1.59)
Black non-Hispanic	0.071***	0.019**	0.114***
	(7.79)	(2.26)	(9.05)
Hispanic	0.032*	0.013	0.045**
	(1.84)	(0.62)	(2.24)
Other race	-0.051**	-0.081***	-0.027
	(2.53)	(4.17)	(0.82)
Age	0.014***	0.011***	0.017***
	(14.76)	(7.09)	(14.06)
Age squared	-0.000***	-0.000***	-0.000***
	(14.86)	(7.11)	(13.10)
Male	-0.036***		
	(5.77)		
Elementary	-0.022**	-0.019	-0.029**
	(2.10)	(1.13)	(2.05)
Some high school	-0.010	0.016	-0.044**
	(1.13)	(1.18)	(2.63)
High school graduate	-0.024**	0.019	-0.072***
	(2.32)	(1.20)	(4.83)
Some college graduate	-0.052***	-0.006	-0.101***
	(4.98)	(0.44)	(6.15)
College graduate	-0.088***	-0.045***	-0.146***
	(7.56)	(3.47)	(7.56)
Household income	-0.016***	-0.006	-0.024***
	(4.23)	(1.10)	(5.54)
Household income squared	0.001***	0.001	0.002***
	(2.90)	(0.93)	(3.69)
Married	0.013	0.032**	-0.001
	(1.12)	(2.22)	(0.08)
Divorced	-0.007	-0.017	-0.011
	(0.50)	(1.06)	(0.63)
Widowed	0.028	0.024	0.001
	(1.58)	(0.80)	(0.08)
Constant	-0.456***	-0.388**	-0.532***
	(3.30)	(2.11)	(2.71)
R-square	0.05	0.04	0.07
Sample size	42,003	18,707	23,296

Note: All regressions include state and year dummies. All regressions employ sample weights. Absolute values of t -ratios are reported in parentheses. Huber (1967) or robust standard errors on which they are based allow for state clustering.

* Significant at the 10 percent level.

** Significant at the 5 percent level.

*** Significant at the 1 percent level.

TABLE 6
Elasticities of Body Mass Index with Respect to Selected Variables

Independent Variable	Pooled	Males	Females
Restaurants	0.090	0.083	0.091
Cigarette tax	0.011	-0.021	0.011
Gas tax	0.004	0.001	0.009
Income	-0.011	0.009	-0.028
Age	0.127	0.036	0.186

Computed at weighted sample means.

TABLE 7
Impacts of Selected Factors on Body Mass Index, Persons 17 Years of Age and Older, 1971-1994

Factor	Pooled	Males	Females
	Observed Change = 1.662 (1994 average – 1971 average)	Observed Change = 1.238 (1994 average – 1971 average)	Observed Change = 2.046 (1994 average – 1971 average)
Race/Ethnicity	-0.013	-0.027	-0.019
Schooling	-0.159	-0.034	-0.338
Marital status	-0.054	-0.085	0.025
Age	0.062	0.029	0.036
Household income	-0.053	0.023	-0.193
Restaurants	0.904	0.837	0.913
Cigarette tax	-0.113	0.207	-0.103
Indoor air laws	-0.062	0.042	-0.153
Gas tax	-0.071	-0.013	-0.139
Total predicted change	0.443	0.978	0.029

Note: Impacts of selected factors obtained by multiplying coefficients from pooled models by the observed change of that factor between 1971 and 1994.

DISCUSSION

Obesity is now a major epidemic in the United States that calls for immediate attention. The ready availability of inexpensive restaurants has not only caused people to consume more, but has made them less active – less likely to prepare food at home or travel further distances to obtain a healthy meal. The existence of numerous restaurants per capita facilitates caloric intake. And historically, man is conditioned to consume in order to live well.[14] Technological "advances" that have made daily chores easier discourage physical activity, as does work that has increasingly become more sedentary over time.

Our model shows the rapid increase in obesity over time, especially during the 1980s, to be due in part to the great increase in the per capita number of restaurants, and partly an unintended consequence of the campaign to reduce smoking. The increased number of restaurants could be reflective of the increased value of time for women. Possible solutions to the obesity problem might include publicly financed education about dieting and exercise, although health information does not seem to be lacking and yet we still have an epidemic [Philipson, 2001]. If obesity is not only bad for one's health but imposes negative externalities on others, as do cigarettes, then taxing food might be a solution.[15] If habits such as eating healthily and being physically active are formed from childhood, perhaps our primary focus should be on schools. Yet massive government intervention is not necessarily required. We realize that obesity is a health problem, and may be one of the costs of economic progress. We have identified the problem and recognized that we have a serious epidemic; finding a solution should be high on our agendas.

NOTES

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1. While Cutler et al. [2003] say that the shift to more households with women working accounts for a mere ten percent of the increase in obesity, there is an additional indirect effect on other households through cultural changes via externalities. Using international cross-sectional data from 22 OECD countries, they find no effect of the percentage of females in the labor force on obesity.
2. This estimate is based on self-reported measures from the Behavioral Risk Factor Surveillance System.
3. Waist circumference might be an alternate measure of obesity, as a waist circumference of over 35 inches for women and 40 inches for men has been associated with a markedly increased likelihood of a variety of diseases [Janssen et al., 2002]. However, waist circumference is not commonly measured in national public health data sets, and only NHANES III measures waist circumference.
4. We do not use the most recent NHANES data in our analysis as the most current data available for the number of restaurants from the Census of Retail Trade is in 1997.
5. This method uses NHANES data, which contains both self-reported and actual measures of height and weight, and obtains age-gender-race-specific corrections. This is done by regressing the actual measure on the self-reported measure and its square and using the coefficient to adjust the self-reported measures in the data set being used. This is also the method used by Chou, Grossman, and Saffer [2004] in their study using the BRFSS. Yet there have been arguments that even this correction does not completely eliminate error and is not a perfect substitute for actual measures (see, for example, Plankey et al. [1997].
6. For a further discussion on possible grounds for government intervention in the obesity epidemic, see Rashad and Grossman [2004].
7. This conclusion was made using data from the Continuing Survey of Food Intake, and does not take into account snacks purchased at restaurants and consumed at home.
8. In preliminary regressions, we find evidence that these continuous variables – the only continuous variables on the RHS with the exception of *indoor*, which take on only four values, have non-linear effects.
9. Caloric intake is based on 24-hour recall, and the measures for physical activity are not consistent across the three NHANES data sets.
10. Tests for changes in coefficients across gender and race are statistically significant at the 1 percent level.
11. Males are more likely to be overweight yet less likely to be obese.
12. Note that the average body mass index increased by 1.66 kg/m^2 from 1971 to 1994 (see Table 7).
13. Using instrumental variables, such as female labor force participation, in an attempt to correct for the possible omitted variables bias that exists is risky, as most instruments are weak and do not pass tests for exclusion restrictions. Nevertheless, we ran models with state-level female labor force participation (and its square) as instruments for the number of restaurants (and its square). Overidentification tests could not be run as the model was exactly identified. While there were

indications that the instruments were weak (F values in the first stage hovered around 3), IV results were very similar to OLS results (carrying the same sign but slightly higher in magnitude, another indication of possibly weak instruments), and Durbin-Wu-Hausman tests indicated that OLS regressions were consistent.

14. Obesity was once associated with wealth and power.
15. As Philipson suggests, taxing food would be a regressive move, affecting the poor more than the rich [Mitka, 2003]. He suggests subsidizing physical activity and/or tax breaks to people joining health clubs or businesses that provide exercise opportunities to their workers.

REFERENCES

Averett, S. and Korenman S. The Economic Reality of the Beauty Myth. *Journal of Human Resources*, Spring 1996, 304-330.

Becker, G.S. A Theory of the Allocation of Time. *Economic Journal*, September 1965, 493-517.

Bureau of the Census, US Department of Commerce. *1972, 1982, 1987, 1992, and 1997 Census of Retail Trade*. Washington, DC: US Government Printing Office, 1976.

Cawley, J. Addiction, Calories, and Body Weight. *PhD Dissertation, University of Chicago*, 1999.

Cawley, J. The Impact of Obesity on Wages. *Journal of Human Resources*, Spring 2004, 451-474.

Chou, S., Grossman, M., and Saffer H. An Economic Analysis of Adult Obesity: Results from the Behavioral Risk Factor Surveillance System. Presented at the *International Health Economics Association Third International Conference*, York, England, 2001.

Chou, S., Grossman, M., and Saffer H. An Economic Analysis of Adult Obesity: Results from the Behavioral Risk Factor Surveillance System. *National Bureau of Economic Research Working Paper 9247*, October 2002.

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

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

Cutler, D.M., Glaeser, E.L., and Shapiro, J.M. Why Have Americans Become More Obese? *Journal of Economic Perspectives*, Summer 2003, 93-118.

Ewing, R., Schmid, T., Killingsworth, R., Zlot, A., and Raudenbush, S. Relationship Between Urban Sprawl and Physical Activity, Obesity, and Morbidity. *American Journal of Health Promotion*, September/October 2003, 47-57.

Fehily, A.M., Phillips, K.M., and Yarnell, J.W. Diet, Smoking, Social Class, and Body Mass Index in the Caerphilly Heart Disease Study. *American Journal of Clinical Nutrition*, October 1984, 827-833.

Flegal, K.M., Carroll, M.D., Ogden, C.L, and Johnson, C.L. Prevalence and Trends in Obesity Among US Adults, 1999-2000. *JAMA*, October 2002, 1723-1727.

Fontaine, K.R., Redden, D.T., Wang, C., Westfall, A.O., and Allison, D.B. Years of Life Lost Due to Obesity. *JAMA*, January 2003, 187-193.

Frazao, E. *America's Eating Habits: Changes and Consequences*. Washington DC: US Department of Agriculture, 1999.

Freedman, D.S., Khan, L.K., Serdula, M.K., Galuska, D.A., and Dietz, W.H. Trends and Correlates of Class 3 Obesity in the United States From 1990 Through 2000. *JAMA*, October 2002, 1758-1761.

Freedman, D.S., Dietz, W.H., Srinivasan, S.R., and Berenson, G.S. The Relation of Overweight to Cardiovascular Risk Factors Among Children and Adolescents: The Bogalusa Heart Study. *Pediatrics*, June 1999, 1175-1182.

French, S.A., Harnack, L., and Jeffery, R.W. Fast Food Restaurant Use Among Women in the Pound of Prevention Study: Dietary, Behavioral, and Demographic Correlates. *International Journal of Obesity and Related Metabolic Disorders*, October 2000, 1353-1359.

Ippolito, P.M. and Mathios, A.D. Information and Advertising: The Case of Fat Consumption in the United States. *American Economic Review*, May 1995, 91-95.

Janssen, I., Katzmarzyk, P.T., and Ross, R. Body Mass Index, Waist Circumference, and Health Risk. *Archives of Internal Medicine*, October 2002, 2074-2079.

Huber, P. J. The Behavior of Maximum Likelihood Estimates Under Non-Standard Conditions. In *Proceedings of the Fifth Berkeley Symposium on Mathematical Statistics and Probability*. Berkeley CA: University of California Press, 1, 1967, 221-233.**Katona, G.** *The Mass Consumption Society*. New York: McGraw Hill, 1964.

Keeler, E.B., Manning, W.G., Newhouse, J.P., Sloss, E.M., and Wasserman, J. The External Costs of a Sedentary Life-Style. *American Journal of Public Health*, August 1989, 975-981.

Koplan, J.P. and Dietz, W.H. Caloric Imbalance and Public Health Policy. *JAMA*, October 1999, 1579-1581.

Lakdawalla, D. and Philipson, T. The Growth of Obesity and Technological Change: A Theoretical and Empirical Examination. *NBER Working Paper No. 8946*, May 2002.

McGinnis, J.M. and Foege, W.H. Actual Causes of Deaths in the United States. *JAMA*, November 1993, 2207-2212.

Mitka, M. Economist Takes Aim at 'Big Fat' US Lifestyle. *JAMA*, January 2003, 33-34.

Mokdad, A.H., Ford, E.S., Bowman, B.A., Dietz, W.H., Vinicor, F., Bales, V.S., and Marks, J.S. Prevalence of Obesity, Diabetes, and Obesity-Related Health Risk Factors, 2001. *JAMA*, January 2003, 76-79.

Must, A., Spadano, J., Coakley, E.H., Field, A.E., Colditz, G., and Dietz, W.H. The Disease Burden Associated With Overweight and Obesity. *JAMA*, October 1999, 1523-1529.

Naik, N.Y. and Moore, M.J. Habit Formation and Intertemporal Substitution in Individual Food Consumption. *Review of Economics and Statistics*, May 1996, 321-328.

National Institute of Diabetes and Digestive and Kidney Diseases. *Statistics Related to Overweight and Obesity*. NIH Publication No. 96-4158 ed. Washington DC: US Government Printing Office, 1996.

Nielsen, S.J. and Popkin, B.M. Patterns and Trends in Food Portion Sizes, 1977-1998. *JAMA*, January 2003, 450-453.

Peeters, A., Barendregt, J.J., Willekens, F., Mackenbach, J.P., Mamun, A.A., and Bonneux, L. Obesity in Adulthood and Its Consequences for Life Expectancy: A Life-Table Analysis. *Annals of Internal Medicine*, January 2003, 24-32.

Philipson, T. The World-Wide Growth in Obesity: An Economic Research Agenda. *Health Economics*, January 2001, 1-7.

Plankey, M.W., Stevens, J., Flegal, K.M., and Rust, P.F. Prediction Equations Do Not Eliminate Systematic Error in Self-Reported Body Mass Index. *Obesity Research*, July 1997, 308-314.

Public Health Service, US Department of Health and Human Services. *The Surgeon General's Call To Action To Prevent and Decrease Overweight and Obesity*. Washington, DC: US Government Printing Office, 2001.

Rashad, I. and Grossman, M. The Economics of Obesity. *Public Interest*, Summer 2004, 104-112.

Raynor, H.A. and Epstein, L.H. Dietary Variety, Energy Regulation, and Obesity. *Psychological Bulletin*, May 2001, 325-341.

Rolls, B.J. and Hammer, V.A. Fat, Carbohydrate, and the Regulation of Energy Intake. *American Journal of Clinical Nutrition*, November 1995, 1086S-1095S.

Schlosser, E. *Fast Food Nation: The Dark Side of the All-American Meal*. Boston: Houghton Mifflin Company, 2001.

Segal, N.L. and Allison, D.B. Twins and Virtual Twins: Bases of Relative Body Weight Revisited. *International Journal of Obesity and Related Metabolic Disorders*, April 2002, 437-441.

Tomeo, C.A., Field, A.E., Berkey, C.S., Colditz, G.A., and Frazier, A.L. Weight Concerns, Weight Control Behaviors, and Smoking Initiation. *Pediatrics*, October 1999, 918-924.