OBESITY, CIGARETTE PRICES, YOUTH ACCESS LAWS AND ADOLESCENT SMOKING INITIATION

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INTRODUCTION

During the 1990s the prevalence of smoking and the prevalence of obesity increased among U. S. adolescents. In the Monitoring the Future Study, the percent of twelfth-graders who report having smoked any cigarettes in the last thirty days rose from 28.3 percent in 1991 to 35.1 percent in 1998; similar rises in 30-day prevalence occurred among eighth-graders and tenth-graders [Johnston, 2002]. Data from the National Health and Nutrition Examination Surveys indicates that the prevalence of overweight among 12-19 year olds rose from 10.5 percent to 15.5 percent during the 1990s; a similar rise in prevalence occurred among children aged 6-11.[1] Both of these trends are troubling, because smoking and obesity are among the top causes of preventable death in the United States.[2]

Body weight and smoking are interrelated. Adult smokers weigh less than non-smokers[3] and smoking cessation by adults results in an average weight gain of 2-3 kilograms.[4] In contrast, young smokers may be heavier than, or weigh roughly the same as, young non-smokers.[5] This discrepancy may exist because any anorectic effects of smoking are slow to accumulate or because adolescents are more likely than adults to use smoking as a method of weight control.

The vast majority of people who will ever smoke begin smoking during adolescence[USDHHS,1994]. This may also be the stage of life when people, especially girls, are most sensitive to their body weight. The perception that smoking reduces levels or changes in weight is common among teenage girls.[6]

This paper estimates models that measure the role of body weight in the decisions of adolescents to initiate smoking, controlling for cigarette prices and state tobacco control policies. Understanding the relative effects of weight and price may help to identify adolescents most likely to initiate smoking, and allow anti-smoking efforts to

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better target at-risk teens. We estimate our models using nationwide panel data of adolescents.

This paper relates to two previous literatures. The first is a medical and sociological literature on the relationship between girls' body image and their probability of smoking initiation. The second is an economics literature that focuses on the relationship between cigarette prices, tobacco control policies, and smoking initiation.

A few previous studies have examined the effects of concerns about weight on youth smoking. Tomeo et al. [1999], Wiseman et al. [1998], and French et al. [1994] find that concern about weight is correlated with current smoking or smoking initiation for female adolescents. Voorhees et al. [2002] show that teenage girls who are currently trying to lose weight, or who tried to lose weight in the past, are more likely to be daily smokers. Tucker [1983] finds that obese boys have stronger intentions of smoking than lighter boys. Cawley, Markowitz, and Tauras [2004] studied data from the National Longitudinal Survey of Youth 1997 Cohort and found that weight influenced the smoking initiation decisions of girls but not boys.

Most of the existing studies on smoking and weight suffer from the fact that their samples are a single cross-section. French et al. [1994] and Cawley et al. [2004] are the only studies to examine the probability of transition from non-smoker to smoker using a panel of respondents. Our study contributes to this literature by examining the transition from non-smoker to smoker using a large national panel data set of adolescents that covers a longer period than the data used in Cawley et al. [2004]. This paper also considers certain measures of body weight not considered by Cawley et al. [2004].

Another limitation is that all of these studies except Cawley et al. [2004] fail to control for cigarette prices and tobacco control policies such as youth access laws, which are potentially important predictors of adolescent smoking initiation. The omission of these economic variables will not bias the coefficient on weight unless they are correlated with weight; however, we believe that controlling for both is important because it yields information on the relative importance of the two factors in the smoking initiation decision.

In contrast, economic studies of adolescent smoking initiation have focused on the impact of price and tobacco control policies while ignoring the role of body weight. To date, six econometric studies have examined the impact of cigarette prices or taxes on smoking initiation, the results of which vary considerably. The earliest studies, Douglas and Hariharan [1994] and Douglas [1998], find that current cigarette prices are uncorrelated with smoking initiation. However, these results should be interpreted with caution because the smoking variables were created using retrospective data; incorrect recall, along with errors in matching historical price to past residence may bias the results. In another study using retrospective data, Forster and Jones [1999] find that higher taxes are associated with later initiation, although the magnitude of the impact is small.

The results from initiation studies that use longitudinal data are mixed. Tauras, Johnston, and O'Malley [2001] conclude that cigarette prices are strongly negatively correlated with the probability of transition to daily smoking. However, the effect of price on the probability of transition to smoking any quantity of cigarettes is not statistically significant. DeCicca, Kenkel, and Mathios [2002] control for state fixed effects and find that cigarette excise taxes are insignificant determinants of smoking

onset. Neither of the aforementioned studies analyzes the smoking decision separately by gender. Cawley, Markowitz, and Tauras [2004] find significant gender differences; specifically, that price is negatively correlated with smoking initiation by boys but uncorrelated with smoking initiation by girls.

This paper is distinct from Cawley, Markowitz, and Tauras [2004] in that it uses a different dataset that spans a larger time period: the Children of the National Longitudinal Survey of Youth, 1979 Cohort.[7] In addition, this paper is more concerned with objective measures of weight such as BMI and clinical weight classification (both levels and changes) while Cawley et al. [2004] focuses more on self reported body image and dieting.

METHODS

Our methods are based on a simple latent variable model. We assume that the net utility that an adolescent derives from smoking (U_S) is a function of his body weight W, other characteristics X and has an error term u: $U_{Sit} = \alpha_{it} + W_{it}\beta + X_{it}\gamma + u_{it}$.

Included in characteristics X are the monetary and time costs of acquiring cigarettes. Where cigarettes are more expensive, or are harder to acquire because of state youth access laws, adolescents may derive less utility from initiating.

The adolescent will choose to initiate smoking if $U_{Sit} > 0$. We estimate the probability of smoking initiation as a function of weight W and other characteristics X using linear probability regression.[8] Based on findings from our previous research, we hypothesize that, for adolescent girls, body weight increases the probability that adolescent girls will initiate smoking; i.e. that $\beta > 0$. We hypothesize that, for boys, weight is uncorrelated with the initiation decision; i.e. that $\beta = 0$.

There are two complications. The first is that smoking may lower weight. To address this possibility, we also estimate our models using a measure of weight lagged two years. This allows us to test whether initiation is more likely among adolescents who were heavy when they were still abstaining.

The second complication of the model is that there may be unobserved personality traits that are correlated with both overweight and smoking. If there exist unobserved personality traits that affect both weight and smoking then weight will be correlated with the error term in the smoking initiation regression. Such traits might include having an "addictive" personality that leads one to both overeat and smoke, or assigning little value to future events so one heavily discounts the future health costs of smoking and obesity. Such a correlation between a regressor and the error term would violate the assumptions behind the linear regression model. The solution is that, given an instrument, one can use the method of instrumental variables to generate a consistent estimate of the effect of the regressor on the outcome.

In this paper, our instrument is the weight of the adolescent's mother.[9] Our identifying assumption is that the weight of the mother is correlated with the adolescent's weight and is not correlated with the residual in the smoking equation. In using the weight of the mother as an instrument for an adolescent's weight, we pick up the variation in weight due to that part of the genetic variation in weight shared by mother and child. It is our identifying assumption that the adolescent's personality traits that

affect smoking are uncorrelated with the mother's personality traits that affect weight. If this assumption is violated, our instrument is correlated with the residual in the smoking equation, and the method of instrumental variables would not have solved the problem of endogeneity and may in fact have made the problem worse [Bound, Jaeger, and Baker, 1995].

We next address two potential concerns about the suitability of the mother's weight as an instrument. First, one might be concerned that a mother's weight is an unsuitable instrument for an adolescent's weight because common household environment affects both the weight of the mother and the adolescent's propensity to smoke. However, a body of literature finds no measurable effect of common household environment on body weight [Grilo and Pogue-Geile, 1991; Maes et al., 1997]. This literature finds that all of the similarity in weight between parents and children is genetic in origin.[10] The consistent inability of that literature to detect any nongenetic component of weight shared by parents and children is consistent with the assumption that there is no trait shared by parents and children that affects smoking *and* weight.

Alternatively, one might be concerned that an adolescent's smoking initiation might be correlated with the mother's weight if heavy mothers tend to become smoking mothers, and one tends to smoke if one's mother smokes. To address this potential problem, we control in all regressions for whether the mother reports ever having smoked 100 cigarettes in her life, and whether she is a current smoker (defined as having smoked any cigarettes in the past thirty days).

DATA: THE CHILDREN OF THE NLSY

The dataset used in all estimations reported in this paper is the Children of the National Longitudinal Survey of Youth, 1979 Cohort (CoNLSY). The Children of the NLSY consists of the biological children of female respondents of the National Longitudinal Survey of Youth, 1979 Cohort (NLSY79) who were living in their mother's household at the time of a child assessment interview and who completed an interview. The baseline survey was conducted in 1986, with respondents interviewed every even-numbered year thereafter. Unlike most longitudinal surveys, which start with a fixed number of respondents and lose respondents to attrition over time, the size of the CoNLSY is continuously increasing as female respondents to the NLSY continue to have children. Because the NLSY79 is a nationally representative sample of youths aged 14-21 in 1979, the Children of the NLSY is not a nationally representative data set, but is representative of the children born to women aged 14-21 in 1979.

We use three measures of smoking initiation: (1) whether the respondent has ever smoked a cigarette, (2) whether the respondent smoked at least once a week in the 30 days prior to interview, and (3) whether the respondent has smoked five to six times a week in the 30 days prior to interview. The first initiation measure is constructed using a question posed to CoNLSY respondents in each interview starting in 1988: Have you ever smoked a cigarette? Our first initiation variable equals one if this question was answered no in all previous interviews but is answered yes in the current interview. Alternatively, the variable equals zero if the current answer to the question is no and in no previous interview has the answer been yes. Since this ques-

tion was asked starting in 1988, we have data for our first initiation measure for 1990, 1992, 1994, 1996, 1998, and 2000.

Our second and third initiation measures reflect more strict definitions of smoking. Our second initiation variable equals one if reported smoking frequency in all previous interviews is less than once a week but is reported as once a week or more in the current interview. Alternatively, the variable equals zero if the current reported smoking frequency is less than once a week and in no previous interview has reported smoking frequency been higher. Likewise, the third initiation variable equals one if reported smoking frequency all previous interviews is less than five to six times a week but is reported as at least that frequent in the current interview. The third initiation variable equals zero if the respondent has never reported smoking 5-6 times per week in the past month in the current or any past interview. Thus, occasional smokers are coded as "non-smokers" for the second and third (more strict) definitions of smoking initiation. The question about smoking frequency in the past month was asked in each interview starting in 1994, so we have data for the second and third initiation measures for 1996, 1998, and 2000.

For each of our measures of smoking initiation, the measure is set to missing for all periods subsequent to that of initiation. That is, if a person does not smoke (however defined) until time *t*, each period prior to *t* the initiation measure is set equal to 0; at time *t* it is set equal to 1, and for all periods after *t* the initiation measure is set to missing. In this way, our data set is composed exclusively of people either at risk of initiation or who have just initiated.

Tables 1A and 1B list, for female and male adolescents, summary statistics of each of the variables used in our models. By the first, most liberal, definition of smoking initiation, 10.6 percent of the female (and 12 percent of the male) person-year observations in our sample are initiations. Under the second and third – more strict – definitions of smoking initiation, 4.8 percent and 3.4 percent of female (and 7 percent and 5 percent of the male) observations are initiations. The youngest respondents in our sample are 10 and the oldest are 20; this age range covers the ages at which the vast majority of eventual smokers initiate.

The weight and height of CoNLSY respondents are either reported or measured in each interview. We use three variables to measure the respondent's level of body weight. The first measure is Body Mass Index (BMI), the standard measure of body weight in epidemiology and medicine [U. S. National Institutes of Health, 1998; Epstein and Higgins, 1992], which is calculated as weight in kilograms divided by height in meters squared.[11] The second measure is weight in pounds; when we use this measure we also control for height in inches. Although BMI reflects both height and weight, it may prove interesting to control for the two separately. The third way we control for weight is using a set of indicator variables for clinical weight classification. In the year 2000, the Centers for Disease Control revised the growth charts used by pediatricians to classify children and adolescents as underweight and overweight. While the highest clinical weight classification for adults is "obese", for children it is "overweight." Among the new charts are BMI-for-age charts for boys and girls aged 2 to 20. The charts list, by gender and age, the BMI cutoff associated with underweight, at risk of overweight, and overweight. These cutoffs are based on the percentiles of BMI-for-height found in past National Health and Nutrition Examination Surveys. We use

these cutoffs with two modifications: first, we use the average cutoff for an adolescent of a given gender and year of age rather than assigning different cutoffs based on month of age; this is done because for older adolescents age is reported in years instead of months. Second, when the thresholds for underweight, at risk of overweight, and overweight at higher ages exceed the adult cutoffs for underweight, overweight, and obese, we use the adult cutoffs. This is done to ensure continuity across ages in the definitions of underweight, overweight, and obese. Table 1A indicates that, of the girls in our sample, 4 percent
are clinically underweight, 17.4 percent are at risk of overweight, and 13.7 percent

TABLE 1A
Summary Statistics
Female Children of the NLSY

Variable	N	Mean	Std. Dev.	Minimum	Maximum
Indicator: initiated smoking For the first time, reported having smoked a cigarette	3756	.106	.31	0	1
Indicator: initiated smoking For the first time, reported having smoked once a week in past 30 days	3121	.048	.21	0	1
Indicator: initiated smoking For the first time, reported having smoked five to six times a week in past 30 days	3168	.034	.18	0	1
Body mass index	4307	21.49	5.09	10.04	52.09
Weight in pounds	4307	117.74	35.09	42	313
Height in inches	4307	61.69	4.25	39	76
Indicator: Underweight	4307	.040	.20	0	1
Indicator: At Risk of Overweight	4307	.174	.38	0	1
Indicator: Overweight	4307	.137	.344	0	1
Average real price of a pack of cigarettes	4307	1.37	.31	.91	2.51
Index: state laws on youth possession, youth, and purchase of tobacco	4099	1.23	1.04	0	3
Index: state laws on smoke-free air in various facilities	4099	11.53	7.67	0	32
Index: state laws on youth access	4099	13.58	6.78	0	31
Indicator: black	4307	.343	.48	0	1
Indicator: Hispanic	4307	.189	.39	0	1
Age	4307	13.00	2.49	10	20
Year	4307	96.58	2.81	90	100
Indicator: enrolled in school	4307	.953	.21	0	1
Grade	4127	7.18	2.44	0	16
Percentile score on PIAT reading test	2942	57.75	28.17	1	99
Family income	4307	32,846	56,995	1	851,343
Mother's highest grade completed	4307	12.30	2.21	1	20
Mother's age	4307	35.93	3.31	26	43
Indicator: mother is employed	3319	.059	.236	0	1
Indicator: mother is married with spouse present	4307	.612	.49	0	1
Indicator: mother has smoked 100 cigarettes in lifetime	4307	.522	.50	0	1
Indicator: mother currently smokes	4307	.368	.48	0	1
Mother's body mass index	4307	27.52	6.60	7.83	62.19

TABLE 1B
Summary Statistics
Male Children of the NLSY

Variable	N	Mean	Std. Dev.	Minimum	Maximum
Indicator: initiated smoking For the first time, reported having smoked a cigarette	4692	.120	.32	0	1
Indicator: initiated smoking For the first time, reported having smoked once a week in past 30 days	3546	.070	.26	0	1
Indicator: initiated smoking For the first time, reported having smoked five to six times a week in past 30 days	3661	.050	.22	0	1
Body mass index	5536	21.38	4.87	10.82	62.93
Weight in pounds	5536	126.15	42.26	46	398
Height in inches	5536	63.70	6.02	36	84
Indicator: Underweight	5536	.044	.21	0	1
Indicator: At Risk of Overweight	5536	.167	.37	0	1
Indicator: Overweight	5536	.153	.360	0	1
Average real price of a pack of cigarettes	5536	1.34	.30	.91	2.51
Index: state laws on youth possession, youth, and purchase of tobacco	5536	1.17	1.06	0	3
Index: state laws on smoke-free air in various facilities	5536	11.27	7.54	0	32
Index: state laws on youth access	5536	13.28	6.88	0	29
Indicator: black	5536	.348	.48	0	1
Indicator: Hispanic	5536	.224	.42	0	1
Age	5536	13.39	2.66	10	20
Year	5536	96.06	3.04	90	100
Indicator: enrolled in school	5536	.92	.27	0	1
Grade	5099	7.29	2.47	1	20
Percentile score on PIAT reading test	3499	51.93	31.13	1	99
Family income	5536	30,131	48,329	1	851,343
Mother's highest grade completed	5536	12.11	2.31	0	20
Mother's age	5536	35.58	3.39	25	43
Indicator: mother is employed	4446	.067	.249	0	1
Indicator: mother is married with spouse present	5536	.572	.50	0	1
Indicator: mother has smoked 100 cigarettes in lifetime	5536	.549	.50	0	1
Indicator: mother currently smokes	5536	.409	.49	0	1
Mother's body mass index	5536	27.36	6.27	15.50	91.23

are overweight. Table 1B indicates that, of the boys in our sample, 4.4 percent are underweight, 16.7 percent are at risk of overweight, and 15.3 percent are overweight. We use both current and lagged values of these three measures. We also measure recent change in weight using change in BMI, change in weight in pounds, an indicator variable for whether one changed to a higher weight classification and an indicator variable for whether one changed to a lower weight classification, since the last interview (which was conducted roughly two years prior). We drop observations with obviously erroneous measures of weight: a BMI greater than 63 (three observations) or BMI below 10 (9 observations).

Using identifiers for state of residence, we merged into the CoNLSY cigarette prices and state tobacco regulations. The cigarette price is the state real yearly price of a box of 20 cigarettes; the price is a weighted average of the prices of single packs, cartons, and vending machine sales where the weights are the national proportions of each type of sale.[12] Generic cigarettes are included in calculation and prices are inclusive of state excise taxes. The source of this data is the Tobacco Institute's annual *Tax Burden on Tobacco.*

We also control for three measures of state tobacco regulations. The first is an index ranging from 0 to 3 that records the presence of state laws barring youth possession, use, and/or purchase of tobacco. The second captures the overall magnitude of state level policies on smoke free air. It is an index that ranges from 0 to 32 and reflects the presence of state laws requiring smoke-free air in various types of establishments and facilities.[13] These two measures were created for Project ImpacTeen by Gary Giovino and colleagues at the Roswell Park Cancer Institute. The third measure captures the extensiveness and comprehensiveness of state policies aimed at reducing youth access to tobacco products. It is an index that ranges from 0 to 31 that reflects the presence and severity of youth access laws; these youth access laws concern minimum purchase age, restrictions on packaging, photo ID requirements, clerk intervention during sales, restrictions on vending machines, restrictions on free samples, penalties to retailers who sell to minors, random inspections, and statewide enforcement. This index was developed by Alciati et al. [1998] for the National Cancer Institute and updated by Gary Giovino and colleagues at the Roswell Park Cancer Institute for Project ImpacTeen.

Other regressors in our smoking initiation regressions include natural log of family income, current grade in school, percentile score on PIAT reading test, year, mother's highest grade completed, mother's age, and indicator variables for black, Hispanic, age, enrolled in school, mother is married with her spouse present, mother is employed, mother has smoked 100 cigarettes in lifetime, and mother currently smokes.

Given the panel nature of the data, the standard errors of the estimates are cluster corrected at the individual level using a robust method of calculating the variance covariance matrix developed by Huber [1967]. The cluster correction relaxes the assumption of independence of observations so that observations only have to be independent across individuals but not among observations of the same individual.

We are regressing individual outcomes on some regressors that vary at the state level (e.g. price, clean indoor air laws). As a result of regressing micro outcomes on an aggregate regressor, unadjusted standard errors will be biased downwards, perhaps dramatically [Moulton, 1990]. To adjust for this, we re-estimate our models clustering the standard errors at the state level. In our tables of results, t statistics for individual-level variables reflect clustering at the individual level, and t statistics for state-level variables reflect clustering at the state level. CoNLSY sample weights are used in all estimations.

EMPIRICAL RESULTS

Table 2A and 2B present the linear probability coefficients and t statistics for nine regressions: the three initiation measures as dependent variables, each regressed on

a different measure of weight: BMI, weight in pounds, and indicator variables for clinical weight classification. The first, fourth, and seventh columns of Table 2A indicate that, for each measure of body weight, heavier girls are more likely to initiate when initiation is defined very loosely as smoking any cigarettes for the first time. Both BMI and weight in pounds are positive and statistically significant at the 10 percent level. The indicator variable for underweight is negative and statistically significant at the 10 percent level, while that for overweight is positive and significant at the 10 percent level. While BMI and weight in pounds are not statistically significant for the second and third (more stringent) definitions of initiation, the indicator variable for underweight remains statistically significant and negative in each regression. Underweight girls are 3.6 percentage points less likely to smoke at all for the first time, 3.7 percentage points less likely to start smoking at least once a week, and 2.6 percentage points less likely to start smoking 5-6 times a week. This pattern is consistent with heavier girls being more likely to initiate smoking than lighter girls. However, while we initially hypothesized that overweight girls would be more likely to initiate than healthy weight girls, it appears that the major difference in initiation is between the underweight girls and all other girls (those of healthy weight, at risk of overweight, and overweight).

Table 2A also indicates that cigarette prices have little effect on the initiation decisions of adolescent girls. The state regulations on possession, use, and purchase is statistically significant and negatively correlated with the second measure of initiation, but regulations on smoke-free air are significant and positively correlated in the same regression, which may be an artifact of multicollinearity between the two policy variables.

The results for adolescent boys, presented in Table 2B, differ considerably from the results for girls. While weight but not price was correlated with the initiation decisions for girls, price but not weight appears important for boys. No coefficient on any weight measure is statistically significant. The coefficient on cigarette price is negative and statistically significant in the regressions using the first measure of initiation. In the regressions using BMI as the measure of weight, boys' elasticity of initiation (the most liberal definition) with respect to cigarette price (calculated at the mean of the initiation and price variables) is -1.2. This is five times larger than the price elasticity of initiation among girls (which is -0.24). The results suggest that, among boys, price matters for starting casual smoking, but the initiation of heavier smoking is driven by nonprice considerations.

Many individual level characteristics also predict smoking initiation. These results are not shown for the sake of brevity but are available upon request. For females, mother's characteristics have a strong influence on whether or not the female begins smoking. Having an older mother is negatively correlated with two of the measures of smoking initiation (any level and smoking 5-6 times per week) and having a mother who is married with the spouse present is negatively correlated with all measures of smoking initiation. The measures of mother's smoking are positively correlated with initiation. Higher family income is positively associated with the probability of heavy smoking, possibly indicating that children from higher income families have the resources to frequently purchase cigarettes.

TABLE 2A
Female Children of the NLSY
Smoking Initiation and Current Weight
Linear Probability Coefficients and t Statistics

Variable	Init 1	Init 2	Init 3	Init 1	Init 2	Init 3	Init 1	Init 2	Init 3
BMI	.0028#	.0008	-.0008						
	(1.90)	(0.72)	(-1.06)						
Weight in Pounds				.0005#	.0002	-.0001			
				(1.70)	(0.75)	(-1.05)			
Indicator:							-.0358#	-.0369**	-.0264**
Underweight							(-1.70)	(-3.85)	(-3.37)
Indicator: Risk							.0219	-.0148	-.0070
of Overweight							(1.39)	(-1.49)	(-0.76)
Indicator:							.0378#	.0212	-.0031
Overweight							(1.85)	(1.24)	(-0.27)
Cigarette Price	-.0186	-.0315	-.0181	-.0178	-.0315	-.0181	-.0189	-.0312	-.0182
	(-0.60)	(-1.31)	(-0.69)	(-0.57)	(-1.31)	(-0.69)	(-0.60)	(-1.31)	(-0.69)
Regulation index:	.0012	-.0082*	-.0056	.0009	-.0082*	-.0056	.0010	-.0082*	-.0056
youth use	(0.24)	(-2.05)	(-1.42)	(0.18)	(-2.03)	(-1.41)	(0.20)	(-2.08)	(-1.43)
Regulation index:	.0009	.0009*	.0004	.0009	.0009*	.0004	.0009	.0009*	.0004
smoke-free air	(1.35)	(2.17)	(0.80)	(1.28)	(2.17)	(0.80)	(1.35)	(2.08)	(0.79)
Regulation index:	.0001	-.0005	-.0002	.0002	-.0005	-.0001	.0001	-.0005	-.0002
youth access	(0.12)	(-0.59)	(-0.28)	(0.14)	(-0.60)	(-0.27)	(0.12)	(-0.64)	(-0.31)
Number of Observations	3755	3120	3167	3755	3120	3167	3755	3120	3167

Notes:

1) Init 1 indicates started smoking at all. Init 2 indicates started smoking at least once a week. Init 3 indicates started smoking 5-6 times a week.
2) Other regressors include: natural log of family income, grade, percentile score on PIAT reading test, year, mother's highest grade completed, mother's age, and indicator variables for black, Hispanic, age, enrolled in school, mother is married with her spouse present, mother is employed, mother has smoked 100 cigarettes in lifetime, and mother currently smokes.
3) t statistics for individual-level variables reflect clustering at the individual level, and t statistics for state-level variables reflect clustering at the state level.
4) Symbols indicate that the coefficient is significant at:# = 10 percent level, * = 5 percent level, ** = 1 percent level

For males, years of schooling are negatively associated with all measures of smoking initiation. Having higher PIAT reading scores negatively correlates with initiating any quantity. Higher family income is positively associated with the probability of heavy smoking, and having a mother who is married with the spouse present is negatively correlated with the first measure of smoking initiation.

For both boys and girls, blacks are significantly less likely to initiate. The coefficients on age indicator variables indicate that the probability of initiation generally rises with age for both boys and girls. In some regressions the probability levels off at age 16, or even falls slightly, until age 20.

The decision to initiate may be driven less by the level of one's weight than by the recent change in one's weight. To investigate this possibility, we re-estimated our models using change in BMI, change in weight in pounds, or change in clinical weight classification since the last interview (roughly two years). For change in BMI and

TABLE 2B
Male Children of the NLSY
Smoking Initiation and Current Weight
Linear Probability Coefficients and t Statistics

Variable	Init 1	Init 2	Init 3	Init 1	Init 2	Init 3	Init 1	Init 2	Init 3
BMI	-.0010	.0012	-.0002						
	(-0.91)	(1.08)	(-0.24)						
Weight in Pounds				-.0002	.0002	-.0001			
				(-1.01)	(0.79)	(-0.43)			
Indicator:							-.0151	-.0166	-.0028
Underweight							(-0.73)	(-0.93)	(-0.16)
Indicator:							-.0019	-.0169	-.0061
Risk of Overweight							(-0.13)	(-1.33)	(-0.51)
Indicator:							-.0191	.0129	.0003
Overweight							(-1.37)	(0.92)	(0.03)
Cigarette Price	-.1072**	-.0681	-.0359	-.1069**	-.0690	-.0361	-.1091**	-.0648	-.0351
	(-3.48)	(-1.57)	(-0.99)	(-3.44)	(-1.57)	(-0.99)	(-3.53)	(-1.49)	(-0.98)
Regulation index:	.0095	-.0007	-.0043	.0095	-.0009	-.0044	.0095	-.0009	-.0044
Youth Use	(1.26)	(-0.10)	(-0.77)	(1.26)	(-0.13)	(-0.80)	(1.26)	(-0.13)	(-0.79)
Regulation index:	.0001	.0002	-.0002	.0001	.0002	-.0002	.0001	.0001	-.0002
Smoke-free Air	(0.10)	(0.21)	(-0.31)	(0.09)	(0.21)	(-0.31)	(0.10)	(0.18)	(-0.31)
Regulation index:	-.0001	.0009	.0005	-.0001	.0010	.0005	-.0001	.0009	.0005
Youth Access	(-0.17)	(1.02)	(0.59)	(-0.17)	(1.04)	(0.61)	(-0.19)	(0.99)	(0.60)
Number of Observations	4700	3555	3669	4700	3555	3669	4700	3555	3669

Notes:

1) Init 1 indicates started smoking at all. Init 2 indicates started smoking at least once a week. Init 3 indicates started smoking 5-6 times a week.
2) Other regressors include: natural log of family income, grade, percentile score on PIAT reading test, year, mother's highest grade completed, mother's age, and indicator variables for black, Hispanic, age, enrolled in school, mother is married with her spouse present, mother is employed, mother has smoked 100 cigarettes in lifetime, and mother currently smokes.
3) t statistics for individual-level variables reflect clustering at the individual level, and t statistics for state-level variables reflect clustering at the state level.
4) Symbols indicate that the coefficient is significant at: # = 10 percent level, * = 5 percent level, ** = 1 percent level

weight in pounds, a positive value means that the individual gained weight since the last interview. Tables 3A and 3B present the results for females and males. For females, columns 1, 4, and 7 indicate that initiating any smoking is positively correlated with change in BMI. For the first and broadest definition of initiation, those who rose to a higher weight classification were 2.4 percentage points more likely to initiate, while those who fell to a lower weight classification were 3.9 percentage points less likely to initiate. However, when the strictest definition of smoking is used, initiation is *less* likely among girls who recently gained in BMI or weight in pounds; this difference could be due to a nonlinear anorectic effect with smoking. That is, anorectic effects may be felt only by the heaviest smokers. These results are consistent with girls who recently gained weight starting to smoke in order to lose weight (or in order to slow their rate of increase), while heavy-smoking girls experience the anorectic effects of smoking and gain less weight over time than other girls.

TABLE 3A
Female Children of the NLSY
Smoking Initiation and Recent Change in Weight
Linear Probability Coefficients and t Statistics

Variable	Init 1	Init 2	Init 3	Init 1	Init 2	Init 3	Init 1	Init 2	Init 3
Change in BMI	.0069**	-.0012	-.0043**						
	(3.71)	(-0.80)	(-3.08)						
Change in Weight in Pounds				.0013**	-.0006	-.0013**			
				(3.11)	(-1.50)	(-3.74)			
Indicator: rose to higher weight classification							.0237#	.0096	-.0051
							(1.79)	(0.91)	(-0.70)
Indicator: fell to lower weight classification							-.0390#	.0114	.0268
							(-1.89)	(0.48)	(1.12)
Cigarette Price	-.0179	-.0315	-.0182	-.0180	-.0314	-.0183	-.0172	-.0321	-.0189
	(-0.58)	(-1.32)	(-0.71)	(-0.58)	(-1.32)	(-0.72)	(-0.54)	(-1.32)	(-0.72)
Regulation index: youth use	.0007	-.0084*	-.0055	.0006	-.0084*	-.0055	.0007	-.0085*	-.0054
	(0.13)	(-2.08)	(-1.36)	(0.12)	(-2.09)	(-1.36)	(0.14)	(-2.13)	(-1.38)
Regulation index: smoke-free air	.0009	.0009*	.0004	.0008	.0009*	.0005	.0008	.0009*	.0005
	(1.22)	(2.16)	(0.82)	(1.19)	(2.21)	(0.85)	(1.17)	(2.12)	(0.88)
Regulation index: youth access	.0002	-.0005	-.0002	.0002	-.0005	-.0003	.0002	-.0005	-.0002
	(0.18)	(-0.57)	(-0.35)	(0.21)	(-0.59)	(-0.46)	(0.15)	(-0.58)	(-0.34)
Number of Observations	3755	3120	3167	3755	3120	3167	3755	3120	3167

Notes:

1) Init 1 indicates started smoking at all. Init 2 indicates started smoking at least once a week. Init 3 indicates started smoking 5-6 times a week.
2) Change in BMI, change in weight in pounds, and change in clinical weight classification are measured between the last interview conducted roughly two years ago and the current interview.
3) Other regressors include: natural log of family income, grade, percentile score on PIAT reading test, year, mother's highest grade completed, mother's age, and indicator variables for black, Hispanic, age, enrolled in school, mother is married with her spouse present, mother is employed, mother has smoked 100 cigarettes in lifetime, and mother currently smokes.
4) t statistics for individual-level variables reflect clustering at the individual level, and t statistics for state-level variables reflect clustering at the state level.
5) Symbols indicate that the coefficient is significant at: # = 10 percent level, * = 5 percent level, ** = 1 percent level

Table 3B indicates that change in weight in BMI and change in pounds are generally negatively correlated with smoking initiation for boys. Change in BMI is statistically significant and negative for each measure of initiation. Change in weight in pounds is statistically significant and negative for the two stricter definitions of smoking. These results are consistent with smoking suppressing the appetite and lowering weight; boys who have initiated since the last interview gained less weight since the last interview than boys who remained nonsmokers. However, boys' initiation is generally uncorrelated with changes in clinical weight classification.

A challenge in interpreting the results so far is that it is unclear whether the correlations between weight and smoking initiation are due to weight causing adolescents to

TABLE 3B
Male Children of the NLSY
Smoking Initiation and Recent Change in Weight
Linear Probability Coefficients and t Statistics

Variable	Init 1	Init 2	Init 3	Init 1	Init 2	Init 3	Init 1	Init 2	Init 3
Change in BMI	-. 0044*	-.0036*	-.0029#						
	(-2.25)	(-2.08)	(-1.91)						
Change in Weight in Pounds				-.0006	-.0006#	-.0009**			
				(-1.49)	(-1.88)	(-2.84)			
Indicator: rose to rose to higher weight classification							-.0092	-.0150	-.0050
							(-0.85)	(-1.64)	(-0.60)
Indicator: fell to lower weight classification							.0536#	.0190	.0045
							(1.87)	(0.76)	(0.21)
Cigarette Price	-.1059**	-.0678	-.0362	-.1073**	-.0691	-.0378	-.1076**	-.0676	-.0358
	(-3.46)	(-1.56)	(-1.00)	(-3.53)	(-1.60)	(-1.06)	(-3.55)	(-1.57)	(-1.01)
Regulation index: youth use	.0097	-.0005	-.0041	.0097	-.0005	-.0041	.0097	-.0007	-.0043
	(1.29)	(-0.08)	(-0.75)	(1.29)	(-0.08)	(-0.73)	(1.30)	(-0.10)	(-0.78)
Regulation index: smoke-free air	.0001	.0001	-.0002	.0001	.0001	-.0002	.0001	.0001	.0002
	(0.09)	(0.18)	(-0.31)	(0.11)	(0.19)	(-0.30)	(0.13)	(0.18)	(-0.31)
Regulation index: youth access	-.0001	.0009	.0005	-.0001	.0008	.0004	-.0001	.0009	.0005
	(-0.19)	(0.95)	(0.57)	(-0.18)	(0.93)	(0.54)	(-0.15)	(0.95)	(0.59)
Number of Observations	4691	3545	3659	4691	3545	3659	4691	3545	3659

Notes:

1) Init 1 indicates started smoking at all. Init 2 indicates started smoking at least once a week. Init 3 indicates started smoking 5-6 times a week.
2) Change in BMI, change in weight in pounds, and change in clinical weight classification are measured between the last interview conducted roughly two years ago and the current interview.
3) Other regressors include: natural log of family income, grade, percentile score on PIAT reading test, year, mother's highest grade completed, mother's age, and indicator variables for black, Hispanic, age, enrolled in school, mother is married with her spouse present, mother is employed, mother has smoked 100 cigarettes in lifetime, and mother currently smokes.
4) t statistics for individual-level variables reflect clustering at the individual level, and t statistics for state-level variables reflect clustering at the state level.
5) Symbols indicate that the coefficient is significant at: # = 10 percent level, * = 5 percent level, ** = 1 percent level

initiate, or due to smoking decreasing appetite and lowering weight, or to some combination of both. To better determine whether weight causes initiation, we next use lagged measures of weight in our initiation regressions. Specifically, whether an adolescent initiated smoking since the last interview is regressed on the adolescent's weight at the last interview when he or she was still a nonsmoker; the results of these regressions are presented in Tables 4A and 4B.

The results in Table 4A reveal that no coefficient on lagged weight is statistically significant at the 5 percent level for girls; notably, the coefficients on underweight are no longer statistically significant. The regressions using lagged values of weight do not yield supporting evidence that weight affects girls' decisions to initiate smoking.

TABLE 4A
Female Children of the NLSY
Smoking Initiation and Lagged Weight
Linear Probability Coefficients and t Statistics

Variable	Init 1	Init 2	Init 3	Init 1	Init 2	Init 3	Init 1	Init 2	Init 3
Lagged BMI	-.0001	.0016	.0013						
	(-0.10)	(1.35)	(1.33)						
Lagged Weight				-.0002	.0003	.0002			
in Pounds				(-0.56)	(1.09)	(1.11)			
Indicator: Lagged							-.0037	.0037	.0056
Underweight							(-0.24)	(0.34)	(-0.70)
Indicator: Lagged							.0382#	.0134	.0111
Risk of Overweight							(1.78)	(0.77)	(0.79)
Indicator: Lagged							-.0224	.0182	.0081
Overweight							(-1.03)	(0.89)	(0.48)
Cigarette Price	-.0181	-.0315	-.0181	-.0167	-.0307	-.0175	-.0199	-.0317	-.0185
	(-0.57)	(-1.32)	(-0.69)	(-0.53)	(-1.29)	(-0.67)	(-0.64)	(-1.30)	(-0.70)
Regulation index:	.0011	-.0081*	-.0053	.0006	-.0084*	-.0055	.0012	-.0081*	-.0053
Youth Use	(0.22)	(-2.04)	(-1.36)	(0.11)	(-2.09)	(-1.40)	(0.26)	(-2.05)	(-1.34)
Regulation index:	.0008	.0009*	.0005	.0008	.0009*	.0004	.0009	.0009*	.0005
Smoke-free Air	(1.20)	(2.27)	(0.89)	(1.11)	(2.19)	(0.88)	(1.24)	(2.21)	.0005
Regulation index:	.0002	-.0005	-.0002	.0002	-.0005	-.0002	.0002	-.0005	-.0002
Youth Access	(0.16)	(-0.63)	(-0.37)	(0.17)	(-0.62)	(-0.38)	(0.13)	(-0.63)	(-0.36)
Number of	3755	3120	3167	3755	3120	3167	3755	3120	3167
Observations									

Notes:

1) Init 1 indicates started smoking at all. Init 2 indicates started smoking at least once a week. Init 3 indicates started smoking 5-6 times a week.
2) Lagged weight was reported at previous interview conducted roughly two years prior.
3) Other regressors include: natural log of family income, grade, percentile score on PIAT reading test, year, mother's highest grade completed, mother's age, and indicator variables for black, Hispanic, age, enrolled in school, mother is married with her spouse present, mother is employed, mother has smoked 100 cigarettes in lifetime, and mother currently smokes.
4) t statistics for individual-level variables reflect clustering at the individual level, and t statistics for state-level variables reflect clustering at the state level.
5) Symbols indicate that the coefficient is significant at: # = 10 percent level, * = 5 percent level, ** = 1 percent level

However, Table 4B indicates that weight may play a role in the second measure of initiation for boys; the coefficients on lagged BMI and lagged weight in pounds are positive and significant, and that on the indicator for underweight is negative and significant. This suggests that the linear result is driven by underweight boys being less likely to initiate smoking. Cigarette price remains an important consideration in the initiation decision; it is statistically significant and negative in the regressions using the first two measures of initiation.

The use of a lagged value of weight is not ideal, because important changes in weight could have taken place after weight was recorded two years prior. For example, if girls' weight has a high variance, and girls initiate smoking quickly after crossing a critical weight threshold, the use of lagged weight may miss this relationship because weight from two years ago does not capture the dynamics that occurred

TABLE 4B
Male Children of the NLSY
Smoking Initiation and Lagged Weight
Linear Probability Coefficients and t Statistics

Variable	Init 1	Init 2	Init 3	Init 1	Init 2	Init 3	Init 1	Init 2	Init 3
Lagged BMI	.0012	.0030*	.0010						
	(0.83)	(2.22)	(0.93)						
Lagged Weight Pounds				.0002	.0005#	.0001			
				(0.72)	(1.86)	(0.60)			
Indicator: Lagged Underweight							.0090	-.0204#	-.0075
							(-0.62)	(-1.87)	(-0.72)
Indicator: Lagged Risk of Overweight							-.0056	-.0133	-.0129
							(-0.34)	(-0.84)	(-0.88)
Indicator: Lagged Overweight							.0080	.0267	.0054
							(0.40)	(1.35)	(0.36)
Cigarette Price	-.1085**	-.0689	-.0363	-.1050**	-.0709	-.0384	-.1081**	-.0663	-.0350
	(-3.59)	(-1.61)	(-1.01)	(-3.43)	(-1.63)	(-1.07)	(-3.57)	(-1.56)	(-0.97)
Regulation index: Youth Use	.0098	-.0005	-.0043	.0100	-.0007	-.0046	.0096	-.0009	-.0045
	(1.28)	(-0.07)	(-0.76)	(1.31)	(-0.10)	(-0.83)	(1.27)	(-0.13)	(-0.80)
Regulation index: Smoke-free Air	.0002	.0002	-.0002	.0001	.0002	-.0002	.0001	.0002	-.0002
	(0.18)	(0.24)	(-0.28)	(0.14)	(0.26)	(-0.27)	(0.16)	(0.20)	(-0.32)
Regulation index: Youth Access	.0001	.0010	.0005	-.0001	.0010	.0006	-.0001	.0009	.0004
	(-0.07)	(1.06)	(0.63)	(-0.18)	(1.07)	(0.68)	(-0.11)	(1.02)	(0.61)
Number of Observations	4691	3545	3659	4691	3545	3659	4691	3545	3659

Notes:

1) Init 1 indicates started smoking at all. Init 2 indicates started smoking at least once a week. Init 3 indicates started smoking 5-6 times a week.
2) Lagged weight was reported at previous interview conducted roughly two years prior.
3) Other regressors include: natural log of family income, grade, percentile score on PIAT reading test, year, mother's highest grade completed, mother's age, and indicator variables for black, Hispanic, age, enrolled in school, mother is married with her spouse present, mother is employed, mother has smoked 100 cigarettes in lifetime, and mother currently smokes.
4) t statistics for individual-level variables reflect clustering at the individual level, and t statistics for state-level variables reflect clustering at the state level.
5) Symbols indicate that the coefficient is significant at: # = 10 percent level, * = 5 percent level, ** = 1 percent level

since. As a better test of whether weight affects initiation, we estimate instrumental variables models using mother's BMI as an instrument.

The first stage of IV indicates that mother's BMI is a strong instrument; the F statistic and partial in the BMI first stage are 116 and .075 for girls, and 114 and .061 for boys. In the weight in pounds first stage they are 112 and .047 for girls, and 105 and .024 for boys. In the first stage for the indicator for at risk of overweight or higher they are 102 and .06 for girls, and 134 and .051 for boys.[14] These F statistics far exceed the minimum values recommended by Staiger and Stock [1997]. The second-stage IV results are presented in Tables 5A and 5B.

No IV coefficient on weight is statistically significant for either girls or boys. This could be due to a change in the point estimates or due to the IV procedure raising the

standard errors. A Hausman [1978] test is conducted to determine the need for the IV procedure; in this case, it represents a test for the exogeneity of weight. The p values of the Hausman test statistic are greater than .1 in each case, indicating that the null hypothesis that weight is exogenous cannot be rejected, and the linear probability estimates are to be preferred to the IV estimates. The results of the Hausman test are not surprising, for a comparison of the point estimates in Tables 5A and 5B with those in Tables 2A and 2B indicates that many of the IV coefficients are quite close to the corresponding linear probability coefficients.

For the sake of brevity, the tables report only the results for weight variables, cigarette price, and smoking regulations. However, there are a few results of interest for other regressors whose coefficients are not reported in the tables of this paper (full tables of results are available upon request). Two results in particular stand out. First, if the mother is married with a spouse present, the child is significantly less

TABLE 5A
Female Children of the NLSY
Smoking Initiation and Instrumented Current Weight
Instrumental Variables Coefficients and t Statistics

Variable	Init 1	Init 2	Init 3	Init 1	Init 2	Init 3	Init 1	Init 2	Init 3
Instrumented BMI	.0019	-.0016	-.0017						
	(0.38)	(-0.47)	(-0.57)						
Instrumented				.0003	-.0003	-.0003			
Weight in Pounds				(0.34)	(-0.47)	(-0.57)			
Instrumented Indicator:							.0222	-.0190	-.0184
Risk of Overweight							(0.38)	(-0.47)	(-0.70)
Cigarette Price	-.0184	-.0315	-.0182	-.0177	-.0315	-.0182	-.0189	-.0317	-.0184
	(-0.59)	(-1.31)	(-0.69)	(-0.57)	(-1.31)	(-0.69)	(-0.61)	(-1.31)	(-0.70)
Regulation index:	.0012	-.0086*	-.0058	.0009	-.0086*	-.0058	.0011	-.0086*	-.0057
youth use	(0.24)	(-2.12)	(-1.41)	(0.18)	(-2.09)	(-1.40)	(0.21)	(-2.13)	(-1.41)
Regulation index:	.0009	.0008#	.0004	.0008	.0008#	.0004	.0009	.0008#	.0004
smoke-free air	(1.26)	(1.89)	(0.75)	(1.20)	(1.90)	(0.75)	(1.24)	(1.83)	(0.73)
Regulation index:	.0002	-.0004	-.0001	.0002	-.0004	-.0001	.0002	-.0004	-.0001
youth access	(0.14)	(-0.53)	(-0.25)	(0.16)	(-0.53)	(-0.24)	(0.14)	(-0.54)	(-0.25)
Number of	3755	3120	3167	3755	3120	3167	3755	3120	3167
Observations									

Notes:

1) Init 1 indicates started smoking at all. Init 2 indicates started smoking at least once a week. Init 3 indicates started smoking 5-6 times a week.
2) Indicator for Risk of Overweight equals one if BMI is greater than or equal to the CDC cutoff for risk of overweight for a person of that gender and age; that is, it equals one for both those at risk of overweight and those who are overweight.
3) Other regressors include: natural log of family income, grade, percentile score on PIAT reading test, year, mother's highest grade completed, mother's age, and indicator variables for black, Hispanic, age, enrolled in school, mother is married with her spouse present, mother is employed, mother has smoked 100 cigarettes in lifetime, and mother currently smokes.
4) t statistics for individual-level variables reflect clustering at the individual level, and t statistics for state-level variables reflect clustering at the state level.
5) Symbols indicate that the coefficient is significant at: # = 10 percent level, * = 5 percent level, ** = 1 percent level

TABLE 5B
Male Children of the NLSY
Smoking Initiation and Instrumented Current Weight
Instrumental Variables Coefficients and t Statistics

Variable	Init 1	Init 2	Init 3	Init 1	Init 2	Init 3	Init 1	Init 2	Init 3
Instrumented BMI	0	.0016	.0034						
	(-0.01)	(0.40)	(0.93)						
Instrumented				0	.0002	.0006			
Weight in Pounds				(-0.01)	(0.34)	(0.91)			
Instrumented Indicator:							-.0003	.0174	.0361
Risk of Overweight							(-0.01)	(0.40)	(0.92)
Cigarette Price	-.1080**	-.0683	-.0369	-.1080**	-.0691	-.0373	-.1080**	-.0691	-.0391
	(-3.57)	(-1.57)	(-1.04)	(-3.55)	(-1.58)	(-1.05)	(-3.56)	(-1.56)	(-1.09)
Regulation index:	.0096	-.0007	-.0043	.0096	-.0009	-.0043	.0096	-.0005	-.0040
youth use	(1.27)	(-0.10)	(-0.77)	(1.27)	(-0.13)	(-0.77)	(1.27)	(-0.07)	(-0.70)
Regulation index:	.0001	.0002	-.0002	.0001	.0002	-.0002	.0001	.0002	-.0001
smoke-free air	(0.15)	(0.21)	(-0.23)	(0.15)	(0.21)	(-0.23)	(0.15)	(0.23)	(-0.16)
Regulation index:	-.0001	.0009	.0006	-.0001	.0010	.0006	-.0001	.0009	.0006
youth access	(-0.12)	(1.01)	(0.71)	(-0.12)	(1.03)	(0.71)	(-0.12)	(1.01)	(0.71)
Number of	4691	3545	3659	4691	3545	3659	4691	3545	3659
Observations									

Notes:

1) Init 1 indicates started smoking at all. Init 2 indicates started smoking at least once a week. Init 3 indicates started smoking 5-6 times a week.
2) Indicator for Risk of Overweight equals one if BMI is greater than or equal to the CDC cutoff for risk of overweight for a person of that gender and age; that is, it equals one for both those at risk of overweight and those who are overweight.
3) Other regressors include: natural log of family income, grade, percentile score on PIAT reading test, year, mother's highest grade completed, mother's age, and indicator variables for black, Hispanic, age, enrolled in school, mother is married with her spouse present, mother is employed, mother has smoked 100 cigarettes in lifetime, and mother currently smokes.
4) t statistics for individual-level variables reflect clustering at the individual level, and t statistics for state-level variables reflect clustering at the state level.
5) Symbols indicate that the coefficient is significant at: # = 10 percent level, * = 5 percent level, ** = 1 percent level

likely to smoke. For girls, this result holds for virtually all models and the magnitude is such that girls with married mothers are between 2 and 5 percentage points less likely to initiate. Among boys, this result is significant only for the first, most liberal, definition of smoking initiation, and in those regressions boys with married mothers are 4.5 percentage points less likely to initiate.

The second interesting result is that girls whose mothers have some kind of smoking history are more likely to initiate smoking, but for boys there is no such correlation. Among girls, this correlation varies depending on the definition of initiation that is used. If the first, most liberal, definition of smoking initiation is used, we find that girls whose mothers currently smoke are roughly 4.6 percentage points less likely to initiate but whether the mother has smoked 100 cigarettes in her life is not statistically significant. However, when we use the second, more strict, definition of initia-

tion, the results reverse and the coefficient on the indicator for whether the mother currently smokes is not statistically significant while that on whether the mother has smoked 100 cigarettes in her life is statistically significant and positive, indicating that girls with such mothers are roughly 3 percentage points more likely to initiate smoking. Neither of the coefficients on these variables is statistically significant when we study the third, strictest, definition of initiation. None of the maternal smoking variables are statistically significant for boys.

We checked the robustness of our results in several ways. First, we estimate our non-IV models using probit instead of linear probability regression. We find that the results are extremely similar: for the models in which we found that higher weight is associated with a higher probability that girls initiate when estimated by linear probability, we find the same result using probit. Likewise, for the models in which we found that a higher cigarette price is associated with a lower probability that boys initiate smoking when estimated by linear probability, we find the same result using probit.

We also estimated IV models in which the weight of a sibling, instead of the weight of the mother, served as the instrument and found very similar results. Finally, we also estimated IV models in which the endogenous variable was an indicator for whether the respondent was clinically underweight (instead of overweight) and found very similar results.

CONCLUSION

This paper examines the role of body weight, cigarette price, and state tobacco regulations in adolescent smoking initiation and finds major gender differences. Consistent with previous research, we find that smoking initiation (defined liberally) is less common among lighter adolescent girls, whether weight is measured by BMI, weight in pounds, or an indicator variable for clinically underweight.

In contrast, current weight is uncorrelated with the initiation decisions of adolescent boys. While any anorectic effects of smoking may bias the coefficients on weight in initiation regressions, Hausman tests indicate that it is not possible to reject the hypothesis that weight is exogenous, which indicates that linear probability models are preferable to IV models.

Our results are generally consistent with those in Cawley, Markowitz, and Tauras [2004], which found in a different dataset limited to the late 1990s that girls' initiation decisions were correlated with weight but not price, and that boys' initiation decisions were correlated with price but not weight.

The results of this paper help to clear up a disagreement in the smoking initiation literature. Tauras, Johnston, and O'Malley [2001] found that the smoking initiation decisions of adolescents are sensitive to cigarette price; while DeCicca, Kenkel, and Mathios [2002] found no evidence that price affects initiation. Neither of these studies estimated models separately by gender; when we do this, we find major differences between boys and girls. We find evidence that higher cigarette prices lower the probability that adolescent boys will initiate light smoking. Boys' elasticity of initiation

(ever smoked) with respect to cigarette price is -1.2. However, the initiation of heavier smoking appears to be driven by nonprice considerations. We also find no evidence that price affects the probability that girls initiate smoking, no matter how initiation is defined. This gender difference may help explain the mixed evidence of the impact of price on smoking initiation found in previous literature.

NOTES

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1. Ogden et al. [2002]. Overweight was defined as exceeding the 95th percentile of weight in age-growth charts.
2. There is debate over the annual number of deaths attributable to obesity [Mokdad, 2004, 2005; Flegal et al., 2004], but there is wide agreement that the number is substantial and that obesity is a major public health issue.
3. See, for example, Nemery et al. [1983], Fehily et al. [1984], USDHHS [1988], and Klesges et al. [1989]. Differences in diet and metabolic rates may be responsible for the weight gap between smokers and non-smokers [Klesges et al., 1989].
4. See, for example, Gordon et al. [1975], USDHHS [1990], Klesges et al. [1989], and Pinkowish [1999]. There is less research on the change in weight associated with the transition from non-smoker to smoker, and these results are mixed. For example, Colditz et al. [1992] find that smoking initiation does not result in any weight loss, while Lissner et al. [1992] show weight loss as a result of smoking initiation.
5. See, for example, Townsend et al. [1991], Klesges, Robinson and Zbikowski [1998], Brooks [1998], Larkin et al. [1990], Crawley and While [1995], Klesges, Zbikowski et al. [1998].
6. See, e.g. Camp et al. [1993] and Brooks [1998].
7. Cawley et al. [2004] used the National Longitudinal Survey of Youth, 1997 Cohort.
8. We estimate linear probability rather than probit models for ease of comparison with our subsequent two-stage least squares models. Heckman and MaCurdy [1985] and Angrist [2001] show the validity of using linear probability models for estimating simultaneous equations with dichotomous endogenous variables.
9. Cawley [2000] uses the weight of a child as an instrument for the weight of a mother in order to estimate the causal effect of body weight on employment disability. Cawley [2001] uses the weight of a father to instrument for the weight of a child in order to estimate the causal effect of body weight on adolescent dating and sexual activity. Cawley [2004] uses the weight of a sibling as an instrument in order to estimate the causal effect of body weight on wages.
10. See Grilo and Pogue-Geile [1991] and Maes et al. [1997].
11. U. S. National Institutes of Health [1998].
12. Prices were converted into real dollars using the 1982-1984 average as the base.
13. The index of state laws regarding smoke-free air is calculated as the following:[(restaurants * 2) + (recreational facilities* 2) + (cultural facilities* 2) + (shopping centers * 2) + (public schools * 2) + (private schools * 2) + (private worksites) + (health facilities) + (public transit) + (retail/grocery stores)] – (20 percent of total sum, if preemption). State preemption laws prevent a local area within a state from enacting smoke-free ordinances that are stronger or more protective than those of the state.
14. The dependent variable in one IV regression is an indicator variable for whether the respondent has a BMI that is equal to or greater than the age-specific CDC cutoff for risk of overweight. This differs from the regressor used earlier in that it also equals one if the respondent is clinically classified as overweight; in earlier regressions the indicator for at risk of overweight would equal zero if the respondent's BMI exceeded the cutoff for overweight (and the indicator for overweight would equal one). We found very similar results when we used an indicator for underweight instead of an indicator for at risk of overweight.

REFERENCES

Alciati, M. H., Frosh M., Green S. B., et al. State laws on youth access to tobacco in the United States: measuring their extensiveness with a new rating system. *Tobacco Control*, Winter 1998, 345-352.

Angrist, J. D. Estimation of Limited-Dependent Variable Models With Dummy Endogenous Regressors: Simple Strategies for Empirical Practice. *Journal of Business and Economic Statistics*, January 2001, 2-17.

Bound, J., Jaeger D. A., and Baker, R. M. Problems with Instrumental Variables Estimation When the Correlation Between the Instruments and the Endogenous Explanatory Variable is Weak. *Journal of the American Statistical Association*, June 1995, 443-450.

Brooks, A. Teenage Girls Start Smoking to Lose Weight. *British Medical Journal (International)*, August 8, 1998, 317-366.

Camp, D. E., Klesges R. C., and Relyea, G. The Relationship Between Body Weight Concerns and Adolescent Smoking. *Health Psychology*, January 1993, 24-32.

Cawley, J. An Instrumental Variables Approach to Measuring the Effect of Obesity on Employment Disability. *Health Services Research*, December 2000, 1159-1179.

_____. Body Weight and the Dating and Sexual Behaviors of Young Adolescents, in *Social Awakenings: Adolescents' Behavior as Adulthood Approaches*, edited by R. T. Michael. New York: Russell Sage, 2001.

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

Cawley, John, Markowitz Sara, and Tauras, John. Lighting Up and Slimming Down: The Effects of Body Weight and Cigarette Prices on Adolescent Smoking Initiation. *Journal of Health Economics*, March 2004, 293-311.

Centers for Disease Control and Prevention. Cigarette Smoking-Attributable Mortality and Years of Potential Life Lost—United States 1990. *Morbidity and Mortality Weekly Report*, August 27, 1993, 645–49.

Colditz, G. A., Segal, M. R., Myers, A. H., Stampfer, M. J., Willett, W., and Speizer, F. E. Weight Change in Relation to Smoking Cessation Among Women. *Journal of Smoking Related Diseases*, 3, 1992, 145-153.

Crawley, H. F. and While, D. The Diet and Body Weight of British Teenage Smokers at 16-17 Years. *European Journal of Clinical Nutrition*, December 1995, 904-914.

DeCicca, P., Kenkel, D., and Mathios, A. Putting Out the Fires: Will Higher Taxes Reduce Youth Smoking? *Journal of Political Economy*, February 2002, 144-169.

Douglas, S. M. The Duration of the Smoking Habit. *Economic Inquiry*, January 1998, 49-64, .

Douglas, S. M. and Hariharan, G. The Hazard of Starting Smoking: Estimates from a Split Sample Duration Model. *Journal of Health Economics*, July 1994, 213-230.

Epstein, F. H. and Higgins, M. Epidemiology of Obesity, in *Obesity*, edited by P. Bjorntorp and B. N. Brodoff. New York: J. B. Lippincott Company, 1992.

Fehily, A. M., Phillips, K. M., and Yarnell, W. G. 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., Williamson, D. F., Pamuk, E. R., and Rosenberg H. M. Estimating Deaths Attributable to Obesity in the United States. *American Journal of Public Health*, September 2004, 1486-1489.

Forster, M. and Jones, A. M. The Role of Tobacco Taxes in Starting and Quitting Smoking: Duration Analysis of British Data. Working Paper, University of York, September 3, 1999.

French, S. A., Perry, C. L., Leon, G. R. and Fulkerson, J. A. Weight Concerns, Dieting Behavior and Smoking Initiation in Adolescents: A Prospective Epidemiologic Study. *American Journal of Public Health*, November 1994, 1818-1820.

Gordon T., Kannel, W. B., Dawber, T. R., and McGee, D. Changes Associated with Quitting Cigarette Smoking: The Framingham Study. *American Heart Journal*, September 1975, 322-328.

Grilo, C. M. and Pogue-Geile, M. F. The Nature of Environmental Influences on Weight and Obesity: A Behavioral Genetic Analysis. *Psychological Bulletin*, November 1991, 520-537.

Hausman, J. Specification Tests in Econometrics. *Econometrica*, November 1978, 1251-1271.

Heckman, J. J. and MaCurdy, T. E. A Simultaneous Equations Linear Probability Model. *Canadian Journal of Economics*, February 1985, 28-37.

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.

Johnston, L. D. Changing Demographic Patterns of Adolescent Smoking over the Past 23 Years: National Trends from the Monitoring the Future Study, in *Changing Adolescent Smoking Prevalence: Where It Is And Why*. National Cancer Institute's Smoking and Tobacco Control Monograph #14. Washington, D.C.: U. S. Department of Health and Human Services, 2002.

Klesges, R. C., Myers, A., Klesges, L. M., and LaVasque, M. E. Smoking, Body Weight and Their Effects on Smoking Behavior: A Comprehensive Review of the Literature. *Psychological Bulletin*, September 1989, 204-230.

Klesges, R. C., Robinson, L. AL., and Zbikowski, S. Is Smoking Associated with Lower Body Mass Index in Adolescents? A Large-Scale Biracial Investigation. *Addictive Behaviors*, January 1998, 109-113.

Klesges, R. C., Zbikowski, S. M., Lando, H. A., Haddock, C. K., Talcott, G. W., and Robinson, L. A. The Relationship Between Smoking and Body Weight in a Population of Young Military Personnel. *Health Psychology*, September 1998, 454-458.

Larkin, F. A., Basiotis, P. P., Riddick, H. A., Sykes, K. E., and Pao, E. M. Dietary Patterns of Women Smokers and Non Smokers. *Journal of the American Dietetic Association*, February 1990, 230-237.

Lissner, L., Bengtsson, C., Lapidus, L., and Björkelund, C. Smoking Initiation and Cessation in Relation to Body Fat Distribution Based on Data From a Study of Swedish Women. *American Journal of Public Health*, February 1992, 273-275.

Maes, Hermine H. M., Neale, M. C., and Eaves, L. J. Genetic and Environmental Factors in Relative Body Weight and Human Adiposity. *Behavior Genetics*, July 1997, 325-351.

Mokdad, A. H., Marks, J. S., Stroup, D. F., and Gerberding, J. L Actual Causes of Death in the United States, 2000. *JAMA*, March 2004, 1238-1245.

_____. 2005. Correction: Actual Causes of Death in the United States, 2000. *JAMA*, January 2005, 293.

Moulton, B. R. An Illustration of a Pitfall in Estimating the Effects of Aggregate Variables in Micro Units. *Review of Economics and Statistics*, May 1990, 334-338.

Nemery B., Moavero, N. E., Brasseur, L., and Stanescu, D. C. Smoking, Lung Function and Body Weight. *British Medical Journal (Clinical Research Edition)*, January 1983, 249-251.

Ogden, C. L., Flegal, K. M., Carroll, M. D., Johnson, C. L. Prevalence and Trends in Overweight Among US Children and Adolescents. *JAMA*, October 2002, 1728-1732.

Pinkowish, M. D. Hand in Glove: Smoking Cessation & Weight Gain. *Patient Care*, 33: 134, 1999.

Staiger, D., and Stock, J. H. Instrumental Variables Regression With Weak Instruments *Econometrica*, May 1997, 57-586.

Tauras, J. A., O'Malley, P. M. and Johnston, L. D. Effects of Price and Access Laws on Teenage Smoking Initiation: A National Longitudinal Analysis. NBER Working Paper, No. 8331, June 2001.

Tobacco Institute. *The Tax Burden on Tobacco*, Washington, D.C.: Tobacco Institute, 1997. Historic Compilation, Volume 2.

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, 918-24.

Townsend, J., Wilkes, H., Haines, A., and Jarvis, M. Adolescent Smokers Seen in General Practice: Health Lifestyle, Physical Measurements and Response to Antismoking Advise. *British Medical Journal*, October 1991, 947-950.

Tucker, L. A., Cigarette Smoking Intentions and Obesity Among High School Males. *Psychological Reports*, April 1983, 530.

U.S. Department of Health and Human Services. *Preventing Tobacco Use Among Young People: A Report of the Surgeon General.* Atlanta, Georgia: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, National Center for Chronic Disease Prevention and Health Promotion, Office on Smoking and Health, 1994.

_____. *The Health Benefits of Smoking Cessation: A Report of the Surgeon General, 1990*. Atlanta Georgia: U.S. Dept. of Health and Human Services, Public Health Service, Centers for Disease Control, Center for Chronic Disease Prevention and Health Promotion, Office on Smoking and Health, 1990.

_____. *The Pharmacology of Tobacco Use: Nicotine Addiction: A Report of the Surgeon General* Atlanta, Georgia: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, National Center for Chronic Disease Prevention and Health Promotion, Office on Smoking and Health, 1988.

U. S. National Institutes of Health, National Heart, Lung, and Blood Institute. *Clinical Guidelines on the Identification, Evaluation, and Treatment of Obesity in Adults* Washington, DC: National Institutes of Health, National Heart, Lung, and Blood Institute, 1998.

Voorhees, C. C., Schreiber, G. B., Schumann, B. C., Biro, F., and Crawford, P. B. Early Predictors of Daily Smoking in Young Women: The National Heart, Lung, and Blood Institute Growth and Health Study. *Preventive Medicine*, June 2002, 616-624.

Wiseman, C. V., Turco, R. M., Sunday, S. R., and Halmi, K. A. Smoking and Body Image Concerns in Adolescent Girls. *International Journal of Eating Disorders*, December 1998, 429-433.