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Changes in Youth Smoking, 1976–2002

A Time-Series Analysis

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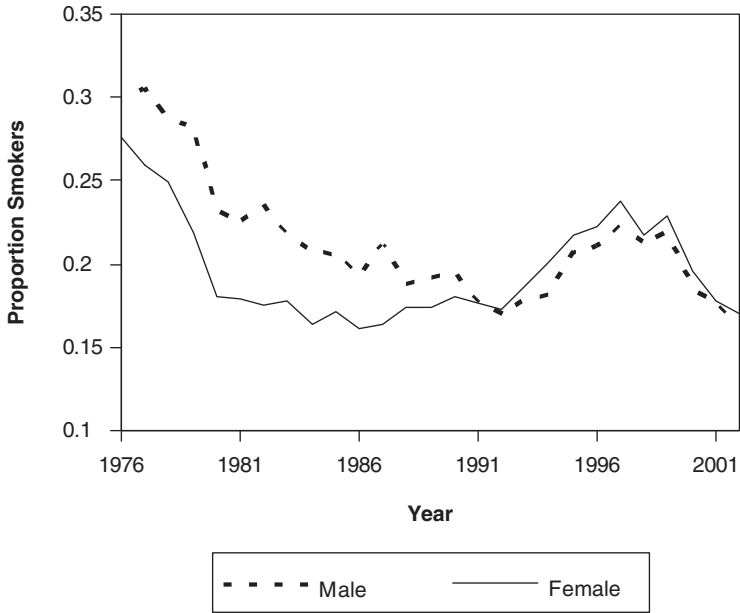
During the past several decades, smoking prevalence among youth has fluctuated in puzzling and unexpected ways. To help understand these changes, this study tests seven explanations: (a) compositional changes, (b) sample selection, (c) adult smoking, (d) social strain, (e) cigarette prices, (f) tobacco advertising, and (g) other drug use. Figures on smoking prevalence come from the Monitoring the Future (MTF) Surveys from 1976–2002, whereas figures on aggregate determinants for the same time period come from government publications. Graphs of the time-series trends to determine temporal correspondence and time-series regression models to test for statistical influence reveal two variables that have expected effects. Increases in cigarette prices reduce smoking, particularly in the most recent years, and higher marijuana initiation (or use) is associated with greater smoking during most of the time period. However, much of the change in youth smoking, particularly the most recent rise and fall, remains unexplained.

Keywords: *teen smoking trends; cigarette prices; Monitoring the Future Surveys*

After falling in the late 1970s and leveling off at new lows in the 1980s, youth cigarette smoking in the 1990s received renewed attention because of two unexpected shifts: From 1992 to 1997, smoking first rose to

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Figure 1
Proportion Smokers by Gender and Year



a new peak that matched earlier levels in the 1970s, and second fell from that peak during the late 1990s and early 2000s (Crump & Packer, 1998; Department of Health & Human Services [DHHS], 2001, p. 60; Johnston, O’Malley, & Bachman, 1996, 2000; Monitoring the Future [MTF], 2004; Nelson et al., 1995). Thus, 28.8% of high school seniors in 1976 had smoked daily during the past 30 days, 17.2% smoked daily in 1992, 24.6% smoked daily in 1997, and 15.6% smoked daily in 2004 (MTF, 2004). As shown in Figure 1, the trends for boys and girls differ only slightly, with both groups exhibiting the recent rise and decline.

Given the developmental pattern of smoking, adolescent trends affect not only the well-being of teens but also their health as adults. Because cigarette smoking remains the leading cause of preventable death (DHHS, 1989; Rogers, Hummer, Krueger, & Pampel, 2005), the decisions made to smoke during the teen years have long-term consequences (DHHS, 1994). Teens often begin with the expectation that they will soon quit (Slovic, 2001), but

the addictive nature of nicotine leads most to continue the habit for decades (Gruber, 2001). According to figures from Bachman et al. (1997, p. 53), daily smoking peaks at ages 21 to 22 at 26% for men and 28% for women. By ages 31 to 32, the percentages fall to 22% for men and 20% for women. The large majority of teen smokers thus remain smokers into their 30s. Their actions set a trajectory of risky health behavior and eventual poor health. No wonder that after the unexpected and discouraging rise in smoking during the mid-1990s, the most recent decline has been welcome news (MTF, 2004).

Besides their health implications, trends in smoking are important in another way: They reflect the crucial influence of broad societal and historical forces on teen decisions. Although the developmental experiences of adolescents makes them prone to unhealthy choices (Ellickson, Perlman, & Klein, 2003), the choices involving smoking clearly vary across time and cohorts (Ferrence, 1989; Pampel, 2005). Societal conditions shape teen experiences and affect individual decisions to adopt or reject smoking. The combined influence of societal and developmental change thus shapes the adoption by teens of a risky behavior like cigarette use. Although most studies of smoking examine individual differences in the propensity to use cigarettes (e.g., Nofziger & Lee, 2006), macro-level conditions that affect all youth within a cohort also deserve study.

Despite the importance of the trends and the changing social conditions they reflect, scholars have only a limited understanding of the causes of the fluctuations in smoking (National Cancer Institute, 2001). In a study of changes in smoking among low- and high-risk youth during the past several decades, An, O'Malley, Schulenberg, Bachman, and Johnston (1999, p. 704) note that their "analysis focuses on the who, what, and when of smoking, rather than the why." In describing the rise in smoking during the mid-1990s after earlier periods of decline, Anda et al. (1999, p. 1652) state that "we have an incomplete understanding of the reasons for this reversal." And in a study of the trends in youth smoking using several data sets through the 1980s, Nelson et al. (1995, p. 36) conclude that the "reasons for the overall decline in the prevalence of smoking from 1974 through 1985 are not well understood."

The limited understanding comes not from lack of ideas about causes of the changes—each shift in the direction of the trends produces many insightful explanations. Rather, it results at least partly from the lack of systematic tests of the explanations. Most research focuses on individual-level determinants with cross-sectional and longitudinal survey data. Although personal beliefs, social background, and personality characteristics affect the propensity of individuals to smoke, they say little about why the propensities have changed over time. For example, association with peers proves

crucial at the individual level for the likelihood of cigarette adoption by young people but cannot explain why smoking prevalence among peers has changed or how it has been affected by societal forces. As An et al. (1999, p. 704) state, "The fact that the recent increase in cigarette smoking occurred in nearly all demographic subgroups suggests that there are broad cultural forces at work." Understanding shifts in the health behavior of youth may require more attention to broad cultural, social, and economic influences.

Explanations

We consider seven explanations of the trends in youth smoking depicted in Figure 1. The explanations focus on macro-level social, economic, and cultural forces that can affect all demographic and regional groups of youth. Although not mutually exclusive, the explanations differ enough in their essential logics and the underlying motivations they posit for starting to smoke that they can be treated as separate and contrasting.

Compositional Change

The background characteristics of the population of youth may have changed in ways that account for the trends. Smokers tend to come from single-parent families with lower levels of education (Droomers, Schrijvers, Casswell, & Mackenbach, 2005; Griesbach, Amos, & Currie, 2003; Jacobson et al., 2001, p. 93; Jefferies, Power, Graham, & Manor, 2004; Soteriades & DiFranza, 2003), and they tend to do less well academically in school, work more in paid jobs, have little involvement in church, and go out at night more often (An et al., 1999; Bryant, Schulenberg, O'Malley, Bachman, & Johnston, 2004; Emmons, Wechsler, Dowdall, & Abraham, 1998; Johnston et al., 1996; Safron, Schulenberg, & Bachman, 2001; Wallace, Forman, & Guthrie, 1999). Perhaps changes in the prevalence of these characteristics might contribute to changes in smoking. However, An et al. (1999) and Gruber and Zinman (2001) argue that only a small portion of the total variance in the trend in smoking is due to compositional change, and indeed it seems unlikely that the youth population could change in ways that would account for a decline, rise, and decline again during a period of several decades. Still, the trends in smoking should be examined net of such compositional changes.

Sample Selection

Surveys of youth, including the ones to be examined in this study, often come from samples of high school students. Because the surveys exclude dropouts and the rate of dropping out varies over the years, sample selection may affect the trends. Given the higher rate of smoking among dropouts (Substance Abuse and Mental Health Services Administration, 2006), increases in dropout rates should lower smoking among the remaining sample and decreases in dropout rates should raise smoking. Johnston et al. (1996) suggest that the dropouts missed by high school surveys have not changed enough over time to seriously bias the results, and Nelson et al. (1995) find that data from national samples reveal much the same trends as high school samples. Still, the potential for sample selection to influence the trends by removing dropouts with high rates of smoking suggests that a negative relationship should exist over time between high school dropout rates and smoking (i.e., the years with the highest dropout rate should have the lowest rate of smoking).

Adult Smoking

The trends in youth smoking may reflect adult norms, whereby changes in the smoking prevalence of youth in a particular year follow changes in the prevalence among adults. Youth may respond to larger societal norms about smoking that affect all age groups and, given the importance of smoking by parents and norms about tobacco use at home (Jacobson et al., 2001; Soteriades & DiFranza, 2003), they may even imitate adult smoking. Increases, decreases, or stability in adult smoking would then result, respectively, in increases, decreases, or stability in youth smoking. However, a positive relationship between adult and youth smoking is not the only possibility. To the extent that youth act in opposition to adult norms, a negative relationship between youth and adult smoking may emerge. Youth smoking may represent a form of oppositional behavior among subcultures that reflects nonconformity, rebelliousness, and risk-taking (DHHS, 1994, p. 134). If so, declining smoking among the adult population and strengthening views of smoking as disreputable may have the effect of increasing the attraction of youth to smoking. This reasoning fits the rise in smoking among youth in the 1990s—a time of increased disapproval of smoking (Johnson & Hoffman, 2000).

Social Strain

The trends in youth smoking may reflect changing levels of social strain among youth. The propensity to smoke, despite its long-term harm and immediate financial cost, may represent a short-term coping mechanism to deal with difficult circumstances (Lloyd & Lucas, 1998) or a form of self-medication to deal with negative emotions (Anda et al., 1999). Youth in general and disadvantaged youth in particular face high levels of social strain because of the difficult transition from childhood to adulthood, and problems may worsen during periods of unemployment, suicide, crime, and youth violence (Blum, Buehring, & Shew, 2000; Paternoster, Bushway, & Brame, 2003; Scal, Ireland, & Borowsky, 2003; Unger, Hamilton, & Sussman, 2004). Increases in strain among youth may in turn raise their smoking.

Prices

The trends in smoking among youth may reflect changes in costs of purchasing cigarettes.¹ Despite the addictiveness of nicotine, the demand for cigarettes responds directly to prices (Dedobbeleer, Béland, & Contandriopoulos, 2004; DHHS, 1994, pp. 272–273; Gruber & Köszegi, 2001; Ross & Chaloupka, 2003). According to figures for the United States, a 10% increase in cigarette prices reduces purchases by 4% (World Bank, 1999, pp. 41–42). Young people are even more responsive to price changes than older adults, reducing purchases by about 7% for a 10% increase in prices (Grossman & Chaloupka, 1997). Increases in prices through state excise taxes have consequently become a key policy tool in lowering cigarette use and may contribute to the observed changes in smoking. However, some suggest that prices have little influence on trends over time (DeCicca, Kenkel, & Mathios, 2002; Gilpin, Lee, & Pierce, 1997; Gruber 2001). It may be instead that price-subsidizing promotions sponsored by the tobacco industry have cushioned the impact of rising prices and increased youth smoking (Pierce et al., 2005).

Advertising

The trends in youth smoking may reflect changing advertising and marketing of tobacco companies. Studies have demonstrated that youth are exposed to cigarette advertising and promotions, despite the banning of television ads since January 1, 1971, through print media, billboards, sporting events, sales displays, popular films, and specialty items (Altman, Levine, Coeytaux, Slade, & Jaffe, 1996; Pierce et al., 1991; Pollay et al., 1996). The

ads use images rather than information to portray smokers as independent, attractive, healthful, adventure-seeking, and youthful—in short, they play on concerns for peer acceptance (DeCicca et al., 2002). Indeed, some cigarette advertising and promotional expenditures show an increase in the 1990s—around the same time that youth smoking rose (Federal Trade Commission, 2000; Pierce et al., 2005)—and campaigns such as the Joe Camel cartoon ads gained a following among children and adolescents (Pierce et al., 1991). At the same time, anti-smoking advertising may influence youth smoking as well (Taurus, Chaloupka, & Farrelly, 2005). Although spending for anti-smoking ads is dwarfed by tobacco-industry spending, counteradvertising that began in 2000 with funding from the American Legacy Foundation has proven effective (Farrelly, Davis, Haviland, Messeri, & Heaton, 2005). The mix in information presented to youth in both promoting and opposing cigarette use may influence the trends over time.

Other Drug Use

Use of other drugs does not itself cause cigarette use—to the contrary, use of cigarettes and ingestion of nicotine, a mild stimulant, may in the long run promote experimentation with stronger drugs. However, the simultaneous use of multiple substances often occurs (Brook, Balka, & Whiteman, 1999; Duhig, Cavallo, & McKee, 2005; Sneed, Morisky, Rotheram-Borus, Ebin, & Malotte, 2001), and the attraction to cigarettes may be seen as part of broader trends among teens toward use and abuse of other substances such as marijuana. Assuming that marijuana use is not affected by cigarette prices or advertising, any relationship between cigarette and marijuana use, although spurious rather than causal, may reflect leisure and recreation activities of youth that vary over time and involve changes in tastes for risk and experimentation. If so, it would suggest that cigarette use can be seen as part of a broader set of behaviors involving substance use.

Methodology

Data

This study uses data from two sources to test hypotheses derived from these explanations: the MTF survey of high school seniors from 1976–2002 and aggregate data reported by government agencies. The micro-level data are used to generate yearly figures on the prevalence of smoking—both

without and with controls for background characteristics. The aggregate data tap changes in dropout rates, adult smoking, social strain, cigarette prices, advertising, and drug use.

The MTF project has surveyed nationally representative samples of high school seniors during the spring of each year since 1976 (MTF, 2005). To obtain a nationally representative sample, the MTF surveys use multistage sampling procedures for the 48 coterminous states: Each year the project first selects geographic areas, roughly 130 schools within the geographic areas, and about 400 students in each school (or the entire senior class if it has fewer than 400 students). Of the schools, 65% to 80% have agreed to participate throughout the years and allowed the students to complete a self-administered questionnaire during a normal class period. Within schools, the response rate of 83% largely excludes those students absent on the day of collection (only about 1% refused to complete the questionnaire). An et al. (1999, p. 700) summarize the conclusions of a good deal of analysis of possible biases in the samples: "While both school and student response rates have varied somewhat over time, adjustments for these differences indicate that any bias in overall prevalence rates is likely to be quite small and that variation in response rates over time are not a significant factor in explaining trends in cigarette use." Pooling the respondents for all years yields more than 430,000 cases.

A problem with the surveys of high school seniors is that they exclude absentees at the time of the survey (about 17% of the sample) and high school dropouts (about 15% of youth at high school ages). Analyses of the MTF data address the possible bias created by these missing groups (Johnston et al., 2005, pp. 461–472). Concerning the absentees, comparing survey respondents by the number of absences during the past 4 weeks indicates that those with many absences use substances and drugs more than those with few, but their absence depresses the estimates of smoking prevalence only slightly. More important, the underestimate due to absentees remains stable over time and does not influence trend results. Concerning dropouts, those who fail to complete high school likely have higher rates of tobacco use than those who graduate. Johnston et al. (2005, p. 463) suggest that the higher smoking of dropouts does not affect the trend, and the trend for seniors would not deviate from the trend for the entire class cohort. Further support for this claim comes from studies of youth smoking based on household rather than high school surveys. Despite including all youth, both dropouts and students, data from the National Health Interview Survey and the National Household Survey on Drug Abuse reveal much the same trend as the MTF surveys (Nelson et al., 1995). However, the potential biasing effect of missing dropouts is important enough to test for directly.

Measures

During the 27-year time span from 1976–2002, the percentage of smokers is measured by a question on cigarette use in the past 30 days, with respondents divided into two categories, daily smokers and others. The question focuses on daily use and, in contrast to measures of initiation, excludes those who may have tried smoking but not taken it up more regularly. Compared to never smokers or occasional smokers, daily smokers have a high likelihood of continuing to smoke as adults (An et al., 1999; DHHS, 1994). Self-report questions about cigarette use appear to be reliable and valid (Bachman et al., 1991; Patrick et al., 1994), particularly when the surveys are completed in school—as is the case for the MTF data—rather than at home (Nelson et al., 1995).

Besides demographic variables such as gender and race, the MTF data contain a variety of individual background and activity measures relevant to smoking (Aguilar & Pampel, 2007). Parents' education measures the years of schooling completed by the respondent's mother or father if available for only one parent, and an average score when data are available for both parents. Living arrangements are measured with a dummy variable that codes respondents living with both parents as zero and all others as one. Community size consists of nine categories ranging from rural/farm communities to urban city centers. Religiosity is measured by combining religious attendance (*never, rarely, once or twice a month, and once a week or more*) and the importance of religion (*not important, a little important, pretty important, and very important*) into a single standardized scale (Cronbach's $\alpha = .736$). School commitment consists of a standardized scale (Cronbach's $\alpha = .670$) that combines four items: self-assessed school ability compared to others the same age (ranging in seven categories from *far below average* to *far above average*), self-assessed intelligence compared to others the same age (using the same seven categories), days missed from cutting classes, and grade point average (for categories of A, A–, B+, and so on to D). Teen's income is measured by a question on the earnings per week (in tens of real dollars) from a job or other cash source. Social activities are measured by a question about how many evenings the respondent goes out during a typical week for fun and recreation (ranging in six categories from *less than one to six or seven*).

Aggregate indicators gathered from other sources match each of the hypotheses (see the appendix for the definitions and sources of the indicators). The youth dropout rate equals the percentage of persons aged 16 to 19 who dropped out of high school. Adult smoking taps the percentage of

persons aged 18 and older who currently smoke cigarettes. Social strain is measured by a standardized scale combining items that reflect youth social problems: the victimization rate at ages 16 to 19 by rape, robbery, and assault; the suicide rate ages 15 to 19; and the birth rate at ages 15 to 19. All three items correlate highly, and the scale has an alpha reliability of .907. The unemployment rate at ages 16 to 19, which does not correlate closely enough with the other indicators to include in the scale, equals the percentage of those aged 16 to 19 who are in the labor force but not currently employed.

Cigarette prices are measured as the average cost of a pack of cigarettes in 1982–1984 dollars.² Following Pierce et al. (2005), another cost-related measure captures the influence of marketing promotions. Promotional expenditures of tobacco companies that lower costs include allowances to retailers, free samples, specialty item giveaways, coupons, and retail value-added specials (e.g., two packs for the price of one). These expenditures are combined into a price-promotion category that is then transformed into real dollars and divided by population size.

Other advertising and promotional expenditures are treated as two categories (Pierce et al., 2005). Traditional advertising expenditures include costs for magazine, newspaper, billboard, transit, and point of sale ads. Promotional expenditures that do not lower the price of purchasing cigarettes such as direct mail, sponsorship of public sports and entertainment events, and other costs make up another category to supplement traditional advertising. Both are measured in real dollars per capita. These measures are less than ideal. They include expenditures on brands that appeal largely to adults rather than focusing on campaigns targeted specifically at teens. Unfortunately, the data source does not break down the figures by cigarette brand or primary advertisement audience.

Still, one more advertising measure combines in a rough way the possible influence of Joe Camel ads from 1987 to 1998 and of the American Legacy Foundation “Truth” campaign from 2000 to 2002. The measure has values of one in 1987–1997 to indicate the promotion of cigarette use by the Joe Camel campaign, values of -1 in 2000–2002 to indicate the inhibition of smoking by the Truth campaign, and 0 otherwise. Although crude, the measure may supplement figures on expenditures.

A measure of marijuana initiation comes from calculations done on the 2002 and 2003 National Surveys on Drug Use and Health (NSDUH). These face-to-face surveys of representative probability samples of the U.S. population ask a variety of questions about the use of illegal drugs, including age of first use. Based on responses to the questions, it is possible to determine the age and year respondents who ever smoked marijuana first used the drug. The measure equals the initiation rate for youth aged 12 to 17 during

each year from 1976–2002 (Substance Abuse and Mental Health Services Administration, 2004).³ Because the measure depends on recall of sometimes distant events, it is subject to reporting bias, particularly for older respondents and earlier years. Another measure comes directly from the MTF. The surveys ask questions on marijuana use along with tobacco use.⁴ The mean for each year is calculated from a question on the number of times the respondent used marijuana in the past 30 days and ranges from 1 (*none*) to 7 (*40 or more times*). Because this measure and the one for cigarette use come from the same surveys, their relationship may be upwardly biased if respondent error occurs in the same direction (e.g., users of both cigarettes and marijuana tend to deny use of both in some periods more than others). Thus, the NSDUH and MTF figures both have error, but the error takes a different form. The NSDUH measure faces problems of recall error but is obtained independently of cigarette use, whereas the MTF measure may be biased by coming from the same survey as smoking but does not suffer from recall error. The analysis uses both measures.

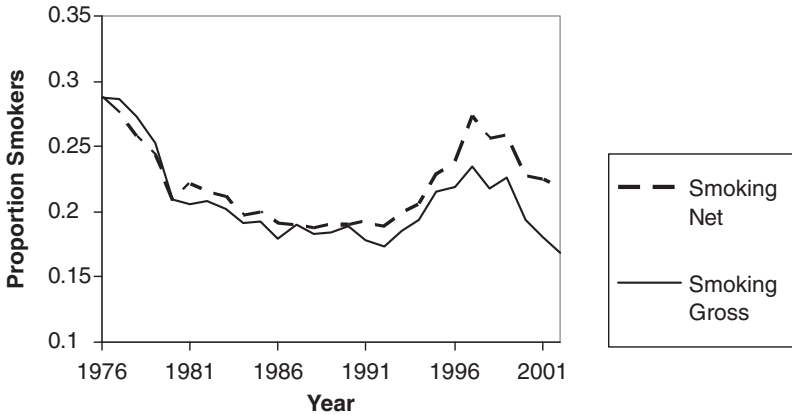
Analysis

The analysis proceeds by first examining how closely the trends in smoking and the potential determinants correspond.⁵ It also estimates time-series regression models that adjust for serial correlation with Prais-Winsten procedures and adjust for heteroscedasticity with robust standard errors (STATA, 2005). The time-series models in essence examine difference scores for the variables that are weighted by the size of the estimated serial correlation coefficient. They thereby control for over-time spuriousness in trends and provide a stringent test for the existence of relationships. However, with data available for only 27 years, the models allow for use of only one or two independent variables at a time.

Results

The influence of changes in the composition of the MTF samples can be determined by comparing two micro-level models. The first includes dummy variables for year, and the second includes dummy variables for year plus the individual background variables (which control for changes in composition). Figure 2 graphs the predicted proportion smokers averaged across males and females from models with dummy variables for year alone (which gives the mean proportion smokers in the samples for each year). The figure also graphs the predicted proportions with controls for the individual level

Figure 2
Gross and Net Proportion Smokers by Year



variables (assuming the same starting point as the unadjusted trends). We refer to these lines as the gross and net trends.

The gross and net trends do not differ greatly, and both show considerable fluctuation. The similarity indicates the inability of the compositional variables to explain the changes. There are some differences in the trends: The adjusted or net trend rises higher and falls less than the unadjusted or gross trend in the 1990s. This indicates that compositional changes have inhibited smoking and that groups less prone to smoke have grown in size. Absent the compositional changes, the trend would have risen more in the mid-1990s and fallen less in the years to follow. Still, the widely fluctuating trends remain, even with controls for composition of the youth population.

A few calculations reveal that the compositional variables explain only a small part of the over-time variance in smoking. The variance explained in individual smoking by the year dummy variables alone equals 0.62%, whereas the additional variance explained by year when added to the composition variables equals 0.56%. Thus, the compositional variables account for only 9.68% ($1 - .56/.62$) of the trend in smoking. As a result, the two trends are largely similar and have a correlation across years of .86. However, the gross and net trends deviate enough in more recent years to warrant study of youth smoking with adjustment for changes in the background characteristics of the youth population. Controlling for the composition of the youth

Table 1
Unstandardized Regression Coefficients and *t* Ratios
(Absolute Values) for Determinants of Adjusted Youth Smoking

Independent Variable	No Controls	Control for Cigarette Prices	Control for Marijuana Initiation	Basic Model
Dropout rate	.63	.15	.23	
Adult smoking	1.19	0.23	0.32	
Social strain	.36	.13	.24	
Unemployment	1.48	0.51	0.82	
Cigarette prices	-.58	-1.17	-.32	
Price promotions	1.10	1.88	0.72	
Traditional advertising	.03	.00	.02	
Other promotions	0.18	0.01	0.12	
Ad campaigns	-.05*		-.06*	-.06*
Marijuana initiation	2.81		2.47	2.47
Marijuana use	-.18	.11	-.13	
	1.37	0.66	0.92	
	.17	-.86	.24	
	0.26	1.45	0.44	
	-.60	-.28	-.86	
	0.66	0.64	1.00	
	1.40	.96	1.75	
	1.67	1.41	1.92	
	.11	.06		.06
	2.12*	1.63		1.63
	9.27	7.74		
	2.57*	1.67		

Note: Estimates adjust for first-order serial correlation and use robust standard errors. Youth smoking is adjusted for compositional changes in individual-level determinants.

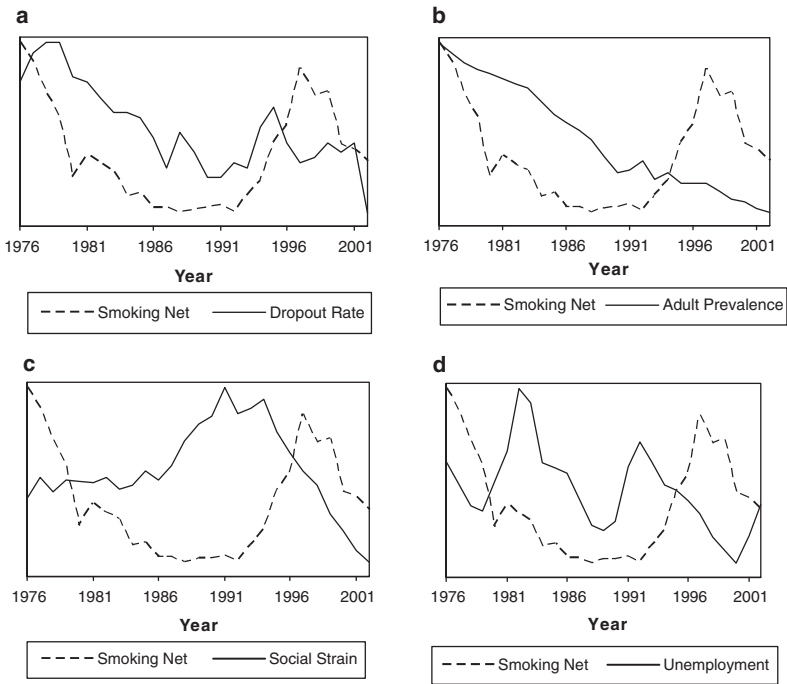
* $p < .05$.

population eliminates spurious overlap of changes in smoking with possible determinants and better isolates trends in the propensity for persons of similar social backgrounds to smoke.

To test the other, noncompositional explanations, Table 1 presents time-series models for the net measure of smoking that controls for compositional changes.⁶ To supplement the statistical results visually, graphs of the trends are also presented in Figures 3a-3k.

First, sample selection in the form of the exclusion of high school dropouts from the MTF sample does not contribute to the trends. A high rate of high school dropouts—who tend to have high smoking rates—should

Figure 3
a. Smoking and Dropout Rate
b. Smoking and Adult Prevalence
c. Smoking and Social Strain
d. Smoking and Unemployment



lower the observed smoking rate of high school students and produce a negative relationship between the dropout rate and smoking. In fact, Table 1 shows a positive and insignificant relationship. The positive relationship is inconsistent with the possibility that excluding dropouts from the MTF accounts for smoking trends. This can be seen in Figure 3a, where the dropout rate declines with smoking during the early years and rises during the later years.

Second, the trend in adult smoking differs importantly from that for youth. As shown in Figure 3b, adults exhibit a steady decline in smoking

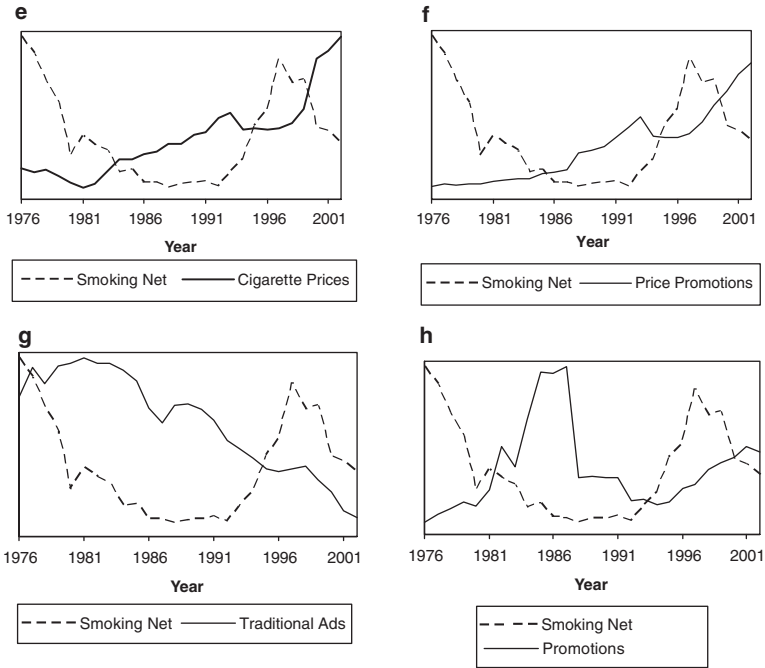
that differs from the ups and downs in smoking shown by youth. Given similar declines in the early years, a positive relationship exists between adult and youth smoking in the time-series model, but the relationship does not reach statistical significance. Although anti-smoking forces no doubt affect persons of all ages, youth smoking in some ways moves independently of adult smoking.

Third, neither the teen social strain scale nor teen unemployment rate matches the net trend in smoking. As shown in the model coefficient, teen suicide, births, and crime victimization in the form of a standardized scale is associated (insignificantly) with lower rather than higher smoking. Opposite of predictions, social strain rises through the 1980s when smoking falls and declines in the mid-1990s when smoking rises (see Figure 3c). Youth unemployment rates have a near-zero relationship with smoking and fluctuate in ways that do not match the fluctuations in smoking (see Figure 3d).

Fourth, cigarette prices contribute to the trends in smoking. The time-series model demonstrates a significant negative effect but one that appears most important in recent years. As shown in Figure 3e, the correspondence in prices and smoking is not apparent until the late 1990s when prices rose sharply and smoking fell sharply. If models are run for the period from 1976 to 1997, cigarette price does not have a significant effect. It may be that only when cigarette prices move above a certain threshold does the cost to teens become great enough to affect their smoking. The related measure of cigarette price promotions does not have a significant effect. Figure 3f graphs the trend, which does not match the trend in smoking as well as cigarette price.

Fifth, neither tobacco advertising nor nonprice promotions affects smoking. The time-series effects do not reach significance and the graphs in Figures 3g and 3h show, if anything, that the relationships are negative rather than positive. Negative relationships suggest that increased advertising responds to declining smoking rather than causes increased smoking. The combined measure of the Joe Camel and Truth advertising campaigns in Figure 3i more closely matches the most recent changes in youth smoking than advertising expenditures but again does not reach statistical significance in the time-series models. The Joe Camel campaign began in 1986, 6 years before cigarette smoking began to rise, and ended in 1998, the same year that smoking began to decline. Also, the Truth campaign from 2000–2002 occurs soon after youth smoking begins to fall and perhaps accelerates a decline that had already begun. Given the weak statistical effects across all measures, however, advertising does not appear central to changes in youth smoking.⁷

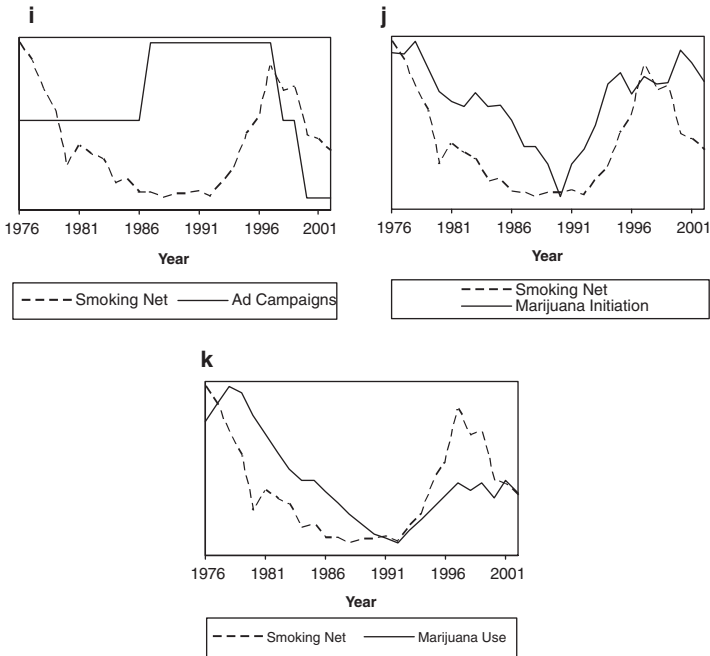
Figure 3
e. Smoking and Cigarette Prices
f. Smoking and Price Promotions
g. Smoking and Traditional Advertising
h. Smoking and Nonprice Promotions



Sixth, initiation and use of marijuana follow patterns of change similar to those for cigarette use. Both measures of marijuana use have positive and statistically significant effects on youth smoking. In Figures 3j and 3k, marijuana initiation and use fall in the 1980s, rise in the 1990s, and level off in the late 1990s. The correspondence is not exact, but the similarity suggests some overlap in attraction to cigarettes and marijuana.

To sum up, cigarette prices, marijuana initiation, and marijuana use most clearly influence trends in smoking. When each determinant is included one at a time in the time-series models, only these three have statistically significant coefficients. As a further check on the results, the next column lists the coefficients for models that include cigarette prices and each of the

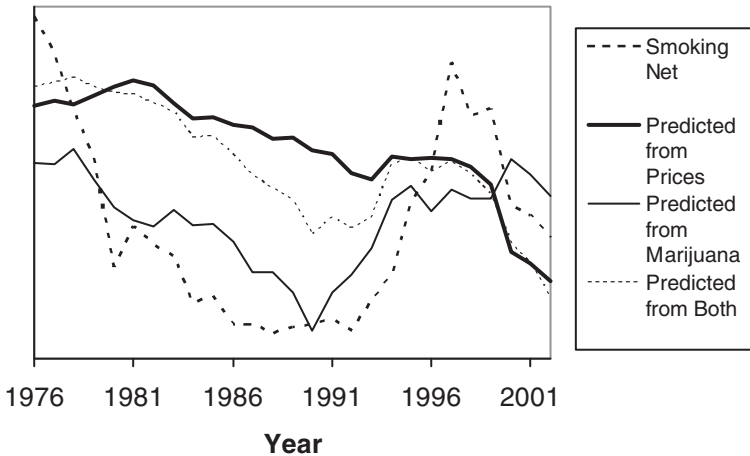
Figure 3
i. Smoking and Ad Campaigns
j. Smoking and Marijuana Initiation
k. Smoking and Marijuana Use



other variables. With controls for cigarette prices, the other variables fail to reach statistical significance. The third column lists the coefficients for models that include marijuana initiation, and each of the other variables (except cigarette prices) again shows small effects.

When included in the same equation, cigarette price remains significant whereas marijuana initiation falls to insignificance (column 4). Given their overlap and the small sample, the two variables may not have large unique effects but together may improve the predictive strength of the model. Figure 4 graphs the observed values of the net smoking measure and predicted values from equations with (a) cigarette prices, (b) marijuana initiation, and (c) both cigarette prices and marijuana initiation. Cigarette prices alone fail to match the general trend until the most recent years,

Figure 4
Predicted Net Proportion Smokers



marijuana initiation alone matches the drop and rise in cigarette smoking but not the most recent decline, and both together do better to match the rise in the mid-1990s and the fall afterward. However, even the model with both variables fails to account fully for the decline in smoking during the late 1970s and early 1980s or the jump in smoking during the mid-1990s. Furthermore, they predict to fall to a lower level smoking in the 2000s than actually occurred.

Conclusions

The developmental experiences of adolescents make them prone to unhealthy choices such as the use of cigarettes. Although not immediately harmful, these choices lead to addiction, continued cigarette use, and later health problems. Most approaches to understanding adolescent decisions to use cigarettes focus on individual differences, yet fluctuations in the trends in cigarette use during the past 30 years also indicate that larger societal and historical forces affect individual decisions. To extend the more common study of differences across individuals over a short time span, this study examined societal influences on changes in adolescent smoking over several decades.

Based on survey data from high school seniors matched with data on trends in a variety of possible macro-level determinants, the analyses here found two sources of influence on trends in youth smoking. Cigarette prices and marijuana initiation (or use) most closely match trends in cigarette use once adjusting for changes in the composition of the youth population and over-time spuriousness common in time-series data. Other factors important in cross-sectional studies such as school dropout rates, various aspects of social strain, employment difficulties, and advertising exposure proved of limited value in explaining long-term trends.

The first influential factor, cigarette prices, performs better in explaining trends in the most recent years than earlier years. Perhaps in earlier years, the cost of cigarettes was so low that price increases did not yet affect purchases. In contrast, steep increases in excise taxes and wholesale prices in the late 1990s likely pushed the price above that threshold and the cost of cigarettes had more influence on youth smoking. In relation to debate over the importance of cigarette prices to youth smoking, the over-time evidence points to the benefits of boosting prices to reducing teen cigarette use. Even at that, however, cigarette prices account only modestly for the trend in youth smoking.

The second influential factor, marijuana initiation or use, does not have the same clear interpretation of the meaning of its effects. The similarity in trends in cigarette use and marijuana initiation or use may reflect the broad influence of changes over time in youth attraction to risk, independence, and unconventionality on use of multiple substances. However, it is also possible that increasing or decreasing cigarette use has the effect of reducing or increasing the propensity to try marijuana in years to come. The evidence is mixed on this possibility. On one hand, Figure 3k indicates that during the 1970s and 1980s, marijuana use declined after cigarette use declined, which suggests that changes in cigarette use cause later changes in marijuana. On the other hand, Figure 3j indicates that marijuana initiation trended upward earlier than cigarette use in the 1990s, which suggests the opposite. In either case, changing marijuana use would not serve as an effective mechanism to reduce smoking; rather, both may reflect the importance of other causes that underlie substance use.

Although cigarette prices and marijuana use have expected effects, much of the change in smoking appears to move independently of these determinants. Youth smoking dropped faster than would have been expected based on the determinants, rose more in the mid-1990s than would have been expected, and since the late 1990s has not fallen as much as would be expected. The lack of effects of determinants found important in cross-sectional studies such

as social strain, parental smoking, dropping out, and advertising highlight some limitations of existing explanations. In addition, however, something more than the usual explanations is needed to make sense of the trends in youth smoking.

It might appear that one neglected factor, changes in knowledge of the harm of cigarette use, would strongly influence youth smoking. However, the evidence indicates the contrary. According to the DHHS (1994, p. 135), "Knowledge of the long-term health consequences of smoking has not been a strong predictor of adolescent onset . . . perhaps because virtually all U.S. adolescents—smokers and non-smokers alike—are aware of the long-term health effects of smoking." According to recent surveys, 95% of the population in 1990 believed that smoking is a health risk for lung cancer (Kenkel & Chen, 2000), and most people actually overestimate the harm of smoking (Viscusi, 1992). Thus, youth who start smoking do so with a recognition of the health risks, but believe (most often mistakenly) that they will be able to quit before the health consequences become serious (Slovic, 2001). Among those who reject the claim that cigarette use is harmful, such beliefs likely rationalize or stem from use of cigarettes rather than cause nonsmokers to take up the habit. Thus, "Beginning to smoke appears to accentuate adolescents' denial of the health consequences" (DHHS, 1994, p. 135). Any association between perceived risks and smoking may result largely from the causal effects of smoking on beliefs rather than vice versa.

What else might account for the unexpectedly steep drop in the late 1970s and the unexpected rise in the mid-1990s? Some unknown factor not included in the theories might yet emerge. Alternatively, youth culture, identity, and behavior may change in ways that do not correspond directly to measurable social forces but take on a momentum of their own. If so, it suggests that youth act with some sense of agency in making smoking decisions rather than only responding to external forces. The lack of a one-to-one correspondence may suggest similarities between an epidemic and the spread of smoking (Gladwell, 2000). Like some diseases, suicide, musical tastes, and clothing styles that spread and disappear in sudden and unexpected ways, teen smoking reflects imitation and contagion. Fashions influenced by singular events, trend leaders, and innovative ideas are notoriously hard to predict, and cigarette smoking may be seen as part of such a fashion change. The decline of adult smoking may have been a spark that ignited a new and stylish disdain for smoking among teens in the late 1970s, and a few influential ads, a temporary price decrease, or use of cigarettes by attractive stars in films may have been enough to shoot smoking upward in the 1990s. Although initiated by external forces, the imitation and contagion exaggerate the response.

Capturing this sort of pattern and change may require different sorts of methods than used here or in other studies.

The inability to account fully for trends in youth smoking may also stem from a methodological source—the reliance on aggregate data. Much variation exists in smoking across regions, races, cities, states, and social groups that yearly figures cannot capture, and the yearly analysis provides only a crude test of many of the theoretical arguments. However, strong theories should explain trends over time as well as cross-sectional differences across individuals, and the results presented here provide some indication of those forces most important in explaining trends. The time-series data miss much variation in cigarette use but offer the chance to examine one crucial component of that variation.

Appendix

Variable Definitions, Sources, and Descriptive Statistics

Smoking Gross

Definition: Percentage of high school seniors having smoked cigarettes daily in the past 30 days

Source: Computations from Monitoring the Future Survey data, 1976–2002

Statistics: $M = 20.8$, $SD = 3.3$, Minimum = 16.9, Maximum = 28.7

Smoking Net

Definition: Percentage of high school seniors having smoked cigarettes daily in the past 30 days after controlling for background determinants

Source: Computations from Monitoring the Future Survey data, 1976–2002

Statistics: $M = 22.1$, $SD = 3.0$, Minimum = 18.8, Maximum = 28.7

Dropout Rate

Definition: Percentage of teens aged 16 to 19 who dropped out during the previous year

Source: U.S. Census Bureau, Current Population Survey

Statistics: $M = 5.0$, $SD = 0.9$, Minimum = 3.3, Maximum = 6.7

Adult Smoking

Definition: Percentage of persons aged 18 and older who currently smoke cigarettes

Source: National Center for Chronic Disease Prevention and Health Promotion, Centers for Disease Control and Prevention (URL: www.cdc.gov/tobacco/research_data/adults_prev/prevali.htm)

Statistics: $M = 28.2$, $SD = 4.2$, Minimum = 22.5, Maximum = 35.6

Social Strain

Definition: Scale based on the summation of standardized measures of suicide, violence victimization, and birth rates

Source: See individual items below

Statistics: $M = 0$, $SD = 0.9$, Minimum = -2.0, Maximum = 1.7

(continued)

Appendix (continued)

Suicide Rate

Definition: Deaths from suicide of persons aged 15 to 19 per 100,000 population

Source: Office of Statistics and Programming, National Center for Injury Prevention and Control, CDC Data (URL:

<http://webapp.cdc.gov/sasweb/ncipc/mortrate.html>)

Statistics: $M = 9.4$, $SD = 1.3$, Minimum = 7.4, Maximum = 11.3

Violence Victimization Rate

Definition: Rape, robbery, and assault of persons aged 16 to 19 per 1,000 population

Source: U.S. Department of Justice (URL:

<http://www.ojp.usdoj.gov/bjs/glance/tables/vagetab.htm>)

Statistics: $M = 99.2$, $SD = 16.0$, Minimum = 55.9, Maximum = 123.9

Birth Rate

Definition: Births at ages 15 to 19 per 1,000 female population

Source: Center for Disease Control, National Center for Health Statistics, Vital Statistics Cooperative Program (URL: <http://www.cdc.gov/nchs/fastats/teen-brth.htm>)

Statistics: $M = 52.8$, $SD = 4.4$, Minimum = 43.8, Maximum = 61.8

Unemployment Rate

Definition: Percentage of persons aged 16 to 19 in the labor force who are not employed

Source: U.S. Department of Labor, Bureau of Labor Statistics, Labor Force Statistics from the Current Population Survey (URL: <http://www.bls.gov/data/sa.htm#OEUS>)

Statistics: $M = 17.4$, $SD = 2.4$, Minimum = 13, Maximum = 22.2

Cigarette Prices

Definition: Average cost of a pack of cigarettes in 1982–1984 dollars

Source: Department of Health and Human Services (2000, pp. 346–347)

Statistics: $M = 108.2$, $SD = 30.8$, Minimum = 69.2, Maximum = 187.3

Price Promotion Expenditures

Definition: Domestic tobacco company expenditures in thousands of real dollars per adult for promotional allowances, sampling distributions, specialty item distribution, coupons, and retail value-added

Source: Federal Trade Commission Cigarette Report for 2003 (URL:

<http://www.ftc.gov/reports/cigarette05/050809cigrpt.pdf>)

Source CPI: Bureau of Labor Statistics (URL: <http://data.bls.gov/cgi-bin/survey-most?cu>)

Source Population: Government Printing Office (URL: www.gpoaccess.gov/eop/2006/B34.xls)

Statistics: $M = 8.5$, $SD = 6.9$, Minimum = 1.2, Maximum = 26.8

Traditional Advertising Expenditures

Definition: Domestic tobacco company expenditures in thousands of real dollars per adult for newspaper, magazine, outdoor, transit, and point-of-sale ads

(continued)

Appendix (continued)

Source: Federal Trade Commission Cigarette Report for 2003 (URL: <http://www.ftc.gov/reports/cigarette05/050809cigrpt.pdf>)

Statistics: $M = 3.1$, $SD = 1.3$, Minimum = .67, Maximum = 4.8

Other Promotional Expenditures

Definition: Domestic tobacco company expenditures in thousands of dollars per adult for public entertainment, direct mail, endorsements, and other promotions

Source: Federal Trade Commission Cigarette Report for 2003 (URL: <http://www.ftc.gov/reports/cigarette05/050809cigrpt.pdf>)

Statistics: $M = .83$, $SD = .49$, Minimum = .21, Maximum = 2.02

Advertising Campaigns

Definition: Value of 1 assigned to years of Joe Camel campaign (1987–1997), –1 to years of Truth Campaign (2000–2002), and 0 to other years

Statistics: $M = 0.2$, $SD = 0.7$, Minimum = –1, Maximum = 1

Marijuana Use (NSDUH)

Definition: The initiation rate of those aged 12 to 17 (the number of persons in the age group who first used the drug in the year as a ratio to the person-time exposure of persons in the age group in thousands)

Source: SAMSHA, Office of Applied Studies, *2003 National Survey of Drug Use and Health* (URL: <http://www.oas.samhsa.gov/nhsda/2k3nsduh/2k3Results.htm#ch5>, Table G. 31)

Statistics: $M = 80.4$, $SD = 13.7$, Minimum = 47.2, Maximum = 101.1

Marijuana Use (MTF)

Definition: Mean marijuana use in past 30 days on a scale ranging from 1 (none) to 7 (40 or more times)

Source: Computations from Monitoring the Future Survey data, 1976–2002

Statistics: $M = 1.7$, $SD = 0.3$, Minimum = 1.3, Maximum = 2.2

Notes

1. Price matters only if youth have access to cigarettes. However, during most of the period under study, minors have been able to purchase cigarettes despite laws to the contrary (DHHS, 1994, pp. 248–249).

2. A measure of the price of cigarettes relative to disposable income has effects that differ little from those for cigarettes in real prices.

3. The initiation rate is defined as the number of persons in the age group who first used the drug in the year as a ratio to the person-time exposure of the age group in thousands.

4. The surveys also ask about use of harder drugs, but these have a more distant connection to smoking than marijuana use.

5. We also measured smoking separately for males and females, but the trends are so similar that, for the time-series models to follow, the coefficients determining male and female smoking dependent variables significantly.

6. With this dependent variable, tests show that contemporaneous effects of the independent variables are stronger than or similar to those for lagged effects. Although it makes sense that the determinants of smoking may influence younger teens to smoke several years earlier and that past smoking would then affect smoking of older teens in 12th grade, the models provide little evidence of such lagged effects.

7. Because the ad campaign may most influence those younger than age 15 rather than high school seniors, allowing the measure to reflect the passage of young smokers into the last year of high school might have more influence. However, a measure with values of 1 from 1991–2001 rather than from 1987–1997 has effects no stronger than those presented in Table 1.

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