Do Tobacco-Control Programs Lower Tobacco Consumption? Evidence from California

Michael L. Marlow
California Polytechnic State University, San Luis Obispo

California is often considered the model for tobacco-control programs due to its early adoption of comprehensive programs aimed at lowering tobacco consumption. Tobacco control began when voters approved the California Tobacco Tax and Health Promotion Act of 1988. More than $2 billion has been spent on tobacco-control in California since 1988. The findings of this article indicate that tobacco-control spending is a significant factor for the widening gap between consumption in the United States and in California only in equations that exclude cigarette prices and smoking bans as control variables. When significant, however, estimates suggest that, for every $1 increase in tobacco-control spending per capita, the sales gap widens by only 0.11 to 0.18 cigarette packs per capita, or roughly 2 to 4 cigarettes per capita. This study suggests that future research should address the complexity of interactions among tobacco-control programs, cigarette prices, and smoking bans.

1. Introduction

California is often considered the model for tobacco-control programs due to its early adoption of comprehensive programs that included tax increases, tobacco-control spending on health education and counter-advertising, and smoking bans in public places. Tobacco control began in 1988 when voters approved the California Tobacco Tax and Health Promotion Act of 1988 (Proposition 99), which increased the state surtax on cigarettes by 25cents per pack. Revenues from the new tax were earmarked for tobacco-related disease research, health education against tobacco, and health care for medically indigent families. The authorizing legislation established the goal of reducing tobacco consumption by 75 percent in California by 1999.

Slightly more than $2 billion has been spent in California on tobacco control during 1989-2002, or roughly $62 per capita during this period. The California Department of Public Health (2005) argued that tobacco control programs have been effective because California's adult smoking rate dropped to a historic low of 15.4 percent in 2004, a 32.5 percent decrease since 1988. Figure 1 displays the tax-paid per capita cigarette sales (in packs) in California and demonstrates that sales fell in most years since 1974. Sales of 127 packs per capita in 1974 decreased to 36 packs in 2002, a dramatic reduction of 72 percent. Figure 1 also shows that sales fell 47 percent for the nation as a whole, from 135 packs to 72 packs, during this same period. In 2002, the Centers for Disease Control and Prevention (CDC) called for more than $1.5 billion in additional tobacco-control spending in that year alone for the nation, based in part on its evaluation of the success of the tobacco-control program in California. In 2002, for instance, CDC estimated that, although total state tobacco-control expenditures were $862 million or $3.16 per capita, spending in all states was roughly 56 percent of the ''lower-bound'' or minimum best practices funding recommendation for that year.

It is unlikely that falling cigarette sales is solely the product of tobacco-control programs. Growing awareness of health risks associated with smoking as well as increased availability of various pharmaceutical aids for smoking cessation might also cause falling demand for cigarettes

by Californians.4 Although tobacco-control programs themselves may promote greater awareness of health risks, it is doubtful that the effect on sales from rising health concerns stems entirely from California's tobacco-control program.5 Rising cigarette prices that followed excise tax hikes and the Master Settlements Agreement (MSA) are commonly believed to reduce consumption as well. Higher prices also promote purchases from lower-tax jurisdictions that will result in cigarette sales that are not counted as cigarette sales in California. Rising Internet sales from sellers outside of California may also have contributed to some of the reduction of sales in California, thus suggesting that some of the reduction in cigarette sales may be illusionary.

This study examines the effectiveness of California's tobacco-control programs using a model of the cigarette sales gap between the nation and California during 1975-2002 that controls for prices, income, smoking bans, and smuggling. Previous research that focused on California did not control for many factors outside of the tobacco-control programs themselves and examined data no later than 1993. California is an obvious choice for a focused examination due to its long-standing tobacco-control program and because CDC recommendations for state spending increases are partially based on their interpretation of past evidence on the California program.

2. Literature on Tobacco-Control Programs

The literature often fails to examine factors other than tobacco-control programs when evaluating effectiveness of these programs. In their comprehensive assessment of the literature, Farrelly, Pechacek, and Chaloupka (2003) concluded that most studies simply perform trend analysis surrounding the introduction of new tobacco-control programs and fail to control for price effects and other factors that might also be influencing consumption. When tobacco consumption falls following a particular policy event, authors incorrectly conclude that tobacco-control programs are the sole cause of the reduction. For example, Manley et al. (1997) concluded that per capita monthly sales fell in states participating in the American Stop Smoking Intervention Study (ASSIST) program when compared to states not participating. Other factors that might have led to such a decline were not considered. It is possible that states participating in ASSIST exhibit falling cigarette consumption simply because their citizens express decreasing tolerance for smoking, which then fosters public support for ASSIST that is not as evident in states that do not participate.

Although consumption is falling, it is not clearly the result of participation in ASSIST. Pierce et al. (1998) concluded that California's control programs significantly lowered tobacco use, but they did not control for factors that might also contribute to such a change. These and other studies suggest little about the influence of tobacco-control programs.

Four studies control for one or more factors outside of the tobacco-control programs themselves and therefore contribute more to our understanding of how these programs contribute to falling consumption throughout time. Hu, Sung, and Keeler (1995a) controlled for state excise taxes and tobacco firm media expenditures when concluding that state government media expenditures, or counteradvertising, lowered cigarette consumption in California. They measured tobacco-control expenditures as ''media placement expenditures'' by the Tobacco-Control Section of the California Department of Health Services and calculated that California spent almost $20 million during 1980-1993. This initial effort at measuring control focused on the media campaign portion of the tobacco-control program, and, as discussed below, recent data indicate that during 1989-2002, media spending was roughly one-sixth of total spending on tobacco-control programs. Hu, Sung, and Keeler (1995b) estimated that sales of cigarettes in

California were reduced by 819 million packs from the third quarter of 1990 through the fourth quarter of 1992 owing to an additional 25-cent state tax increase. They also used antismoking media campaign dollars as a proxy for tobacco-control spending.

Farrelly, Pechacek, and Chaloupka (2003) examined the influence of state tobacco-control expenditures on cigarette sales during 1981-2000 in the fifty states and concluded that increased expenditures lower cigarette sales after controlling for excise taxes, smuggling, time, and other statespecific factors. They collected their own data from federal, state, and private funding sources, and concluded that past and current tobacco-control spending lowered current cigarette consumption. They also examined evidence from the four states with the longest history of such programs (Arizona, California, Massachusetts, and Oregon) and found similar conclusions when data on these four states were grouped together. Estimation was not conducted on California alone. Using data collected by the authors on expenditures of tobacco-control programs, Tauras et al. (2005) concluded that per capita state-level spending on tobacco control lowered youth smoking prevalence and the number of cigarettes smoked by smokers during 1991-2000. California was not singled out for examination in this study either.

This literature survey indicates that examination of more recent data on California is an obvious avenue for further research because data from 1993 are from the last year in which California was specifically studied. Past studies that focused on California also only examined media campaign spending and so did not fully examine spending in the overall tobacco-control program. More recent studies have not focused on California and, as discussed above, relied on author-derived estimates that were not publicly available.7 Fortunately, expenditure data on tobacco control in California are now publicly available and span the period 1989-2002, which allows us to focus on program effectiveness in California throughout a relatively long period and on the overall program itself. Data on media campaign spending are also available during this period and are examined.

Most studies do not control for marketing by tobacco firms that may partially overturn effects of tobacco-control programs on tobacco consumption. For example, researchers have argued that the effectiveness of tobacco-control programs is diminished when spending by tobacco firms on marketing increases following major policy events such as tax increases and tobacco settlements.8 More recent studies discussed above—Farrelly, Pechacek, and Chaloupka (2003), and Tauras et al. (2005)—do not control for marketing by tobacco firms. Unfortunately, California-specific data on tobacco advertising are not available and so are not examined here. It would appear inappropriate to simply assume that the amount of spending by tobacco companies is proportionate to the California population. Its inclusion would likely lead to various questions about what effect its inclusion in this form would exert on the empirical results of this article and would also make it more difficult to compare the results here with those of previous studies.

It is, of course, difficult to fully account for all of the factors that influence tobacco consumption such as tax evasion and higher prices, as well as to completely parse out the independent effects of the California tobacco program. Program activities might have been instrumental in changing social norms in ways that led to subsequent tax hikes and smoking bans or greater health concerns that ultimately led to lower cigarette sales. Similarly, state and local smoking bans in public places may have curbed cigarette sales as well, and part of this effect might stem from the tobacco-control program.

Gilpin, Lee, and Pierce (2004) examined changes in population attitudes about where smoking should not be allowed. They reported significant increases in percentages of California adults stating that smoking should not be allowed in many public places in 1998-1999 compared

to 1992-1993. Only modest increases were found for adults in states other than California. They concluded that California's tobacco-control program was a significant factor behind why social norms in California changed more rapidly than in the rest of the nation.

Although it is impossible to know what proportion of any changes in cigarette sales might stem from these dynamics, the possibility of complex interactions suggests the importance of conducting a rather broad empirical approach to examining how the tobacco-control program has influenced cigarette sales. One way to address the complexity of interactions is to examine several empirical specifications of how the tobacco-control program might affect sales. A first step is to examine if contemporaneous spending influences sales. A second step is to examine if inclusion of various lagged values of spending also influences sales. Finally, a cumulative measure of spending is considered following previous studies by Hu, Sung, and Keeler (1995a) and Farrelly, Pechacek, and Chaloupka (2003) that discounted past spending with a discount rate of 5 percent. This measure has been proposed as a way to test whether it takes many years of tobacco-control activity before full effects of that program can be uncovered.
The present study also considers discount rates of 10, 15, and 20 percent
because a 5 percent rate is clearly arbitrary.

Another consideration that follows from our discussion is that examining effects of tobacco-control spending in equations that also control for cigarette prices and smoking bans may underestimate effects of spending. Excluding prices and bans may, however, overestimate effects from spending. It would thus appear prudent to illustrate how effects from tobacco-control expenditures are sensitive to inclusion or exclusion of smoking bans and prices. Regressions are therefore run with and without controls for cigarette prices and smoking bans.

Controlling for time is another area that deserves careful consideration because standard error estimates in regressions are biased downward in the presence of positive serial correlation. As demonstrated in figure 1, tobacco consumption has fallen throughout most years in California. Past studies have simply taken a simple time trend as in Hu, Sung, and Keeler (1995a, 1995b), or a quadratic time trend as in Farrelly, Pechacek, and Chaloupka (2003). Both methods raised serious concerns over multicollinearity in the present article. Examination of prices, smuggling, income, time, smoking ban, and the tobacco-control spending variables indicated variance inflation factors (VIFs) in excess of 10 for price, smoking ban, time, time squared, and cumulative spending variables.10 A value of 10 is commonly used as the threshold for concern. Variables with very high VIF ranges were price (range: 25-33), time squared (range: 25-100), income (range: 8-17), and cumulative spending (range: 13-50).

It is important to remember that the goal of controlling for time is to capture secular trends that are independent of the effects of the tobacco-control program, and, because this indicates a difficult challenge with no control states, it would appear superior to drop time altogether by examining the difference between cigarette consumption in the United States and consumption in California rather than simply examine consumption in California throughout time. As discussed below, VIFs of independent variablesin this article's models of the sales gap mostly exhibit values lower than 10. This sales gap specification is also consistent with the commonly held view that California's tobacco-control program is an important reason for why California's cigarette consumption has fallen more rapidly than that of the nation as a whole. An average gap of 24.17 packs per capita during 1975-2002 indicates that California consumed substantially less than the nation as a whole. The gap also widened during this period from 7.8 packs to 35.9 packs.

In sum, this study provides the following innovations. It examines California's tobacco-control program using data on overall spending as well as media spending during 1989-2003. 1993 is the last year in which California was separately examined, and earlier studies focused on the media campaign portion of the tobacco-control program. This article also examines if the difference between consumption in the United States and California is influenced by the tobacco-control program to examine the commonly held view that this program is an important influence for why consumption in California has declined more rapidly than consumption in the nation.

3. Estimating Effects of Tobacco Control on Tobacco Use

Equation (1) models the effects of California's tobacco-control program on the sales gap between the United States and California, holding constant other factors that might contribute to changes in consumption. The dependent variable CIGGAP is the number of tax-paid per capita cigarette sales (in packs) in the United States minus sales in California, and is obtained from Orzechowski and Walker (2004):

$$CIGGAP = f(PRICEGAP; SMUG; YGAP; BAN; CONTROL); \quad (1)$$

where PRICEGAP is the real (in 2003 dollars) price gap of packs of cigarettes in the United States and California, as reported in Orzechowski and Walker (2004), and is hypothesized to be inversely related to the consumption gap. A rising price gap would indicate that prices in the United States are now relatively higher than in California and therefore consumption in the United States should fall relatively more, thus lowering the gap in sales between the United States and California.

As discussed previously, data on tax-paid cigarette sales in California are distorted because Californians purchase some portion of cigarettes outside of this calculation. Even though taxed sales in California have fallen rapidly, this trend overstates the extent that Californians have lowered consumption. High-tax states are expected to lose some portion of total sales to neighboring states with lower tax rates, and therefore taxed sales are too high in states from which cigarettes are bootlegged and too low in states to which cigarettes are smuggled. The Legislative Analyst's Office (2003) of the California government has argued that the decline in smoking is overstated due to stamp counterfeiting, cross-border smuggling, Internet purchases, and export redirection (redirecting cigarettes meant for export to other jurisdictions back into the state so as to circumvent taxation). This report discusses a recent survey by the California tax authority that found that one-third of the retail outlets had cigarettes with counterfeit stamps. The tax authority also calculated that the loss in excise tax revenue from a load of cigarettes in a fourteen-foot truck would be $180,000 and would approach the mid– to high hundreds of thousands of dollars in a twenty-four-foot truck, thus demonstrating significant financial incentives for smugglers.

SMUG controls for estimation bias and is defined as the ratio of the tax in California to the average of taxes for bordering states (Oregon, Nevada, and Arizona). There is no value for a national smuggling variable under our definition of smuggling, and therefore the model does not examine the differential incentive for smuggling in the United States versus in California. SMUG is hypothesized to exhibit a positive sign because higher values indicate greater incentives for California smokers to purchase from surrounding states offering lower taxes, which would then widen the sales gap in the United States minus in California. It should be noted that significance of variables that measure tax differentials of adjoining states is likely to diminish throughout

time with rising Internet sales because distance from seller becomes less important for buyers when they have access to low-tax cigarettes over the Internet. Many Internet merchants are located in low-tax states such as North Carolina, Virginia, and Kentucky, as well as on American Indian reservations that sell untaxed cigarettes, thus suggesting that tax differentials between bordering states are becoming a less useful means of controlling for the effect of this activity on a state's cigarette sales (General Accounting Office [GAO] 2002).

YGAP controls for the gap in income between the United States and California. Income is defined as real per capita personal income and is obtained from the U.S. Department of Commerce.11 The expected sign in YGAP is positive when cigarettes are normal goods. Higher income gaps are predicted to lead to more consumption in the nation relative to consumption in California, and therefore CIGGAP is expected to rise as a result.

California passed a statewide smoking ban in public places in 1994 that was fully implemented in 1998. Yurekli and Zhang (2000) found that smoking restrictions lead to lower state per capita cigarette consumption in a model that controls for price, income, smuggling, education, and various demographic variables. A smoking ban variable is constructed that calculates the percentage of the California population that was subjected to state and local smoking bans in public places (workplaces, restaurants, and bars) throughout the range of the study.12 This variable was constructed using data on the population covered by such bans obtained from American Nonsmokers' Rights Foundation (2006), and then comparing it to state population for each year obtained from the California Statistical Abstract (California Department of Finance 2006). National comparisons are not calculated for the smoking ban variable, although a few states adopted restrictive bans as well during the period of our study. California may, however, be considered an outlier among the states because it is one of four states with a long-standing history of a comprehensive tobacco-control program, and so it is assumed that national values of the smoking ban variable are zero. It is hypothesized that the smoking ban variable positively influences the sales gap because if the ban lowers smoking in California, the consumption gap between the United States and California should widen.

It should be noted, however, that states that adopt smoking bans may be more likely to have lower smoking rates and smoking rates that fall more quickly than other states. Dunham and Marlow (2000) concluded that the presence of a state smoking law is influenced by whether a state has a significant tobacco presence. Boyes and Marlow (1996) found evidence of many smoke-free restaurants prior to passage of a smoking ban in one of the earliest (San Luis Obispo) cities in California to adopt such a ban. Hersch, Del Rossi, and Viscusi (2004) found that state smoking laws are responsive to voter preferences in a state. It is possible, then, that introduction of a smoking ban may exert little or no effect on tobacco use if the smoking ban is passed after a significant and earlier reduction in consumption. In other words, smoking bans may follow changes in smoking behavior rather than cause such changes. Of course, the ban could also simply lower social costs of smoking as consistent with stated objectives of the law without lowering tobacco consumption. The effect of the smoking ban, then, is an empirical issue to be decided by the data.

CONTROL measures tobacco-control program size in California and is an estimate of the real per capita expenditures on these programs as published in Ibrahim and Glantz (2003). These estimates were compared to the 1989-2000 series in the 2002 California Tobacco-Control Update publication of the California Department of Health Services and were comparable as demonstrated by a correlation coefficient of 0.94. Data in Ibrahim and Glantz (2003) are used because they provide a longer data set, or 1989-2002. Values are set to $0 prior to 1989

following Farrelly, Pechacek, and Chaloupka (2003), who argued that preintervention data isolate the impact of tobacco-control programs on tobacco use. Lagged values of per capita tobacco-control expenditures are also considered following Farrelly, Pechacek, and Chaloupka (2003), who found contemporaneous and lagged effects of tobacco-control expenditures on cigarette consumption. Lags from one to two years are considered to determine whether prior spending exerts significant effects on current cigarette consumption. Finally, cumulative measures of spending are considered following previous studies by Hu, Sung, and Keeler (1995a) and Farrelly, Pechacek, and Chaloupka (2003) that discounted past spending with a discount rate of 5 percent. This measure has been proposed as a way to test whether it takes many years of tobacco-control activity before full effects of that program can be uncovered. Estimations using discount rates of 10, 15, and 20 percent are also considered.

National comparisons are not calculated for tobacco control expenditures because there are no comparable data with which comparisons can be made. This should not, however, pose a problem because the tobacco-control program in California is an outlier among most states, and so it is assumed that national values of these same variables are zero. Expenditures are hypothesized to exert positive effects on the sales gap between the United States and California when tobacco-control policies lead to falling consumption in California.

Unfortunately, data on tobacco-control spending are not fully disaggregated to uncover all activities being funded so as to examine whether all components of tobacco-control programs exert equal effects on cigarette consumption. As discussed below, however, data on tobacco-control media expenditures are examined and include spending on print, radio, television, and billboard campaigns aimed at lowering tobacco use.

Variance inflation factors were calculated given the potential for collinearity in this model. Using the commonly used threshold value of 10 as a sign of potential problems, only cumulative measures of tobacco-control spending consistently exhibited values in excess of this threshold. VIF values for the various discounted measures were 5 percent rate (17), 10 percent rate (13), and 15 percent rate (13).13 Estimations using cumulative tobacco-control spending variables should therefore be considered more
cautiously than estimations using contemporaneous and lagged expenditures. VIFs of all variables in equations that exclude price gap and smoking ban variables all exhibit values lower than 10, thus suggesting little concern for collinearity in these estimations. As noted above, however, effects of tobacco-control programs will tend to be overestimated in equations without price gap and smoking ban variables, and underestimated in equations with these variables. Table 1 displays summary statistics of all variables defined above for 1975-2002.

4. Effects of Tobacco-Control Spending on Tobacco Sales

Table 2 displays estimates of the cigarette sales gap between the United States and California that control for cigarette price gaps and smoking bans. Price gap and smuggling variables never exert effects different from zero. Income gaps always exert positive effects on the sales gap and are consistent with expectations. Smoking bans exert positive effects in equations with contemporaneous and lagged tobacco-control spending, but do not exert significant effects on equations with cumulative measures of spending. No measure of tobacco-control spending exerts effects that differ from zero. It is likely that these effects are underestimated when price gaps and smoking bans are included. Table 2 also lists Ljung-Box Q

statistics to test for serial correlation, and their values indicate no concern, except for the equation with tobacco-control spending lagged two years.

Table 3 displays estimates of the cigarette sales gap that exclude controls for cigarette prices and smoking bans. Smuggling exerts positive effects in all equations except the one with cumulative spending discounted at 5 percent. Contemporaneous and lagged tobacco-control spending continue to exert no significant effects on the sales gap. All measures of cumulative spending exert positive and significant effects, thus indicating that California's program has significantly widened the gap between sales in the United States and those in California. Previous discussion indicated that cumulative measures of spending exhibited VIFs in excess of 10, and therefore caution should be exercised over the preciseness of estimated coefficients because collinearity is a concern. Estimates of cumulative spending elasticities (evaluated at means) are 0.18 (5 percent discount), 0.16 (10 percent discount), and 0.17 (15 percent discount). It is likely that these effects are overestimated because controls for cigarette prices and smoking bans are excluded. Ljung-Box Q statistics indicate the presence of serial correlation in equations with contemporaneous and lagged values of tobacco-control spending, but not in equations using cumulative measures of spending.

5. Effects of Tobacco-Control Media Campaign Spending on Tobacco Sales

Total spending on media campaigns was $377,570,000 during 1989-2002. These expenditures are obtained from Ibrahim and Glantz (2003) and measure media spending such as television, radio, print, billboards, and contained messages on the tobacco industry, secondhand smoke, addiction, cessation, cigarette additives, smokeless tobacco, general health, pregnancy, and prevention among youth. Real per capita spending on media expenditures averaged $0.39 during 1975-2003, with a range of $0.00-1.41. Consistent with earlier discussion, values of $0 are assigned to preintervention years. Throughout 1975-2002, real total tobacco-control spending per capita averaged $2.29, and real media campaign spending per capita averaged $0.39, thus roughly indicating a sixfold difference in magnitude. When compared during the intervention period of 1989-2002, real total tobacco-control spending per capita averaged $4.59, and real media campaign spending per capita averaged $0.79.

A cumulative measure of media spending was calculated in the same manner as for overall tobacco-control spending to allow for all past expenditures to influence the sales gap. As before, past spending was discounted at rates of 5, 10, and 15 percent.

Table 4 displays estimates of the cigarette sales gap that control for cigarette price gaps and smoking bans. Consistent with the results in table 2, price gap and smuggling variables never exert effects different from zero. Income gaps always exert positive effects on the sales gap and are also consistent with the results in table 2. Smoking bans exert positive effects, as hypothesized, on the sales gap in equations with contemporaneous and spending lagged one year, but do not exert significant effects in any other equation. No measure of tobacco-control media spending exerts effects that differ from zero. Values of Ljung-Box Q statistics indicate no concern for serial correlation, except in the equation with spending lagged two years.

Table 5 displays estimates of the cigarette sales gap between the United States and California that exclude cigarette price gaps and smoking bans. Smuggling exerts no significant effects, even though it positively influenced the sales gap in table 3 that runs similar regressions using total tobacco-control expenditures. The income gap variable exerts positive influences on the sales gap and is consistent with results shown in previous tables. All measures of media

spending exert significant and positive influences on the sales gap. These results are somewhat consistent with those in table 3, except only cumulative total tobacco-control spending was found to significantly influence the sales gap. Estimates of media spending elasticities (evaluated at means) exhibit the narrow range of 0.11 (15 percent discount) to 0.14 (5 percent discount). Again, media spending effects are probably overestimated because controls for cigarette price gaps and smoking bans are excluded. Ljung-Box Q statistics indicate presence of serial correlation in only the equation with spending lagged two years.

6. Conclusions

Changes in income were an important factor for why cigarette consumption declined more rapidly in California than in the overall nation. Insignificance of price gap effects is interesting given the large literature demonstrating that price effects are robust and stable. It should be remembered, however, that this literature estimates effects of prices on consumption rather than price differences on consumption differences. Smokers in California have clearly been subject to a rising real price during the period of this study: from $1.65 to $4.42. But, real prices in the United States have risen from $1.64 to $4.05 during the same period. The real price gap between the United States and California has averaged only $0.19 during this period, with a range from –$0.62 to $0.10. It is likely, therefore, that the small range in the price gap explains why it does not exert a statistically significant influence on the sales gap.

Tobacco-control spending exerts a statistically significant influence on the gap between consumption in the United States and California only in equations that exclude cigarette price gaps and smoking bans. Equations with these controls are likely to underestimate effects from tobacco-control programs, and equations without these controls are likely to overestimate effects. The result that tobacco-control spending exerts significant influences only in equations without these control variables would appear consistent with previous discussion about complexities associated with parsing out independent effects of California's tobacco-control program on sales. Although tobacco-control programs may exert independent effects on sales, it is also possible that these programs alter social norms in ways that might have contributed to subsequent tax hikes (and therefore higher prices), smoking bans, or greater health concerns that ultimately led to lower cigarette sales. Governments may as well view smoking bans, price hikes through tax increases, and tobacco-control programs as either substitutes or complements, thus suggesting further ambiguity on parsing out independent effects of tobacco-control programs.

Although tobacco-control spending exerted significant influences at times in equations that excluded cigarette price and smoking ban variables, effects are relatively inelastic. When statistically significant from zero, elasticity coefficients exhibited a relatively narrow range from 0.11 to 0.18. These estimates suggest that, for every $1 increase in tobacco-control spending per capita, the sales gap widens by 0.11 to 0.18 cigarette packs per capita, or roughly 2 to 4 cigarettes per capita. Previous discussion also indicated such estimates are probably overstated because they do not control for cigarette price and smoking ban variables. Nonetheless, these estimates provide information for debates regarding whether past spending on tobacco control yields sufficient reductions in cigarette consumption to justify continuation.

Although the empirical results indicate ambiguity about the independent effect of tobacco-control programs on the sales gap, this ambiguity would appear to be worth noting when analyzing past and future research in this area of public health policy. Within the context of studies that previously focused on California's tobacco-control programs, it would appear that

effects were overestimated because they did not control for cigarette prices and smoking bans. The present study also suggests that future studies that include these control factors would tend to underestimate effects of these programs on cigarette sales. To promote clearer understanding of the independent influences that tobacco-control programs exert on smoking, this article suggests that further research should focus on disentangling the various effects that smoking bans, price increases, and tobacco-control programs exert on cigarette consumption.

Notes

1. CDC (2001, 2002).
2. See Ibrahim and Glantz (2003). Throughout the article, all dollar values are in real 2003 terms. The per capita calculation was computed using average California population during this period.
3. See CDC (2002) for spending recommendations. CDC (1999) discussed spending recommendations based on ‘‘evidence-based’’ evaluations of programs in California, Massachusetts,
   Oregon, and Maine.
4. Pierce and Gilpin (2002) concluded that, since becoming available over the counter in 1996, nicotine-replacement therapy became ineffective in increasing long-term successful smoking cessation in California smokers.
5. Tobacco-control programs of other states and federal programs may foster greater awareness as well.
6. See, for example, GAO (2002).
7. For example, Tauras et al. (2005) calculated tobacco-control spending by adding real per capita state excise tax funding with other state-appropriated funds earmarked for these programs with real per capita nongovernmental spending and per capita tobacco-control spending from the federal tobacco-control program and from American Stop Smoking Intervention Study (ASSIST), Initiatives to Mobilize for the Prevention and Control of TobaccoUse (IMPACT), and SmokeLess States National Tobacco Policy Initiative (supported by the Robert Wood Johnson Foundation and the American Medical Association).
8. See, for example, Hu, Sung, and Keeler (1995a).
9. To conserve space, regressions using the 20 percent rate of discount are not displayed because overall results were unaffected.
10. The time variables were time centered to correct for artificially inflated variance inflation factors (VIFs).
11. See Bureau of Economic Analysis (2007).
12. The variable has a starting value of 0; then rises to 0.04 in 1991, 0.06 in 1992 and 1993, 0.13 in 1994, and 0.24 in 1995; and then stays at 1.0 for the rest of the period under study.
13. The only other variable with a VIF in excess of 10 was PRICEGAP. Although it exhibited values of 13 in equations with a 5 percent discounted cumulative measure and spending lagged two years, all other equations exhibited values less than 10.

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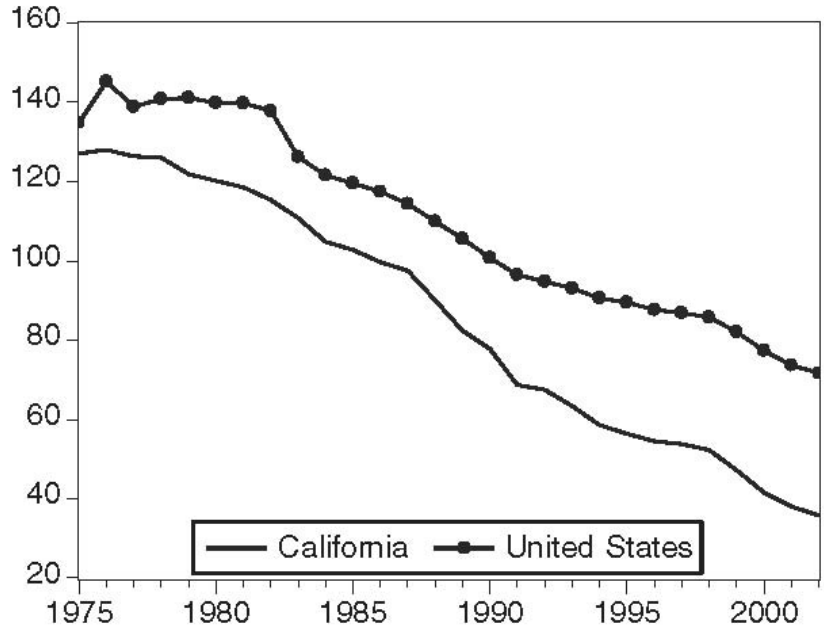
Michael L. Marlow is a professor of economics at California Polytechnic State University in San Luis Obispo. He received his doctorate in economics from Virginia Tech. His research interests are in public finance and public choice with specific interests in the areas of public health, public education, and tax reform.

Figure 1
Tax-Paid per Capita Cigarette Sales (in packs)



Source: Orzechowski and Walker (2004).

Table 1
Summary Statistics

Variable	Mean	Standard Deviation	Minimum	Maximum
CIGGAP (tax paid on cigarettes in packs per capita in United States—California)	24.17	8.29	7.80	35.90
PRICEGAP (real [$2003] price of pack of cigarettes in cents in United States—California)	−19.04	20.55	−62.10	10.40
SMUG (ratio of California tax to average taxes of bordering states)	1.07	0.40	0.49	1.71
YGAP (real [$2003] per capita personal income in United States—California)	−2869.37	962.75	−4100.45	−1280.74
CONTROL (real [$2003] per capita spending on tobacco-control in dollars)	2.29	2.66	0.0	8.76
BAN (share of population subject to bans in workplaces, restaurants, and bars)	0.26	0.43	0.0	1.00
CUMULATIVE (cumulative real [$2003] per capita spending on tobacco-control discounted at a 5 percent rate)	14.26	18.08	0.0	49.37
CUMULATIVE (cumulative real [$2003] per capita spending on tobacco-control discounted at a 10 percent rate)	10.82	14.20	0.00	36.09
CUMULATIVE (cumulative real [$2003] per capita spending on tobacco-control discounted at a 15 percent rate)	8.78	11.36	0.00	27.38
MEDIACONTROL (real [$2003] per capita spending on media campaign for tobacco-control in dollars)	0.39	0.45	0.00	1.41
MEDIACUMULATIVE (cumulative real [$2003] per capita spending on media campaign discounted at a 5 percent rate)	2.15	2.92	0.00	8.72
MEDIACUMULATIVE (cumulative real [$2003] per capita spending on media campaign discounted at a 10 percent rate)	1.71	2.38	0.00	6.79
MEDIACUMULATIVE (cumulative real [$2003] per capita spending on media campaign discounted at a 15 percent rate)	1.43	1.96	0.00	5.54

Table 2
Effects on Cigarette Sales in United States Less California

Explanatory Variables	(1)	(2)	(3)	(4)	(5)	(6)
PRICE DIFFERENCE	−0.1716	−0.1667	−0.0226	−0.0960	−0.1484	−0.1465
	0.1025	0.1061	0.0903	0.1063	0.1005	0.1015
SMUGGLING	−2.1093	−2.0270	3.2122	−0.8994	−1.9431	−1.6520
	4.6870	4.4886	3.6393	4.2767	4.3283	4.3599
INCOME DIFFERENCE	0.0035[a]	0.003454[a]	0.0032[a]	0.0022[c]	0.0025[c]	0.0024[c]
	0.0010	0.001064	0.0008	0.0012	0.0012	0.0013
BAN	6.0970[b]	6.1011[b]	7.0404[a]	0.6350	2.1280	2.8033
	2.4262	2.3763	1.7562	3.9428	3.8745	3.6028
CONTROL	0.0111					
	0.4110					
CONTROL(−1)		0.0697				
		0.3966				
CONTROL(−2)			0.4017			
			0.3257			
CUMULATIVE (5 percent)				0.2387		
				0.1415		
CUMULATIVE (10 percent)					0.2059	
					0.1615	
CUMULATIVE (15 percent)						0.2360
						0.1977
CONSTANT	31.593[a]	31.281[a]	27.175[a]	26.160[a]	27.670[a]	27.178[a]
	4.6778	4.9952	4.2464	5.4289	5.4228	5.8275
Adjusted R^2	0.822	0.822	0.895	0.842	0.834	0.833
Mean dependent variable	24.17	24.17	24.78	24.17	24.17	24.17
F	25.95	25.99	45.16	29.87	28.20	27.92
Ljung-Box Q (lag = 1)	0.579	0.634	3.85[b]	1.35	0.582	0.497
Ljung-Box Q (lag = 2)	2.343	2.313	4.07	3.37	2.523	2.400
Ljung-Box Q (lag = 3)	2.362	2.341	8.01[b]	3.39	2.523	2.402
Observations	28	28	27	28	28	28

a, b, c. Significant (two-tailed test) at 1, 5, and 10 percent levels, respectively. Standard errors are below the coefficient estimate.

Table 3
Effects on Cigarette Sales in United States Less California (without bans and prices)

Explanatory Variables	(1)	(2)	(3)	(4)	(5)	(6)
SMUGGLING	8.1654[c]	7.9077[c]	7.8903[b]	2.4354	3.4480[c]	3.7276[c]
	4.7849	4.3659	3.3052	1.8222	1.8941	1.9016
INCOME DIFFERENCE	0.0057[a]	0.0053[a]	0.0049[a]	0.0021[c]	0.0021[c]	0.0018
	0.0012	0.0012	0.0010	0.0011	0.0012	0.0013
CONTROL	0.3107					
	0.5107					
CONTROL(−1)		0.4921				
		0.4758				
CONTROL(−2)			0.5923			
			0.3838			
CUMULATIVE (5 percent)				0.3029[a]		
				0.0606		
CUMULATIVE (10 percent)					0.3576[a]	
					0.0825	
CUMULATIVE (15 percent)						0.4623[a]
						0.1094
CONSTANT	31.230[a]	30.132[a]	29.180[a]	23.174[a]	22.793[a]	21.399[a]
	6.0678	6.1135	5.0301	4.1714	4.6426	4.9435
Adjusted R^2	0.704	0.713	0.796	0.850	0.829	0.825
Mean dependent variable	24.17	24.17	24.78	24.17	24.17	24.17
F	22.46	23.34	34.90	52.07	44.55	43.37
Ljung-Box Q (lag = 1)	5.71[b]	5.79[a]	11.07[a]	2.26	1.19	0.97
Ljung-Box Q (lag = 2)	9.38[a]	9.27[a]	13.11[a]	4.36	2.85	2.44
Ljung-Box Q (lag = 3)	9.59[b]	9.43[a]	13.17[a]	4.36	2.95	2.54
Observations	28	28	27	28	28	28

a, b, c. Significant (two-tailed test) at 1, 5, and 10 percent levels, respectively. Standard errors are below the coefficient estimate.

Table 4
Media Effects on Cigarette Sales in United States Less California

Explanatory Variables	(1)	(2)	(3)	(4)	(5)	(6)
PRICE DIFFERENCE	−0.1515	−0.1548	−0.0629	−0.1349	−0.1573	−0.1533
	0.1093	0.1043	3.3104	0.1005	0.0991	0.0996
SMUGGLING	−2.0469	−2.1377	1.2725	−2.3676	−2.7213	−2.4667
	4.4586	4.4387	3.3104	4.2738	4.3411	4.3268
INCOME DIFFERENCE	0.0034[a]	0.0032[a]	0.0032[a]	0.0030[a]	0.0030[a]	0.0029[a]
	0.0010	0.0010	0.0008	0.0010	0.0010	0.0010
BAN	5.4022[c]	5.2059[c]	5.5306[a]	0.7859	1.3704	1.6255
	2.7462	2.7017	1.8814	4.1962	4.2298	4.0956
MEDIACONTROL	1.8025					
	3.5596					
MEDIACONTROL(−1)		2.1945				
		3.2208				
MEDIACONTROL(−2)			3.2870			
			2.3766			
MEDIACUMULATIVE (5 percent)				1.1485		
				0.7622		
MEDIACUMULATIVE (10 percent)					1.2046	
					0.9043	
MEDIACUMULATIVE (15 percent)						1.4495
						1.0978
CONSTANT	30.994[a]	30.560[a]	28.564[a]	30.175[a]	30.253[a]	29.676[a]
	4.7664	4.8387	3.5816	4.5147	4.5738	4.6961
Adjusted R^2	0.824	0.836	0.896	0.839	0.835	0.835
Mean dependent variable	24.17	24.17	24.78	24.17	24.17	24.17
F	26.31	26.59	46.02	29.08	28.40	28.36
Ljung-Box Q (lag = 1)	0.69	0.61	3.08[c]	1.09	0.68	0.66
Ljung-Box Q (lag = 2)	2.11	2.23	3.61	3.10	2.72	2.67
Ljung-Box Q (lag = 3)	2.17	2.28	6.42[c]	3.11	2.72	2.68
Observations	28	28	27	28	28	28

a, b, c. Significant (two-tailed test) at 1, 5, and 10 percent levels, respectively. Standard errors are below the coefficient estimate.

Table 5
Media Effects on Cigarette Sales in United States
Less California (without bans and prices)

Explanatory Variables	(1)	(2)	(3)	(4)	(5)	(6)
SMUGGLING	1.3444	2.3692	2.8996	2.3555	2.9173	2.9173
	2.4487	2.3445	1.7896	1.8996	1.9268	1.9268
INCOME DIFFERENCE	0.0039[a]	0.0037[a]	0.0036[a]	0.0031[a]	0.0031[a]	0.0031[a]
	0.0011	0.0012	0.0010	0.0010	0.0010	0.0010
MEDIACONTROL	8.7366[a]					
	2.7738					
MEDIACONTROL(−1)		8.2771[a]				
		2.7810				
MEDIACONTROL(−2)			8.0894[a]			
			2.4112			
MEDIACUMULATIVE (5 percent)				1.5818[a]		
				0.3396		
MEDIACUMULATIVE (10 percent)					1.8671[a]	
					0.4297	
MEDIACUMULATIVE (15 percent)						1.8671[a]
						0.4297
CONSTANT	30.421[a]	29.141[a]	29.278[a]	27.316[a]	26.902[a]	26.901[a]
	4.3403	4.626	3.7314	3.8909	4.0962	4.0962
Adjusted R^2	0.78	0.78	0.84	0.84	0.83	0.83
Mean dependent variable	24.17	24.17	24.78	24.17	24.17	24.17
F	33.63	32.33	48.48	48.09	44.63	44.63
Ljung-Box Q (lag = 1)	2.19	2.26	5.77[b]	2.37	1.78	1.78
Ljung-Box Q (lag = 2)	2.93	2.87	5.82[c]	4.31	3.53	3.53
Ljung-Box Q (lag = 3)	3.00	2.89	5.78[c]	4.32	3.57	3.57
Observations	28	28	27	28	28	28

a, b, c. Significant (two-tailed test) at 1, 5, and 10 percent levels, respectively. Standard errors are below the coefficient estimate.