The Effect of Anti-Smoking Media Campaign on Smoking Behavior: The California Experience

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This paper evaluates the effectiveness of California anti-smoking media campaign in changing smoking behavior of adults and adolescents, in the short run as well as in the long run, through individual self-reported exposure to the media message. We construct pseudo panel data using repeated cross sections, and employ instrumental variables method to address the endogeneity problem. Overall, the results suggest that the anti-smoking media campaign not only significantly reduces the prevalence of smoking among adults and adolescents, but also brings significant long term benefits in smoking reduction, by inducing more future attempts to quit among adult smokers and deterring more initiating intentions among adolescents.

Key Words: Anti-smoking media campaign; Smoking behavior; Program evaluation.

JEL Classification Numbers: I12, I18.

1. INTRODUCTION

It is well established that smoking is the leading cause of many preventable morbidity and mortality, providing a worldwide challenge to public health. Since Minnesota introduced the first paid anti-smoking media campaign in 1986, many other states have used a proportion of their cigarette excise tax revenue to fund large scale anti-smoking advertisement through the mass media. As the result of the Master Settlement Agreement between the tobacco companies and 46 states in 1998, the American Legacy

Foundation launched the national anti-smoking "Truth" campaign in 2000. In 2002, 21 states used paid mass media advertising in the Campaign for Tobacco Free Kids. Those media campaigns try to provide the public with health information about the harmful effects of smoking on health, and, therefore, change people's smoking behavior, based on the theoretical hypothesis that more informed people are more likely to choose healthy lifestyle.

Although some studies find the evidence for the success of such media campaigns in reducing cigarette consumption (Hu, Sung and Keeler, 1995a; Pierce et al., 1998b), a recent finding by Campaign for Tobacco Free Kids (2005) shows that several state governments have cut the spending on their tobacco control programs, especially the funding for anti-smoking media campaign, which may have a serious impact on the future success of tobacco control initiatives. A possible reason for such change could be the lack of complete evaluations of the effectiveness and efficiency of these expenditures versus alternative uses of the funds.

This paper focuses on the evaluation of California's Tobacco Education and Media Campaign (TEMC), one of the largest tobacco control programs implemented by the state government. In recent years, California invested approximately $25 million annually in the TEMC, about 20.1 percent of the total expenditures of the tobacco control program. It aims at changing tobacco-related attitudes and behaviors of four targeted groups, including adult smokers, pregnant women, ethnic minorities and children. The purpose of this study is to investigate empirically how the California anti-smoking media campaign changes individual smoking behavior through self-reported exposure to the advertising, after controlling for endogeneity that comes from non-random awareness of the media message.

More specifically, we not only evaluate the short run effects of media campaign on the prevalence of smoking, but also other outcome variables that have not been adequately studied in the existing literature and may help reduce smoking rate in the long run. We are especially interested in the following changes brought about by the media campaign: adult smoking participation, adolescent smoking initiation, existing smokers' intentions to quit and youth intensions to start. Arguably, the intentions to quit or start will affect the future smoking rate. Adults and adolescents are studied separately to shed light on their different responses to the anti-smoking media campaign. It is also examined what causes the differences in individual exposure to anti-smoking advertising campaign. In particular, we are interested in the role of the choice of media markets and allocation of advertising spending. Moreover, we use a unique population-based data set from the statewide California Tobacco Survey, to construct pseudo-panel data at the zipcode level, employ the fixed effect model to difference out the

unobserved individual heterogeneities with regard to smoking, and address further the endogeneity problem with valid instrumental variables.

The paper is structured as follows. Section 2 provides a literature review of previous studies evaluating the effectiveness of anti-smoking media campaigns. Section 3 discusses the econometric concerns and corresponding empirical methodologies. In section 4, data and main interesting variables are described. Section 5 presents and analyzes the results and the final section concludes this paper and discusses the policy implications.

2. LITERATURE REVIEW

The anti-smoking media campaign has a long history in the United States. In the late 1960s, lots of health-care-oriented anti-smoking commercials were launched on television by health organizations. Most early studies examine their impact on smoking behavior using aggregate level data. For example, Hamilton (1972) finds that, during the period 1953-1970, the anti-smoking advertising has a stronger smoking deterrent effect than the stimulant effect of industry advertising. However, according to the preliminary summary statistics of a population-based survey data, O'Keefe (1971) points out that the influence of such mass communication is quite limited. Only those with the propensity to quit perceive anti-smoking commercials as an effective advocate, whereas the majority of smokers may have more awareness of smoking's harmful effects but would not change their behaviors.

Since the 1990s, many states have implemented statewide anti-smoking advertising campaigns to reduce tobacco use. This renewed the interest among academics and policy makers to evaluate the effectiveness of those programs. Pierce et al. (1998b) examine the effect of California's tobacco control program, started in 1990, on the trend of smoking behavior in California. Their results indicate that per capita cigarette consumption significantly declines 16 percent over the 1989-1993 period and 9 percent over the 1994-1996 period, and the same pattern with smoking prevalence which, in 1996, was 18 percent in California and 22.4 percent in the rest of the nation. The main limitation of this study is that it is difficult to separate the effectiveness of the anti-smoking campaign from that of other concurrent anti-smoking policies. Hu et al. (1995a, 1995b) try to identify the separate effect of California anti-smoking media campaign on cigarette smoking, with controls for tobacco tax policy and the industry's magazine advertising response. They find that the media campaign reduces per capita cigarette consumption by 7.7 packs over the period 1989-1992. However, in order to provide any policy recommendations, just as Hu et al. (1995b) suggest at the end of their paper, it is necessary to conduct intensive survey studies about how this media campaign influences individ-

ual behaviors, including individual exposure to media campaign, message perception, and change of smoking attitudes and behaviors.

Some recent literatures do use individual level data to study the effectiveness of the anti-smoking media campaign. Biener et al. (2000) demonstrate that both adult smokers and non-smokers in Massachusetts are highly exposed to the anti-smoking media campaign, but the effectiveness of the campaign is perceived mostly by those non-smokers, quitters and smokers with the intention to quit. Focusing on Massachusetts adolescents, Siegel and Biener (2000) find that younger adolescents 12 to 13 years of age, who have self-reported exposure to television anti-smoking advertising, are significantly less likely to become established smokers during a 4-year period, but no significant effect among older adolescents 14 to 15 years of age. Studying Florida's "Truth" anti-tobacco media campaign, Sly et al. (2002) show that anti-smoking advertising awareness has not only a direct effect, but also an indirect effect on individual's smoking behaviors, which goes through its effects on perceived influence of message theme and individual anti-tobacco attitudes. Farrelly et al. (2002) find that self-reported exposure to the national "Truth" tobacco counter-marketing campaign ads significantly changes youths' attitudes towards smoking and the cigarette industry during a short period of 10 months after the launch of the campaign. However, those studies are mainly based on descriptive or traditional regression analysis of some subgroups in the population, and don't control enough for unobserved individual heterogeneity, which could simultaneously determine the recall of exposure, smoking attitude and smoking behavior.

Researches on other countries provide mixed empirical findings about the effectiveness of health education through anti-smoking mass media advertisement. Stavrinos (1987) studies the case of Greece and finds that health scares conveyed by media campaign reduce the cigarette consumption by 7.3% in the short run and by 13.5% in the long run, which may be more effective than tobacco taxation policy. Bardsley and Olekalns (1999) examine the cigarette consumption under anti-smoking policies in Australia, using aggregate level data. Their results show no significant separate effect of anti-smoking advertising on cigarette consumption with the control of industry pro-smoking advertising and other regulatory interventions. McVey and Stapleton (2000) study the effectiveness of England's anti-smoking TV campaign with a controlled trial, and find that the UK anti-smoking advertising campaign has a significant negative effect on smoking prevalence through motivating current smokers to quit and preventing former smokers from relapsing.

3. ECONOMETRIC SPECIFICATION

This study aims at evaluating the effectiveness of California statewide anti-smoking media campaign on smoking behavior and intentions of adults and adolescents, respectively. The empirical strategy is to compare the outcomes of two groups of people, the treated group exposed to the communication campaign and the non-exposed control group. However, although it is better to track the change of individual smoking behavior using population-based survey data, the measure of exposure to the campaign is self-reported, which may be correlated with unobserved individual characteristics or preferences with regard to smoking, even conditional on a wide range of exogenous individual specific characteristics. Especially, the anti-smoking media campaign targets at current smokers or potential smokers, so those with unobserved motivation or health conscientiousness about smoking may be more responsive to such media. The non-random assignment into intervention and control groups causes a serious endogenous problem, which may in fact lead to underestimates of campaign effectiveness.

It would be ideal to have panel data on individuals to control for the individual specific heterogeneity, so that we are likely to better identify the parameters of interest, and more reliably measure the structural relationships that help explain why particular individuals are more likely to become aware of a campaign, and why they are more likely to respond to it. The problem is that there are no panel data containing variables on exposure and response to campaigns, so it is essentially impossible to observe an individual's behavior and his or her response to campaigns over time. Only repeated cross-sectional data are available.

To circumvent this problem, we construct a pseudo panel data at the community (zipcode) level, using the repeated cross-sections independently collected each year, following the work of Deaton (1985) and Verbeek and Nijman (1992)[1]. For this, we group individuals from the same residential area into a type, and then track the individuals' behavior over time through these types. The panel estimation method can enable us to difference out unobserved individual effect and also control unobserved group effect.

The use of pseudo panel data changes the nature of dependent and independent variables we analyze. They are now measures of the average group characteristic for each community with the same zipcode. The key variables, which used to be the binary indicators for whether an individual is exposed to the media campaigns or whether the individual changes his/her

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[1]Collado (1997), Girma (2000), and Verbeek and Vella (2005) focus on the estimation and identification of dynamic models using a time series of repeated cross-sections. The demands on the data by those types of models are considerably higher than in the linear pseudo-panel data model that we estimate.

smoking behavior in the presence of those campaigns, are now measures of the proportion of individuals within the community who have been exposed to the media campaign, or that change their smoking behavior.

Moreover, we also use indicators of four main media market divisions and California government's annual expenditure for the anti-smoking media advertising as the instruments to correct for the endogenous bias. By instrumenting the key independent variable, the proportion of media exposure at the community, we expect to capture the component of self-reported exposure independent of those unobserved heterogeneities when observed health, smoking attitude, previous smoking status, socioeconomic and demographic characteristics are controlled for at the community level.

The empirical model is constructed using two equations: media exposure and smoking behavior. Equations explaining the determinants of media exposure ($Expo_{it}$) and the change of smoking behavior (Y_{it}) can be expressed as

$$Expo_{it} = \alpha_0 + \alpha_1 X_{it} + \alpha_2 Z_{it} + v_i + e_{it}, \qquad (1)$$
$$Y_{it} = \beta_0 + \beta_1 X_{it} + \beta_2 Expo_{it} + u_i + \varepsilon_{it}, \qquad (2)$$

where the i subscript denotes a cohort of people from the same zipcode and the t subscript denotes the time period; Z_{it} is the instrumental variables pertaining to the determinants of media exposure for a zipcode area, but unrelated with the residue ε_{it} in the main equation (2); X_{it} is a vector of other covariates affecting both smoking behaviors and media exposure; v_i and u_i are the cohort effects which are taken to be constant over time t and specific to the cohort unit i; e_{it} and ε_{it} are two correlated error terms. Four outcomes of smoking behavior are examined, including smoking participation of adults and adolescents, quiting intention and initiating intention. They are discussed specifically in the following section.

The major characteristic of our empirical specification is that media exposure is treated an endogenous variable in Equation (2). We use fixed effect instrumental variables regression approach to obtain the consistent estimate of exposure to anti-smoking media campaign.

4. DATA AND VARIABLES

4.1. Data

The study uses the data from the California Tobacco Survey, a representative statewide telephone survey of both adults (18+) and teenagers (12-17) conducted by the California Department of Health Services. The data has two unique features which allow us to differentiate our analysis from others. First, the data have direct and detailed measures of three sets of variables: smoking decision, attitude towards smoking, and self-

reported individual exposure to anti-smoking media messages. Second, the California Tobacco Survey (CTS) was conducted in multiple rounds. Since the round of 1996, the survey asks respondents specific questions about individual exposure to anti-smoking media campaign.

We use the repeated cross sectional data, CTS 1996, 1999 and 2002, to construct a pseudo panel data at the community (zipcode) level. In addition, we obtain the data on annual anti-smoking advertising expenditures and choice of media markets from California Department of Health Services, and link them to the main dataset. Thus we can study how the policy decisions about allocation of media spending affect differences in exposure and responses to media campaign. The weighted summary statistics about the pooled individual sample are presented in Table 1.

4.2. Variables

In this study, we have four outcome variables measuring smoking behavior. They are binary at the individual level, indicating whether the respondent engages in smoking-related behavior, and continuous at the community level, showing the proportion of the respondents engaging in smoking.

Adult smoking participation. It is the most widely estimated measure of smoking participation. The respondent who has smoked at least 100 cigarettes in his or her lifetime, and now smokes cigarettes every day or some days is coded as 1 indicating current smokers, otherwise 0.

Adult smokers never quitting smoking. It is defined as those current smokers who had no quit attempt in the past year and explicitly say no intention to quit in the future. Those people are usually regarded as the "hard core" smokers.

Adolescent smoking initiation. Here we still adopt the standard measure of established smokers. The youth adult who has smoked at least 100 cigarettes in his or her lifetime and has smoked a cigarette on any day in the past month is defined as current established adolescent smokers.

Adolescent committed never smoker. Three survey questions ask adolescents' intention to smoke and related self-efficacy: *"Do you think in the future you might experiment with cigarettes?" "If one of your best friends were to offer you a cigarette, would you smoke it?" and "At any time during the next year do you think you will smoke a cigarette?"* Committed never smokers are those who have never tried cigarettes and answer "definitely not" to all the three above questions.

Media exposure is one important outcome of the anti-smoking media campaign as well as the key explanatory variable in the smoking behavior model. Individual exposure to anti-smoking media campaign is constructed based on the CTS survey questions whether the respondents have seen or heard any anti-smoking commercials in a number of media channels (TV,

TABLE 1.

Summary Statistics for Adults and Adolescents

Variable	Adults		Adolescents	
	Mean	S. D.	Mean	S. D.
Dependent Variables				
Smoking participation	0.180	0.384		
Smokers never quitting	0.111	0.315		
Smoking initiation			0.036	0.186
Never smoker			0.414	0.492
Key Independent Variable				
Media Exposure	0.830	0.375	0.947	0.225
Instrumental Variables				
Media market-Los Angeles	0.297	0.457	0.423	0.494
Media market-San Francisco	0.290	0.454	0.197	0.398
Media market-San Diego	0.111	0.314	0.126	0.332
Media market-Sacramento	0.101	0.301	0.068	0.252
Annual media expenditure[i]	0.118	0.036	0.119	0.038
Other Independent Variables				
Fair/poor health	0.156	0.362		
Work smoking-free indoors	0.508	0.500		
Smoke last year	0.178	0.382		
Age	43.102	16.962	14.449	1.697
Male	0.490	0.500	0.519	0.500
Married	0.542	0.498		
Hispanic	0.277	0.447	0.354	0.478
Black	0.061	0.240	0.073	0.261
Asian	0.107	0.309	0.124	0.330
High income ($> 75K$)	0.222	0.415		
Medium income ($30 - 75K$)	0.342	0.474		
Work status	0.632	0.482		
Student status	0.066	0.248		
College Education	0.543	0.498		
Home school			0.011	0.105
Smoking teacher			0.576	0.494
Smoking parents			0.319	0.466
Num. of smoking male friends			2.345	7.403
Num. of smoking female friends			1.430	5.773
Smoking helps when bored			0.190	0.392
Smoking helps relax			0.321	0.467
Smoking reduces stress			0.277	0.448
Smoking controls weight			0.169	0.375
Obs. at individual level	53,852		18,199	
Obs. at zipcode level	4,768		3,595	

Notes: (i) It is the real media campaign expenditure in 1982-1983 dollars (per 100,000,000)

radio and billboard) in the month prior to the survey. The measure at the community level reflects the proportion of respondents having such self-reported media exposure.

The instrumental variables for self-reported media exposure include California government's annual media expenditure and media market division. California statewide media campaign's expenditures are based on total 12 media markets and deflated in 1982-1983 dollars. We construct 4 binary variables indicating the top 4 media markets: Los Angeles — covering Los Angeles, Orange and San Bernardino counties; San Francisco — covering San Francisco, Santa Clara, Alameda, Contra Costa, San Mateo, etc; San Diego — covering San Diego and Riverside counties; And Sacramento — covering Sacramento and Butte counties.

For adults, the empirical model also controls other covariates confounding the correlation between smoking behavior and media exposure, including overall health status, smoking status last year, working completely smoke-free indoors, age, gender, racial/ethnic groups, income, education, employment, and student status. For adolescents, we also have related covariates controlled in the empirical model, as age, racial/ethnic indicators, home school, group or peer effects and preferences towards smoking. There are mainly four types of group or peer effects controlled in the model: smoking teachers in school, smoking parents, smoking best male friends and smoking best female friends. Preferences toward smoking refer to adolescent respondents' agreement with the statement that "Smoking helping people to relax," "Smoking helping people to stay thin," "Smoking helping people to reduce stress," and "Smoking helping people when they are bored."

5. RESULTS AND DISCUSSIONS

5.1. Adult smoking behavior and exposure to anti-smoking media campaign

The empirical results for the model of adult smoking participation and smokers' quitting intention are presented in Table 2 and Table 3, with three specifications, Probit, fixed effect, and fixed effect instrumental variables (FE-IV) estimation.

In Table 2, the Probit results using individual level data show, counterintuitively, that individuals exposed to anti-smoking media are more likely to smoke by 7.3 percent. As discussed in Section 3, the measure of exposure may be non-random, reflecting unobserved individual heterogeneity that are also correlated with individual smoking propensity. The endogeneity problem leads to biased estimate of the effectiveness of anti-smoking media campaign. We first refer to fixed effect model using pseudo-panel data at the 5-digit zipcode level, to control unmeasured individual characteristics.

As predicted, the positive effect of anti-smoking media exposure becomes smaller in magnitude and also insignificant. Furthermore, when we use government's annual media expenditure and media market division to instrument media exposure, it is found that the exogeneity of self-reported media exposure is rejected at 1%, and the results show that one more percentage of community anti-smoking media exposure may significantly decrease smoking prevalence by 0.653 percent.

The first column of Table 3 reports Probit estimates at individual level, which suggest that smokers who are exposed to anti-smoking media campaign have 3.6% higher likelihood to attempt to quit smoking or consider quitting in the future. After controlling for the unobserved individual characteristics, the fixed effect estimates strengthen the preliminary findings, showing that increasing community anti-smoking media exposure by 1 percent may significantly reduce smokers never quitting by 0.078 percent. The exogeneity of media exposure is not rejected at any significance level, indicating that self-reported media exposure is not endogenous in the model of smokers' quitting intention.

As expected, adult smoking behavior is negatively associated with other smoking control policies, such as working completely smoke-free indoors. Previous smoking behavior is a strong predicator of current smoking behavior. Single male with lower socioeconomic status are more likely to smoke and also become hard-core smokers. People at work have higher smoking prevalence but more quitting intention.

5.2. Adolescent smoking behavior and exposure to anti-smoking media campaign

Table 4 and Table 5 report the estimates of the effect of anti-smoking media exposure on adolescents' smoking behaviors, including smoking initiation in the short run and smoking intention in the long run, using different estimation approaches, Probit, fixed effect and fixed effect instrumental variables.

Similar to the regressions in Table 2, the results in Table 4 show that adolescents exposed to anti-smoking media campaign are more likely to become established smokers by 0.4%, without the controls for unobserved individual heterogeneities and the associated endogeneity bias. The fixed effect model using pseudo-panel data improves the Probit results by reducing the magnitude of the positive association as well as the statistical significance. The last column in Table 4, which employs instrumental variables to address the endogeneity problem in the panel regression, reports that the measure of media exposure is not exogenous at significance level 5 percent. The results suggest that anti-smoking media exposure has a significant negative effect on adolescents' smoking participation behavior, and

TABLE 2.

Regression Results — Adults' Smoking Participation

Smoking Participation	Individual Data	Pseudo Panel Data	
	Probit	Fixed effect	FE-IV
Media exposure	0.073***	0.017	−0.653***
	(0.008)	(0.016)	(0.170)
Fair/poor health	0.050***	0.003	−0.007
	(0.008)	(0.017)	(0.038)
Work smoking-free indoors	−0.048***	−0.007	0.047
	(0.007)	(0.015)	(0.030)
Smoke last year	0.783***	0.840***	0.853***
	(0.003)	(0.011)	(0.024)
Age ($>= 18$)	−0.001***	0.000	0.000
	(0.000)	(0.000)	(0.001)
Male	0.012**	−0.008	0.087***
	(0.006)	(0.013)	(0.028)
Married	−0.062***	0.002	0.007
	(0.006)	(0.012)	(0.024)
Hispanic	−0.023***	0.026	−0.002
	(0.007)	(0.017)	(0.033)
Black	0.021*	0.033	−0.079*
	(0.011)	(0.034)	(0.047)
Asian	−0.007	0.024	−0.036
	(0.011)	(0.029)	(0.045)
High income	−0.034***	−0.023	0.011
	(0.008)	(0.017)	(0.034)
Medium income	−0.012*	0.000	0.012
	(0.006)	(0.013)	(0.028)
Work status	0.056***	0.056***	0.061
	(0.008)	(0.017)	(0.038)
Student status	−0.038***	−0.018	0.000
	(0.012)	(0.029)	(0.057)
College Education	−0.041***	−0.008	0.017
	(0.006)	(0.013)	(0.028)
Year 1999	0.002		
	(0.007)		
Year 2002	−0.112***		
	(0.006)		
_cons		0.001	0.516***
		(0.031)	(0.156)
sigma_u		0.173	0.076
sigma_e		0.143	0.094
rho		0.594	0.392
F test that all $u_i = 0$		1.89***	
Test of exogeneity			P-value = 0.000
Overid. Test			P-value = 0.119
Pseudo R^2	0.547		
Num. of obs.	53.665	1.953	1.953

Notes(i) Marginal effects are reported for the Probit estimation. (ii) Standard errors are in parentheses. (iii) *** indicates significance at the 1 confidence level, ** denotes significance at 5 confidence level, and * denotes significance at 10 confidence level.

TABLE 3.

Regression Results — Adults' Smoking Cessation

Smokers Never Quitting	Individual Data	Pseudo Panel Data	
	Probit	Fixed effect	FE-IV
Media exposure	−0.036***	−0.078**	−0.167
	(0.007)	(0.031)	(0.226)
Fair/poor health	−0.003	−0.030	−0.026
	(0.005)	(0.032)	(0.051)
Work smoking-free indoors	−0.015***	−0.028	0.015
	(0.005)	(0.027)	(0.041)
Smoke last year	0.048***	0.037	0.034
	(0.005)	(0.023)	(0.033)
Age (>= 18)	0.004***	0.004***	0.003***
	(0.000)	(0.001)	(0.001)
Male	0.036***	−0.026	0.068*
	(0.004)	(0.024)	(0.037)
Married	−0.007*	0.013	−0.014
	(0.004)	(0.022)	(0.032)
Hispanic	0.008	−0.002	0.036
	(0.006)	(0.031)	(0.045)
Black	−0.046***	0.028	0.101
	(0.006)	(0.055)	(0.065)
Asian	0.016*	0.039	0.056
	(0.010)	(0.047)	(0.061)
High income	−0.013**	−0.051*	−0.022
	(0.006)	(0.030)	(0.045)
Medium income	−0.012**	−0.044*	−0.046
	(0.005)	(0.024)	(0.038)
Work status	−0.016***	0.030	−0.008
	(0.006)	(0.032)	(0.052)
Student status	−0.015	0.021	−0.028
	(0.010)	(0.055)	(0.078)
College Education	−0.013***	−0.040*	−0.033
	(0.004)	(0.024)	(0.037)
Year 1999	−0.002		
	(0.005)		
Year 2002	−0.031***		
	(0.005)		
_cons		0.043	0.094
		(0.056)	(0.207)
sigma_u		0.190	0.112
sigma_e		0.187	0.126
rho		0.509	0.442
F test that all $u_i = 0$		1.51***	
Test of exogeneity			P-value = 0.445
Overid. Test			P-value = 0.617
Pseudo R^2	0.097		
Num. of obs.	20,096	1,942	1,942

Notes(i) Marginal effects are reported for the Probit estimation. (ii) Standard errors are in parentheses. (iii) *** indicates significance at the 1 confidence level, ** denotes significance at 5 confidence level, and * denotes significance at 10 confidence level.

increasing community exposure by one percent may lead to 0.322 percent decrease in smoking initiation among adolescents.

Table 5 reveals a consistent pattern with a different outcome measure: adolescents' smoking intention in the future. Although preliminary Probit results suggest a negative correlation between anti-smoking media exposure and individual propensity to become committed never smoker, the fixed effect instrumental variables estimation shows that media exposure is endogenous at 1 percent, and the percentage of committed never smoker increases by 1.125 percent among adolescents in the community with one more percent self-reported exposure to anti-smoking media campaign.

Not surprisingly, teenagers with smoking teachers and parents are more likely to participate in smoking or have the propensity to initiate. There are also significant peer effects in smoking among adolescents, as indicated by the estimates on smoking male and female friends. Higher smoking prevalence and more smoking intention exist among teenagers with positive attitudes towards smoking.

5.3. Determinants of individual exposure to anti-smoking media campaign

To evaluate how the anti-smoking media campaign influences individual behavior, we need to understand the determinants of individual perception about the messages conveyed during the campaign, as measured by self-reported exposure to anti-smoking commercials. As shown in Table 6, we find that media market divisions and annual campaign expenditure by the California government have significant effects on individual self-reported exposure for adults and adolescents, but don't directly affect smoking behavior at the individual or zip-code level. The over-identification tests presented at the bottom of Table 2-5 indicate that the instruments are exogenous and valid.

Table 6 also shows that, among adults, smokers are more sensitive to anti-smoking commercials[2]. Age is negatively associated with self-reported exposure. Hispanic, male with more income or college education are more likely to perceive the anti-smoking campaign. Besides, teenagers who are elder or have smoking teachers report more exposure. Those with smoking male friends are less likely to be exposed.

5.4. Sensitivity analysis

To the robustness of panel regression results, we also conduct a sensitivity analysis by constructing another pseudo panel data by constructing cohort of individuals based on the first four digits of the zipcode. The results are quite similar to the presented, but with a slightly larger magnitude.

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[2]We obtain similar results if the sample is restricted to smokers.

TABLE 4.

Regression Results — Adolescents' Smoking Initiation

Smoking Initiation	Individual Data	Pseudo Panel Data	
	Probit	Fixed effect	FE-IV
Media exposure	0.004**	0.001	−0.322**
	(0.002)	(0.016)	(0.150)
Age (range 12-18)	0.007***	0.010***	0.022***
	(0.001)	(0.003)	(0.005)
Male	−0.001	−0.021***	−0.015
	(0.001)	(0.008)	(0.013)
Hispanic	−0.005***	−0.015	−0.024
	(0.001)	(0.010)	(0.015)
Black	−0.007***	−0.017	−0.015
	(0.001)	(0.018)	(0.025)
Asian	−0.005***	−0.007	−0.024
	(0.001)	(0.015)	(0.022)
Home school	0.047***	0.044	0.050
	(0.015)	(0.042)	(0.063)
Smoking teacher	0.000	0.004	−0.004
	(0.001)	(0.008)	(0.013)
Smoking parents	0.013***	0.010	0.033**
	(0.002)	(0.008)	(0.013)
N of smoking male friends	0.0004***	0.002***	0.003***
	(0.000)	(0.001)	(0.001)
N of smoking female friends	0.0004***	0.006***	0.004***
	(0.000)	(0.001)	(0.001)
Smoking helps when bored	0.012***	0.062***	0.025
	(0.002)	(0.011)	(0.018)
Smoking helps relax	0.012***	0.029***	0.035**
	(0.002)	(0.011)	(0.017)
Smoking reduces stress	0.015***	0.031***	0.018
	(0.002)	(0.011)	(0.017)
Smoking controls weight	−0.001	−0.028***	−0.013
	(0.001)	(0.011)	(0.019)
Year 1999	−0.004***		
	(0.001)		
Year 2002	−0.007***		
	(0.001)		
_cons		−0.140***	−0.004
		(0.039)	(0.127)
sigma_u		0.113	0.064
sigma_e		0.104	0.075
rho		0.540	0.417
F test that all $u_i = 0$		1.66***	
Test of exogeneity			P-value= 0.036
Overid. Test			P-value= 0.377
Pseudo R^2	0.313		
Num. of obs.	17,147	1,870	1,870

Notes(i) Marginal effects are reported for the Probit estimation. (ii) Standard errors are in parentheses. (iii) *** indicates significance at the 1 confidence level, ** denotes significance at 5 confidence level, and * denotes significance at 10 confidence level.

TABLE 5.

Regression Results — Adolescents' Smoking Intention

Intention: Never Smoker	Individual Data	Pseudo Panel Data	
	Probit	Fixed effect	FE-IV
Media exposure	−0.063***	−0.003	1.125***
	(0.017)	(0.042)	(0.407)
Age (range 12-18)	0.007***	−0.001	−0.006
	(0.002)	(0.007)	(0.012)
Male	−0.055***	−0.032	−0.044
	(0.008)	(0.021)	(0.035)
Hispanic	−0.082***	−0.014	−0.111***
	(0.009)	(0.027)	(0.041)
Black	0.100***	0.065	0.236***
	(0.016)	(0.047)	(0.067)
Asian	−0.015	−0.007	0.016
	(0.014)	(0.040)	(0.059)
Home school	0.037	0.155	0.247
	(0.037)	(0.109)	(0.171)
Smoking teacher	−0.072***	−0.073***	−0.119***
	(0.008)	(0.022)	(0.036)
Smoking parents	−0.099***	−0.130***	−0.150***
	(0.008)	(0.022)	(0.036)
N of smoking male friends	−0.003***	−0.004***	−0.008***
	(0.001)	(0.001)	(0.003)
N of smoking female friends	−0.005***	−0.006***	−0.003
	(0.001)	(0.002)	(0.004)
Smoking helps when bored	−0.084***	−0.061**	−0.077
	(0.010)	(0.029)	(0.049)
Smoking helps relax	−0.126***	−0.121***	−0.092**
	(0.010)	(0.029)	(0.046)
Smoking reduces stress	−0.087***	−0.052*	−0.072
	(0.011)	(0.028)	(0.047)
Smoking controls weight	0.010	0.024	0.059
	(0.011)	(0.029)	(0.051)
Year 1999	0.048***		
	(0.010)		
Year 2002	0.081***		
	(0.010)		
_cons		0.589***	−0.357
		(0.102)	(0.345)
sigma_u		0.274	0.184
sigma_e		0.274	0.204
rho		0.501	0.447
F test that all $u_i = 0$		1.46***	
Test of exogeneity			P-value= 0.002
Overid. Test			P-value= 0.156
Pseudo R^2	0.062		
Num. of obs.	17,147	3,552	1,870

Notes(i) Marginal effects are reported for the Probit estimation. (ii) Standard errors are in parentheses. (iii) *** indicates significance at the 1 confidence level, ** denotes significance at 5 confidence level, and * denotes significance at 10 confidence level.

TABLE 6.

The Determinants of Individual Anti-Smoking Media Exposure

Media Exposure	Adults		Adolescents	
	Individual Data	Pseudo Panel Data	Individual Data	Pseudo Panel Data
	Probit	Fixed Effect	Probit	Fixed Effect
Media market: LA	0.015***	0.189***	0.004	0.021
Media market: SF	−0.011***	0.158**	−0.006	0.027
Media market: SD	0.003	0.032	−0.012**	−0.005
Media market: Sacramento	0.010*	0.018	−0.002	0.001
Annual media expenditure	−0.064	0.510***	0.448***	0.345***
Fair/poor health	−0.004	0.010		
Work smoking-free indoors	0.001	0.027		
Smoke last year	0.060***	0.081***		
Age	−0.004***	−0.004***	0.002**	0.006*
Male	0.043***	0.031*	0.004	−0.007
Married	0.011***	0.005		
Hispanic	0.008*	0.043**	−0.001	−0.003
Black	0.006	0.007	0.009	−0.018
Asian	−0.041***	−0.020	0.007	−0.004
High income	0.014***	0.011		
Medium income	0.021***	0.031*		
Work status	0.012***	−0.009		
Student status	0.017**	−0.054		
College Education	0.018***	0.050***		
Home school			0.004	−0.208***
Smoking teacher			0.013***	0.020*
Smoking parents			0.002	−0.003
N of smoking male friends			0.000	−0.002***
N of smoking female friends			0.000	0.000
Smoking helps when bored			0.004	−0.015
Smoking helps relax			−0.007	0.003
Smoking reduces stress			0.000	0.004
Smoking controls weight			0.004	0.017
Year 1999	0.081***		0.038***	
Year 2002	0.058***		0.000	
_cons		0.772***		0.796***
sigma_u		0.174		0.129
sigma_e		0.167		0.145
rho		0.521		0.442
F test that all $u_i = 0$		1.52***		1.26***
Pseudo R^2	0.092		0.035	
Num. of obs.	53,665	1,953	17,147	1,870

Notes(i) Marginal effects are reported for the Probit estimation. (ii) *** indicates significance at the 1 confidence level, ** denotes significance at 5 confidence level, and * denotes significance at 10 confidence level.

TABLE 7.

Robustness Check-Pseudo Panel Estimation at 4-digit Zipcode Level

	Adults		Adolescents	
	Smoking prevalence	Smokers never quitting	Smoking Initiation	Intention: Never Smokers
	FE-IV	Fixed Effect	FE-IV	FE-IV
Media exposure	−0.723***	−0.107*	−0.465#	1.486**
Fair/poor health	−0.079	−0.153***		
Work smoking-free indoors	0.011	−0.109**		
Smoke last year	0.81***	0.145***		
Age	−0.001	0.005***	−0.002	−0.012
Male	0.109**	0.117***	0.010	−0.070
Married	−0.039	−0.068*		
Hispanic	0.066	0.085	−0.027	−0.006
Black	−0.158*	0.078	−0.026	0.156
Asian	0.058	0.102	−0.119**	0.233**
High income	0.003	−0.036		
Medium income	0.022	−0.117**		
Work status	0.083	0.154***		
Student status	−0.07	0.058		
College Education	−0.043	−0.015		
Home school			0.111*	0.352*
Smoking teacher			0.013	0.058
Smoking parents			0.020	−0.131**
N of smoking male friends			−0.002	−0.009**
N of smoking female friends			0.005***	0.000
Smoking helps when bored			0.036	−0.092
Smoking helps relax			0.066***	−0.007
Smoking reduces stress			0.012	−0.074
Smoking controls weight			−0.017	0.007
_cons	0.655***	−0.148	0.474*	−0.783
sigma_u	0.06	0.076	0.048	0.158
sigma_e	0.086	0.103	0.078	0.185
rho	0.333	0.353	0.276	0.422
Test of exogeneity	P-value = 0.000		P-value = 0.067	P-value = 0.001
Overid. Test	P-value = 0.926		P-value = 0.627	P-value = 0.290
Num. of obs.	920	910	890	890

Notes(i) Marginal effects are reported for the Probit estimation. (ii) # indicates marginal significance at 15 confidence level. (iii) *** indicates significance at the 1 confidence level, ** denotes significance at 5 confidence level, and * denotes significance at 10 confidence level.

6. CONCLUSION

Mass media anti-smoking campaigns are a promising and costly tool for health promotion. This study evaluates the awareness and effectiveness of the California Tobacco Control Media Campaign, one of the nation's longest running and most emulated anti-smoking programs. Based on the implicit theoretical hypothesis that individuals empowered with more information about the health risk of smoking are less likely to engage in smoking behavior, we investigate empirically how the campaign changes the smoking behavior of adults and adolescents, in the short run as well as in the long run, through individual self-reported exposure to the media message. This analysis in the paper uses repeated cross section data to produce pseudo panel data at the community level, and employs instrumental variables method to address the endogeneity problem that may bias the estimates on the campaign effectiveness.

Overall, the results suggest that California anti-smoking media campaign has achieved a high level of public awareness of anti-smoking advertising, and therefore significantly reduced the smoking prevalence among adults and adolescents. In addition, the media campaign also brings significant long term benefits in the smoking reduction, by inducing more future attempts to quit among adult smokers, and by deterring more initiating intentions among adolescents.

Based on the empirical results, it is reasonable to conclude that California anti-smoking media campaign is a successful tobacco control program in reducing smoking prevalence in the short run as well as in the long run. It provides empirical evidence to support the continuous funding of the anti-smoking media campaigns. However, future work will be directed to evaluate the relative efficiency of the funds going to media campaigns versus other measures which also try to reduce smoking in California and other states.

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