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ABSTRACT

The strong negative correlation over time between smoking rates and obesity have led some to suggest that reduced smoking is increasing weight gain in the U.S. This conclusion is supported by findnigs of Chou et al. (2004), who conclude that higher cigarette prices lead to increased body weight. We investigate this issue and find no evidence that reduced smoking leads to weight gain. Using the cigarette tax rather than the cigarette price and controlling for non-linear time effects, we find a negative effect of cigarette taxes on body implying that reduced smoking leads to lower body weights. Yet our results, as ell as Chou et al., imply implausibly large effects of smoking on body weight. Thus, we cannot confirm that falling smoking leads in a major way to rising obesity rates in the U.S.

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Two of the most noticeable trends in the health of Americans over the past thirty years are shown in Figure 1. On the one hand, there has been a striking decline in the incidence of cigarette smoking among Americans; whereas 37.4% of the population smoked in 1970, only 22.5% of the population smoked in 2002. On the other hand, there has been a large rise in the rate of obesity among Americans over this same time period. The obesity rate for Americans over the age of 20 has more than doubled from an average rate of 14.6% between 1971 and 1974 to over 30% today (Flegal et al. 2002).[1] As Figure 1 shows, while the U.S. used to have more than twice as many smokers as obese persons, since the mid 1990s there have been more obese persons than smokers.

Are these trends related? Some suggest so. After all, it has long been believed that quitting smoking can lead to weight gain. In 1990, the U.S. Surgeon General found that between 58% and 87% of those individuals who quit smoking gain weight and, on average, those who quit gain 4 pounds more than those who continue to smoke. While there is clear evidence of short-run weight gains, however, there is little evidence to show a direct link between smoking and steady state weight. Whether or not there is any merit to the perceived wisdom that smoking facilitates weight loss, research suggests that many smokers, particularly women, make no attempt to quit smoking because of fear of ensuing weight gain (Caan et al. 1996)

A large literature documents the welfare gains from reduced smoking in the U.S., both in terms of external gains to society from lower medical costs, and internal gains to individuals from living longer. At the same time, a number of recent studies have emphasized the welfare

[1] Data on smoking trends and obesity from Centers for Disease Control and Prevention (CDC) website http://www.cdc.gov/tobacco/research_data/adults_prev/prevali.htm. Data on obesity prevalence trends from Flegal et al. (2002).

costs from increased obesity in the United States. Medical expenses attributed to individuals being either overweight or obese accounted for 9.1 percent of total U.S. medical expenditures in 1998 (Finkelstein, Fiebelkorn, and Wang, 2003). Additionally, obesity accounts for an almost equal amount of indirect costs, mostly due to the reduced productivity resulting from obesity-related mortality and morbidity (Wolf and Colditz 1998; Wolf 1998). If efforts to reduce smoking do, in fact, lead to increased obesity among Americans, then the welfare costs attributable to the expanding obesity problem may offset the public health benefits of the decline in smoking.

A recent suggestive piece of evidence on the link between smoking and obesity was provided by Chou, Grossman and Saffer (2004). They showed that higher cigarette prices, which reduce smoking, are associated with higher rates of obesity. This suggests a direct link between smoking and weight, and has formed the basis for Rashad and Grossman's (2004) view that rising obesity due to falling smoking is an example of "the price that must be paid to achieve goals that are in general favored by society".

In this paper, we revisit the question of the impact of smoking on obesity. Using the same BRFSS data source as Chou et al., we estimate a negative relationship between cigarette taxes and body weight: higher cigarette taxes lead to lower rates of obesity. Assuming that cigarette tax effects run only through smoking, this implies that reducing smoking actually *lowers* body weight. We can largely explain our differences from Chou et al. by the use of more complete controls for time trends in smoking, and use of cigarette tax rates rather than potentially endogenous cigarette prices. One limitation we highlight for both our results and those of Chou et al., however, is that the findings imply implausibly large effects of smoking on body weight. Overall, we cannot confirm that higher cigarette taxes will lead to increased obesity.

Part I: Background

Smoking and Weight Gain

An extensive medical literature has supported the popular contention that smoking facilitates weight control. In 1990, the U.S. Surgeon General reviewed 15 medical studies involving a total of roughly 20,000 test subjects (U.S. Department of Health and Human Services 1990). Between 58% and 87% of those who had quit smoking gained weight. On average, quitters gained four pounds more than those who continued smoking. Individual weight gains of 20 pounds or more following smoking cessation were found to be rare and occur in only 3.5% of cases.

The followup periods employed in the 15 studies reviewed by the Surgeon General ranged from 1.5 months to 6 years, with a median followup of 2 years. Several studies, however, have shown that the rate of weight gain following cessation is transient, slowing down after 6 months in response to a return in energy intake to baseline levels (Caan et al. 1996). The weight gained prior to this return to equilibrium is generally retained for at least 6 years (Froom et. al. 1999). However, some studies have found that quitters ultimately lose at least a portion of this initially gained weight (Mizoue et al. 1998). Employing a cross-sectional analysis with data from periodic health examinations of Japanese workers, Mizoue et al. find that steady state weight levels for former smokers approach those of never smokers. While heavy smokers may experience large weight gain and weigh more than never smokers in the few years following smoking cessation, they will ultimately lose this weight and return to the never-smoking weight levels. Mizoue et al. further find that light or moderate smokers may gain weight following smoking, but only up to the never smoker levels

Regardless of the merits of the perceived link between smoking and steady-state body weight, the perception itself is very real. According to numerous studies, the fear of weight-gain following smoking cessation discourages many smokers from attempting to quit (Caan et al. 1996). The 1986 Adult Use of Tobacco Survey asked current smokers who had tried to quit to evaluate numerous reasons for the decision to continue smoking (U.S. Department of Health and Human Services 1990). Twenty-seven percent of respondents indicated that "actual weight gain" was a "very important" or "somewhat important" reason for their decision not to quit and forty-seven percent reported that they agreed with the statement that "smoking helps control weight." Thus, aside from any actual connection between weight and smoking, this perception alone may be contributing to negative outcomes.

Even if there is an effect of quitting smoking on weight gain, researchers frequently stress that any such effect is small in relation to the significant health benefits from discontinued smoking. Furthermore, research also indicates that smokers generally exhibit less healthful behavioral habits. For instance, they consume less fruits and vegetables (particularly those high in vitamins A and C), high fiber grains, low fat milk, and vitamin and mineral supplements (Subar, Harlan, and Mattson 1990). According to the 1990 Report by the Surgeon General, some prospective medical studies report increased physical activity following smoking cessation. Moreover, the Surgeon General's Report also notes that any effects from post-cessation weight gain are mitigated by favorable changes in lipid profiles and body fat distribution.

The Decline in Smoking and the Rise in Obesity

The decline in smoking in the U.S. has been one of the major public health victories of the second half of the twentieth century. After rising rapidly until 1953, cigarette consumption per capita rose much more slowly until the late-1970s, and then began to decline. The major determinant is assumed to be changing public attitudes towards the health risks posed by smoking, beginning with the release in 1954 of information on the health hazards of smoking.

Another contributing factor may have been a slow but steady rise in the real price of cigarettes during the 1980s. A large literature shows that smoking is sensitive to cigarette prices, with a consensus elasticity in the range of -0.4 to -0.6.[2] From a minimum of 76 cents per pack in 1980 (in $1982), cigarette prices rose to $1.30 per pack by 1992. This period saw the steepest decline in per capita cigarette consumption, from roughly 2800 cigarettes per capita in 1980 to 2000 cigarettes per capita in 1992. At an elasticity of -0.5, this 70% rise in prices can explain almost all of the 40% decline in cigarette consumption per capita over this period. Prices then fell due to a cigarette industry price war in 1993, and were flat before rising again starting in 1997 due to a series of tobacco industry settlements with the states and private litigants. Smoking was likewise fairly flat in the mid-1990s before declining sharply in the late 1990s.

Over this same time period, the United States has also witnessed considerable growth in the rate of obesity among both the adult and youth populations. The U.S. Surgeon General has recently noted that obesity in the United States has reached "epidemic proportions" (U.S. Department of Health and Human Services 2001). Obesity is determined according to the Body Mass Index (BMI), defined as weight in kilograms divided by height in meters squared

[2] The review in Chaloupka and Warner (2001) points to -0.4 to -0.45 as consensus estimates, but recent work has produced higher elasticities, such as in Gruber and Koszegi (2004).

(kg/m^2). Those with BMI greater than or equal to 30 are considered obese. BMI of less than 18.5 is considered underweight, while 18.5-25 is normal and 25-30 is overweight. Over the last several decades, the rate of obesity among U.S. adults has doubled, reaching over 30% today.[3]

These trends in dietary outcomes are of particular importance to national health policy. The public health arena has long recognized the connection between dietary behavior and various health outcomes, including mortality. In 1999, heart disease was the leading cause of mortality in the United States, amounting to 30.3% of deaths (CDC 1999). Roughly three-quarters of these deaths were due to ischemic heart disease (IHD) (CDC 1999). Medical evidence establishes a strong link between IHD and diet / sedentary lifestyle (Campbell, Parpia and Chen 1988). All told, experts estimate that obesity contributes to over 300,000 premature deaths per year (McGinnis and Foege 1993).

The time series causes of the rise in obesity are not altogether clear. Two leading theories are proposed by Philipson and Posner (1999) and Cutler, Glaeser, and Shapiro (2003). Philipson and Posner attribute the rise in obesity to technological change, which has lowered both the real cost of food and the level of physical intensity in the workplace. In a modern post-industrial society, such as that of the United States today, work tends to be relatively sedentary and non-strenuous, leading to a reduction in the level of calories expended daily. This technological explanation helps in interpreting the puzzling observation of rising obesity during a period of time in which there had been only a modest increase in caloric consumption and a rise in recreational exercise and dieting.

[3] CDC website http://www.cdc.gov/ nchs/data/ hus/tables/2002/02hus070.pdf

Cutler, Glaeser, and Shapiro also attribute the rising obesity trends to technological factors. However, unlike Philipson and Posner who focus on the effect of technology on caloric expenditure, Cutler et al. propose that technological innovations led to increased food consumption. The development of microwave ovens and various innovations in food processing, packaging, and storage have led to a shift in the division of labor in food production. The switch from individual food preparation within the home to mass food production at centralized shipping locations led to a decrease in the time cost of food consumption and to an increase in the quantity and variety of food consumed.

Causal Evidence on the Smoking/Obesity Link

We are aware of only one article in the economics literature which has tried to provide causal evidence on the smoking/obesity link, Chou et al. (2004). Using micro level data from the Behavioral Risk Factor Surveillance Survey (1984-1999), Chou et al. attempt to determine how much of the trend in obesity is explained by various state-specific factors, including the real price of cigarettes. Employing state fixed effects and a quadratic time trend, they run a reduced form model to find an elasticity of BMI with respect to cigarette price (inclusive of state and federal excise taxes) of 0.025 and an elasticity of the probability of being obese with respect to cigarette price of 0.445. They conclude that the effect of smoking on body weight does indeed work in the commonly perceived direction.

Part II: Data

Our basic data source for this analysis is the Behavioral Risk Factor Surveillance System (BRFSS). The data consists of repeated cross-sections for the years 1984 through 2002, collected via monthly telephone surveys of individuals aged 18 years and older. The BRFSS is a nationally representative survey of the United States and has been conducted by state health departments in coordination with the CDC for the purpose of collecting state-level data pertaining to risky personal health behaviors. 15 states took part in the first survey in 1984. By 1994, all 50 states and the District of Columbia became involved. The survey was administered to an average of 817 individuals per state in 1984, rising to an average of 4700 per state in 2002.

The data contain information on respondents' weight, height, smoking behavior and survey month, along with various demographic characteristics. Self-reported weights and heights allow us to calculate the BMI of each respondent, as well as a dummy variable for whether BMI exceeds 30, the generally recognized classification for obese.

We combine responses from two survey questions to construct an indicator for whether or not the respondent currently smokes, conditional on having smoked at least 100 cigarettes in his or her lifetime. The 1984-2000 surveys also contain information on the number of cigarettes smoked per day, on average, by each reported smoker. With this information we construct the average number of cigarettes smoked by all respondents (with 0 values for non-smokers).

We match the BRFSS data to monthly cigarette excise tax data from *The Tax Burden on Tobacco* (Orzechowski and Walker 2000). To allow a slight lag, we match on the tax rate at the end of the previous month. We create real excise tax data using monthly CPI measures from the Bureau of Labor Statistics. We also match onto each respondent state-level data on the average annual real retail price of cigarettes (per pack) from *The Tax Burden on Tobacco*. Finally, we match onto our data unemployment rates by state, year, and month, obtained from the U.S. Bureau of Labor Statistics[4].

An advantage of the BRFSS is that it contains information on both smoking behavior and body weight/height. Another advantage is that the survey has been carried on for many years and ultimately across every state. Over the relevant time period, there has been significant variation in the excise tax rates imposed by the states, in both absolute and relative terms. This extensive variation allows for identification of the effect of smoking on BMI.

In the analysis below we restrict our sample to those respondents under 65 years of age in order to ameliorate a possible health bias. Higher cigarette taxes result in reduced smoking, which in turn results in fewer sick individuals. Since sicker individuals are generally skinnier than healthy ones, we should expect to find a negative bias in the relationship between smoking and weight measures due to this general health mechanism. Restricting the sample to those respondents under 65 should minimize the impact of these more general health factors and focus our results on those behavioral and metabolic forces of interest.

Table 1 reports the means and standard deviations of the relevant variables in the BRFSS. These figures are computed based on BRFSS sampling weights and are representative of the population at large. The BRFSS data are weighted for the probability of selection of a telephone number, the number of adults in a household, and the number of telephones in a household. To generate final sample weights, a poststratification adjustment is made to account for other factors, including the nonresponse and noncoverage of households without telephones. In order

[4] Unemployment data from the Bureau of Labor Statistics website: http://www.bls.gov/lau/home.htm

to ensure consistency of our estimates, these sample weights are also employed in our regression models below (DuMouchel and Duncan 1983).

The average BMI across the sample is 25.8, and 16.8% of the sample is obese (somewhat lower than the average found in the numerous National Health and Nutrition Examination Surveys, as reported in Flegal et al.). Average BMI for smokers is 2.7% lower than that for non-smokers (25.9 v. 25.2), and the obesity rate is 4% lower for smokers than that for non-smokers (13.9% v. 17.6%). It is unclear, however, whether or not these numbers suggest a causal link between decreased smoking and obesity, particularly where these two behaviors are part of a more complex decision-making process.

Table 1 also reports the means and standard deviations of the cigarette excise tax and price data. The average state excise tax (in 2002 dollars) across the sample is $0.44, with a standard deviation of $0.28. The data show a significant variation in excise taxes across states, within any given time period. The standard deviation of real excise taxes in year 2002 is $0.43 (with a mean of $0.60). About 25% of the variation in excise taxes is within states over time (Gruber and Mullainathan 2002). The substantial within-state variation in excise taxes will allow us to identify the impact of smoking on obesity measures while controlling for fixed differences across states, as well fixed differences across sample years.

Finally, Table 1 also shows the means and standard deviations for the control variables used in our analysis. Some interesting observations are worth noting. 48% of the sample is male. Obesity is roughly the same across sexes. However, male BMI's are an average of 1.2 higher than females. Reconciling these two results, males are roughly 17% more likely to be in the "overweight or obese" classification. Males are also more likely to smoke than females (25% v.

21%). 27% of the sample has at least a bachelor's or an associate's degree. 14% did not complete high school. 33% have a high school degree or a GED equivalent. Finally, 26% attended some college or completed a technical degree. Those respondents who have a high school degree or lesser education have a 5% higher obesity rate and have, on average, a higher BMI (26.1 v. 25.4). They also are roughly 10 percentage points more likely to smoke (28.9% v. 18.3% smoking rate). These cursory demographic observations suggest caution in inferring a causal relationship between the smoking and obesity trends.

Part III: Empirical Strategy

We begin our analysis by showing reduced form estimates of the impact of cigarette taxes on measures of body weight. In particular, we estimate regression equations of the form:

$$BMI_{ijt} = \alpha + \beta_1 RTAX_{jt} + \beta_2 X_{ijt} + \beta_3 UR_{jt} + \lambda_j + \tau_t + \varepsilon_{ijt}$$

where i indexes individuals, j indexes states, and t indexes years
BMI is body mass index or some other measure of body weight
RTAX is the real cigarette tax in state j in year t
X are a set of individual-specific covariates (e.g. age)
UR is the unemployment rate in state j in year t
λ_j and τ_t are fixed effects for state and year, respectively

This model estimates the impact of cigarette taxes on body weight controlling for fixed differences in taxes and body weight both across states and over time. In addition, we include controls for a number of individual characteristics: sex, race, age, income, marital status and education. In order to control for time-varying economic conditions of the separate states, we also include monthly state unemployment rates.

In this model, therefore, it is changes in cigarette taxes within states, relative to other states that do not change their tax, that identifies the effect of taxes on body weight measures. Of course, even this fixed effects specification does not control for all potential threats to causal estimation of the impact of cigarette taxation on obesity. For example, it could be that states raise cigarette taxes in times of recession, and body weight goes down (or up) in recessionary periods. We attempt to control for this in two ways in the estimation below: by including controls for state economic conditions, and by including state-specific trends in the analysis.

Part IV: Results

Table 2 presents our initial results from estimating equations such as that shown above. We estimate our model for two different measures of body weight: the level of the BMI (results are similar if we use the logarithm of BMI instead) and an indicator for obesity (BMI>30). We express the cigarette tax in fractions of a dollar, rather than cents (e.g. 0.4 not 40) for ease of interpretation of the coefficients.

Surprisingly, we find that there is a *negative* relationship between cigarette taxes and BMI; higher taxes lead to a lower BMI. This finding implies that the reduced smoking due to higher taxes lowers, rather than raises, weight, although the estimated effects are fairly small. For example, for BMI, our estimates imply that a $1.00 rise in cigarette taxes would lower BMI by 0.15, or less than 1% of the sample mean; this estimate is significant. This same $1.00 rise in cigarette taxes would lower the odds of being obese by 0.015 percentage points, or about 1% of the sample mean, and the estimate here is more highly significant.

Table 2 also shows the coefficients of the control variables used in the initial BMI and obese regressions. We find a negative and statistically significant relationship between real household income and BMI, although the estimated effect is quite small, with an implied elasticity of 0.02. However, the estimated effect of real income on the probability of being obese is of greater magnitude, with an implied income elasticity of 0.18. We estimate a strong negative effect of years of education on both BMI and the probability of being obese. The state-specific unemployment rate has a negative and statistically insignificant effect on BMI and a negative and marginally significant effect on the odds of obesity.

Blacks, whites, and Hispanics all have higher BMI's than individuals of other racial groups, along with higher probabilities of being obese. In particular, blacks have significantly higher measures of both outcomes. Females have lower BMI's than males. However, males and females have roughly equivalent probabilities of being obese. Age follows a non-linear relationship with both BMI and the probability of obesity, with younger individuals having lower weight outcomes. BMI and obesity appear to rise with age and then peak in the 50's, thereafter lowering again for those in their 60's. Married and widowed individuals have higher BMI and obesity odds than divorced and never-married individuals; divorced individuals, in turn, have lower weight outcomes than those who have never married.

Comparison to Chou et. al.

These striking "wrong-signed" findings stand in direct contrast to the results of Chou et al., who found significant positive effects of cigarette prices on body weight. In this section, we reconcile these two sets of findings (thanks to the generosity of Chou et. al. in sharing their data), over the same 1984-1999 period used by Chou et al.

There are three fundamental differences between our approach and that of Chou et. al. The first is the sample and control variables used. Chou et al. include all those age 18 and over (whereas we exclude those over 65 for health reasons), and also control for numerous state-specific measures, including the density of restaurants, fast-food prices, full-service restaurant prices, food-at-home prices, and clean indoor air laws. The second source of difference is the treatment of time controls. While we include dummies for every year, Chou et. al. use a quadratic time trend instead. The third source of difference is the measure of smoking cost. We use the cigarette tax rate, while Chou et. al. use the state-specific cigarette price.

Table 3 shows the comparison of our results, for BMI and obesity; we show just the coefficient of interest, that on cigarette price (or tax). We begin by showing the results for Chou et al. in the first column, and our replication in the second column, which is very close to their result. In the third column, we change the controls for time, moving from a quadratic trend to a full set of year and month dummies. Doing so substantially reduces the coefficients of interest, which are now about half as large, along with the corresponding t-statistics. In the fourth column, we also replace the cigarette price with the cigarette tax. This has a dramatic effect, making the coefficients negative and, in the case of BMI, significant. Indeed, as a comparison with the next-to-last column (which shows our basic specification) illustrates, the results using year/month dummies and cigarette tax rather than price is very similar to our basic findings.

Both of these changes seem reasonable. Given the available data, and the large movements in obesity and smoking over time, it is more careful to control non-parametrically for time trends; doing so causes only a very small rise in the standard errors, so there is little loss in precision. Moreover, while cigarette tax may suffer from political endogeneity, it is clearly a more exogenous measure than price. Price changes within states are largely driven by tax changes, but may also be driven by other market factors which affect both the rate of smoking and eating. For example, suppose there is a demographic shift in a state (e.g. more young persons) which leads to both more smoking and less eating. Cigarette companies may raises prices in the face of this increased cigarette demand, leading to a spurious correlation between cigarette prices and both smoking and body weight.

Robustness to State-Specific Time Trends

One natural concern about using cigarette taxes (or prices) as a regressor is reverse causality: perhaps taxes (or prices) are reacting to the underlying trends in smoking (and body weight). To address this concern, we have also included in our model state-specific linear time trends. These interactions of each state dummy variable with a time trend will pick up generally increasing or decreasing body weight trends in each state that might be correlated with cigarette tax (or price) policy.

The final column of Table 3 shows the effect of including state-specific time trends in our models. The results do not change much at all. This suggests that reverse causality that is caused by a slow-moving trend in the data is not driving any of our results.

Interpretation

One troubling aspect of both the Chou et al. results and our results, however, is that the coefficient on the cigarette price/tax seems much too large. Consider the coefficient on cigarette tax/price in the obesity regression. For our basic specification, we find that each $1 rise in cigarette taxes raises the odds of being obese by 0.015 percentage points. The first column of Table 4 shows corresponding "first stage" regressions of the odds of smoking on the cigarette tax in the BRFSS data. We find that each $1 rise in cigarette taxes lowers the odds of smoking by 0.026 percentage points. Thus, as the second column shows, the "instrumental variables" estimate of the effect of smoking on obesity is enormous: the estimate implies that individuals who quit smoking are 56% less likely to be obese! Since the Chou et al. results are of a similar magnitude (but of an opposite sign), the implication is correspondingly large (in the opposite direction). Such a large effect, in either direction, is clearly implausible and is inconsistent with the relatively small weight gain discussed in observational studies.

Of course, rising taxes lead individuals not only to quit smoking, but also to smoke less, and this second effect may also affect body weight. Thus, in the third column, we show the first stage results using as the dependent variable the number of cigarettes smoked (including zeros for non-smokers). Here we get a coefficient of -0.726, indicating that each dollar of taxation leads individuals to smoke 0.7 fewer cigarettes on average. The second stage coefficient in this case is 0.02, indicating that smoking one fewer pack of cigarettes (20 fewer cigarettes) would lower the odds of obesity by 40%; this is once again implausibly large.

These results are worrisome in that they indicate an effect which seems too large to be plausible. One limitation of these findings, however, is that the BRFSS data seem to indicate an very low price elasticity of cigarette consumption. The overall elasticity is only -0.2, which is much lower than that estimated with aggregate data (-0.5 to -0.6; see Chaloupka and Warner (2001) and Gruber and Koszegi (2001)). Part of the reason may be that aggregate estimates include smuggling across state lines, but part of the reason may also be measurement error in micro-data on smoking.

Yet, even if the true elasticity is -0.5, the implied effect of smoking on body weight remains surprisingly large. By our estimates, at a true elasticity of -0.5, reducing smoking by a pack a day would lower the odds of obesity by 15%, which is still a very large effect relative to the observational literature.

Part V: Conclusions

Smoking and obesity are the two largest (at least partially) self-imposed health risks facing Americans today. The notion that there is a tradeoff between these risks, with lower smoking causing more weight gain, is the type of "common knowledge" that has in fact found relatively little support in the literature. We provide such analysis in this paper and are unable to detect any evidence that higher cigarette taxes, which lead to lower smoking, also lead to higher weight. The existing study purporting to find such a relationship is not robust to reasonable changes to the specification, and neither our approach nor theirs yields results of plausible magnitudes.

We therefore find, in agreement with the medical literature, that there is no evidence for a large weight effect from smoking cessation. Our finding does not, however, rule out a moderate-sized effect. Future research to ascertain such smaller effects must use research designs which yield much more precise inferences about the effects of smoking cessation on weight gain.

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Figure 1: Smoking and Obesity Trends

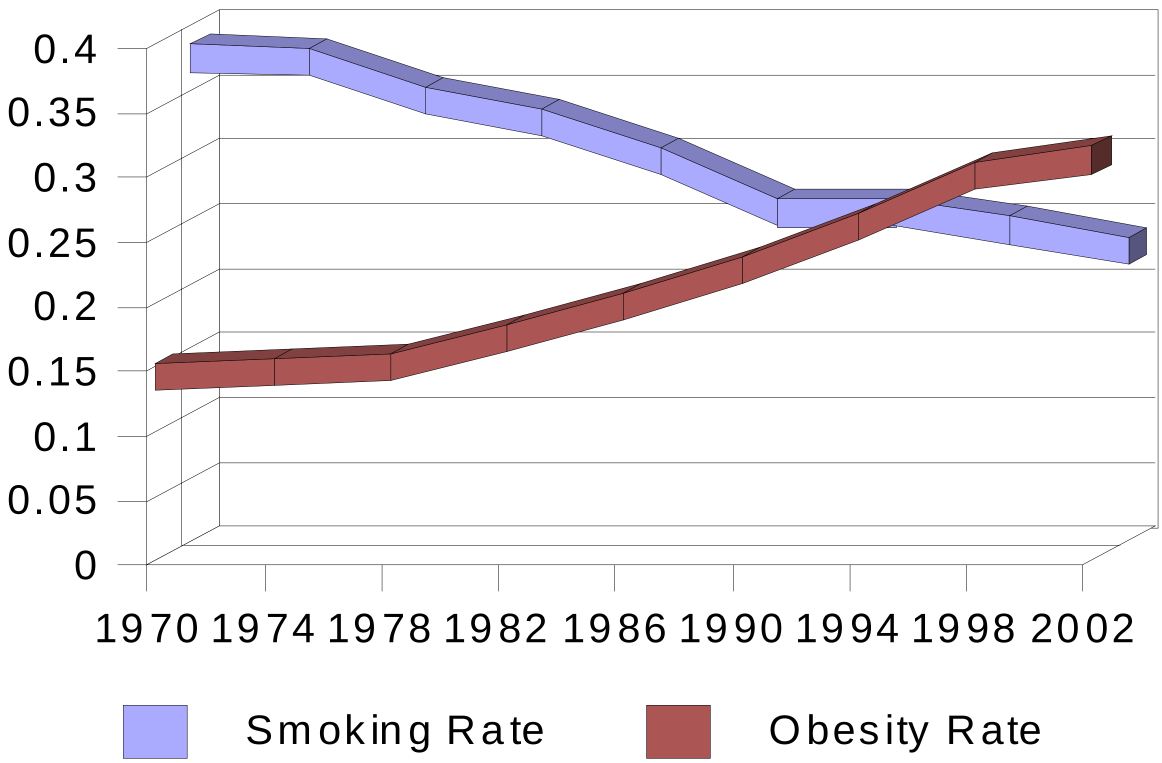

Table 1: Summary Statistics

BMI	25.76
	(4.77)
OBESE (BMI >= 30)	0.17
	(0.37)
Smoke?	0.23
	(0.42)
# Cigarettes Smoked Daily	3.93
(0 for non-smokers)	(8.97)
# Cigarettes Smoked Daily	17.10
(Missing values for non-smokers)	(11.18)
Real Excise Tax (per pack in dollars)	0.44
	(0.28)
Real Price (per pack in dollars)	2.67
	(0.71)
Real Income	48875.23
	(35419.88)
Unemployment Rate	5.47
	(1.48)
White	0.83
	(0.37)
Black	0.10
	(0.30)
Hispanic	0.10
	(0.30)
Married	0.60
	(0.49)

Divorced	0.09
	(0.29)
Widowed	0.07
	(0.26)
<= 8th Grade	0.05
	(0.23)
9th - 11th Grade	0.09
	(0.29)
HS Grad	0.32
	(0.47)
Some College	0.27
	(0.44)
College Grad	0.26
	(0.44)
Age	44.64
	(17.60)
Sex (0 = female, 1 = male)	0.48
	(0.50)
Sample Size	2017239

Notes: Standard errors in parentheses. Means and standard errors are weighted are according to their BRFSS sampling weights.

Table 2: Impact of Cigarette Excise Tax on BMI and Obesity

	BMI	OBESE
Cigarette Excise Tax	-0.15051	-0.01499
	(-2.05)	(-2.56)
Household Income	-0.0000085	-0.000000626
	(-17.12)	(-19.50)
Black	2.041767	0.1050623
	(24.45)	(18.14)
White	0.5051919	0.0225474
	(4.30)	(3.03)
Hispanic	0.7677835	0.0260538
	(6.55)	(3.90)
Married	0.3505483	0.00812
	(15.82)	(7.58)
Divorced	-0.2093631	-0.0214241
	(-5.69)	(-8.27)
Widowed	0.3222335	0.0139377
	(6.62)	(3.44)
Unemployment Rate	-0.0187744	-0.001534
	(-1.69)	(-1.96)
9-11th Grade	-0.1869331	-0.0138325
	(-4.44)	(-4.07)
HS Grad	-0.4675105	-0.0427611
	(-11.15)	(-13.05)
Some College	-0.5658871	-0.0498128

	(-10.89)	(-14.07)
College Grad	-1.249298	-0.091855
	(-16.22)	(-18.72)
Under 25 Males	-1.844826	-0.1285568
	(-31.81)	(-35.18)
Under 25 Females	-3.307866	-0.1355072
	(-53.05)	(-29.21)
25-30 Males	-0.4533448	-0.0682058
	(-8.94)	(-18.15)
25-30 Females	-2.181322	-0.0827264
	(-37.39)	(-22.52)
30-35 Males	0.0772958	-0.0427681
	(1.47)	(-13.39)
30-35 Females	-1.629076	-0.0551878
	(-25.44)	(-11.01)
35-40 Males	0.473051	-0.0208162
	(9.64)	(-5.52)
35-40 Females	-1.198328	-0.0407956
	(-17.91)	(-9.16)
40-45 Males	0.7678728	0.0031409
	(17.57)	(0.70)
40-45 Females	-0.7628335	-0.0207266
	(-17.38)	(-6.41)
45-50 Males	1.029662	0.0205886
	(24.52)	(4.31)
45-50 Females	-0.1912655	0.0057447
	(-4.51)	(1.90)
50-55 Males	1.137072	0.0263507

	(23.72)	(5.23)
50-55 Females	0.1274092	0.0172687
	(2.88)	(3.69)
55-60 Males	1.022028	0.0152686
	(17.27)	(3.04)
55-60 Females	0.2032724	0.0154632
	(4.77)	(3.76)
60-65 Males	0.6843402	-0.0064403
	(14.45)	(-1.97)
Observations	1381248	1381248

Notes: T-statistics in parentheses. Standard errors are corrected to allow for grouped error terms at the state level. The two columns provide the regression results for the two alternative dependent variables employed: BMI and OBESE (BMI >= 30). Fixed effects for state and month/year combinations employed in all regressions. Only those respondents under the age of 65 are included in the regressions. Observations in each regression are weighted by the corresponding BRFSS sampling weight.

Table 3: Comparison to Chou et al.

	Chou et al. Results	Replication of Chou et al.	Replication of Chou et al.. Replace time trend with set of year/month dummies	Replication of Chou et al. Replace time trend with dummies. Replace cigarette price with excise tax.	Our basic results from Table 2	Our basic results, with the addition of state-specific time trends
BMI	0.486 (1.37)	0.487 (1.45)	0.201 (0.55)	-0.174 (-2.06)	-0.151 (-2.05)	-0.148 (-1.99)
OBESE	0.032 (1.32)	0.039 (1.56)	0.020 (0.74)	-0.009 (-1.26)	-0.015 (-2.56)	-0.015 (-2.58)

Notes: Results correspond to the regression coefficients for the cigarette price (or tax) variable. Column 1 provides the published coefficients from Chou et al. In column 2, we present the results from our replication of the model employed by Chou et al.. In column 3, we modify our replication model, replacing quadratic time trends with a full set of year/month dummies. In column 4, we modify the model used in column 3 to replace cigarette price with cigarette tax. In column 5, we present the results from our basic model. Finally, in column 6 we add state-specific linear time trends to our basic reduced form model.

Table 4: First Stage and Instrumental Variables Regressions

	1st Stage Regression of Odds of Smoking on Excise Tax	IV Results:. Coefficient of Smoke Dummy	1st Stage Regression of # Daily Cigarettes Smoked (0's for Non-Smokers) on Excise Tax	IV Results: Coefficient of # Daily Cigarettes Smoked (0's for Non-Smokers)
1st Stage	-0.02611 (-4.90)		-0.72564 (-6.39)	
2nd Stage Dep Var: BMI		5.70467 (1.96)		0.2120206 (1.88)
2nd Stage Dep. Var: OBESE		0.5587893 (2.76)		0.0199107 (2.49)

Notes: T-statistics in parentheses. Standard errors are corrected to allow for grouped error terms at the state level. Fixed effects for state and month/year combinations employed in all regressions. Only those respondents under the age of 65 are included in the regressions. Observations in each regression are weighted by the corresponding BRFSS sampling weight.