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September 30, 2016

Mr. Henry Jones
Chair, Investment Committee
CalPERS
400 Q Street
Sacramento, CA 95811

Dear Mr. Jones,

Thank you for the opportunity to provide information to CalPERS as part of its deliberations on whether or not to reinvest in the tobacco industry. Reinvesting in tobacco stock will be a poor long term financial choice considering the global moves towards cigarette and e-cigarette regulation. Doing so would also undermine California's longstanding tobacco control program, increasing the amount of disease and death in California. It is also at odds with CalPERS' stated investment philosophy, which is *"committed to enhanced transparency, accountability, and the highest ethical standards"*, and to ensure that member benefits are *"as enduring as the state they maintain."*[1]

The tobacco industry is in long term decline

While the tobacco industry has been able to maintain cash flow and profitability despite declining cigarette consumption in recent years by raising prices and expanding markets outside the United States, this situation appears to be coming to an end.

Domestically the cigarette companies have been able to take advantage of the fact that they are selling a highly addictive product by raising prices to maintain profits in the face of declining consumption. There are, however, limits to the efficacy of this strategy. The assumption that there is a "hard core" of smokers who will not or cannot quit is incorrect: in both the United States and Europe, as smoking prevalence has declined, the remaining smokers are smoking fewer cigarettes and making more quit attempts.[2] Continuing to push up prices will accelerate this process.

The US Surgeon General has described a series of feasible steps for eliminating tobacco use in the USA.[3]

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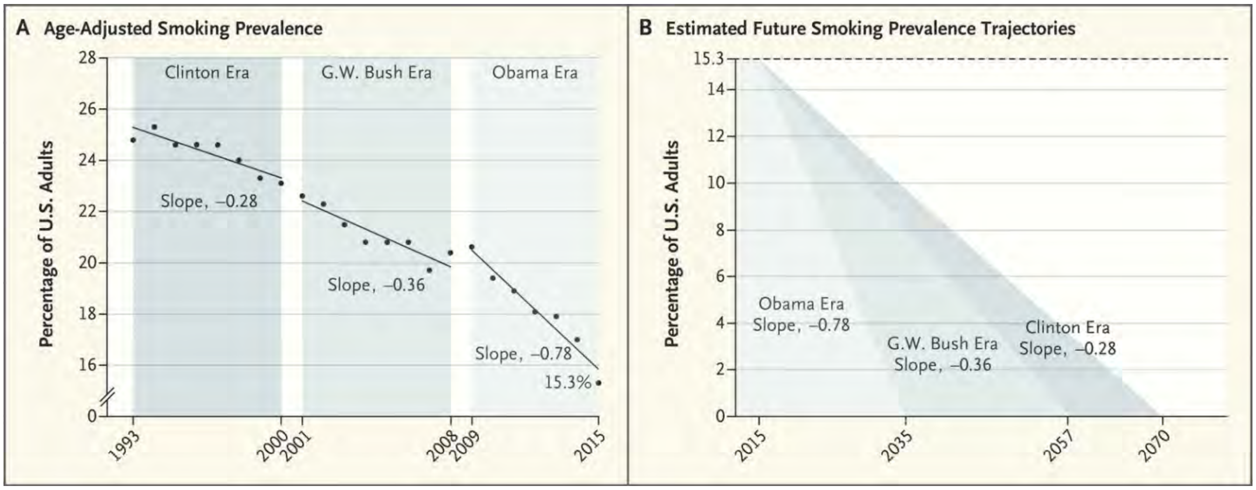
[1] CalPERS. Organization. 2016. https://www.calpers.ca.gov/page/about/organization
[2] Kulik MC, Glantz SA. The smoking population in the USA and EU is softening not hardening. Tob Control. 2016 Jul;25(4):470-5. doi: 10.1136/tobaccocontrol-2015-052329. Epub 2015 Jun 24. https://www.ncbi.nlm.nih.gov/pubmed/26108654 .
[3] The health consequences of smoking – 50 years of progress: a report of the Surgeon General. Rockville, MD 2014.

During the Obama administration, smoking prevalence has been dropping more than twice as fast as before, by approx. 0.78 percentage points per year (graphs below).[4] At this rate, it is projected that smoking rates in the USA will be down to zero by 2035. (Both major presidential candidates have expressed strong anti-tobacco positions in the past.) It is also possible that sooner than that smoking prevalence may reach a point where the behavior becomes so rare and socially unacceptable that the behavior will simply collapse.



The international market is also shrinking. One hundred eighty nations have ratified the World Health Organization Framework Convention on Tobacco Control (FCTC), which legally obligates parties to implement laws to reduce tobacco consumption.[5] Much of the pressure for the FCTC came from the low- and middle-income countries that the tobacco companies have long targeted to compensate for declining consumption in the US and other richer countries. Despite vigorous opposition from the multinational tobacco companies, the treaty ratification has been followed by more implementation of smokefree laws,[6] strong graphic health warnings,[7] advertising bans,[8] and tax increases.[9]

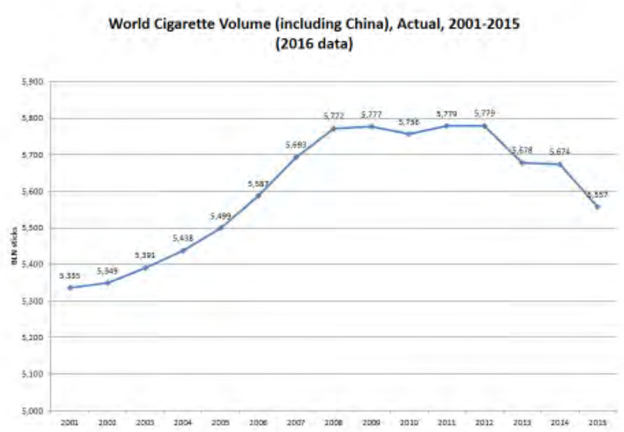
New Zealand, Finland, Scotland and Ireland have all set official targets for a smoking prevalence of 5% or less within the next 10-25 years. As noted above, there is a possibility that the behavior will simply collapse at or even above such a low prevalence. The WHO European Region, which covers 53 countries spanning from the former Soviet Union to Western Europe, has adopted

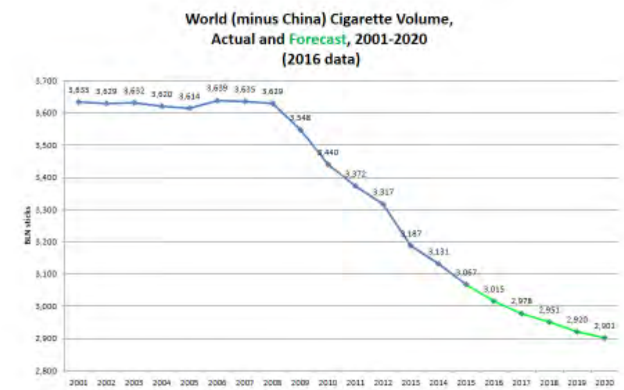
[4] Fiore MC. Tobacco control in the Obama era – substantial progress, remaining challenges. *New Engl J Med*. 2016 http://www.nejm.org/doi/full/10.1056/NEJMp1607850#t=article
[5] World Health Organization. Framework Convention on Tobacco Control. http://who.int/fctc/en/
[6] Uang R, Hiilamo H, Glantz SA. Accelerated Adoption of Smoke-Free Laws After Ratification of the World Health Organization Framework Convention on Tobacco Control. Am J Public Health. 2016 Jan;106(1):166-71. doi: 10.2105/AJPH.2015.302872. Epub 2015 Nov 12. https://www.ncbi.nlm.nih.gov/pubmed/26562125
[7] Sanders-Jackson AN1, Song AV, Hiilamo H, Glantz SA. Effect of the Framework Convention on Tobacco Control and voluntary industry health warning labels on passage of mandated cigarette warning labels from 1965 to 2012: transition probability and event history analyses. Am J Public Health. 2013 Nov;103(11):2041-7. doi: 10.2105/AJPH.2013.301324. Epub 2013 Sep 12. https://www.ncbi.nlm.nih.gov/pubmed/24028248
[8] Hiilamo H, Glantz S. FCTC followed by accelerated implementation of tobacco advertising bans. Tob Control. 2016 Jul 28. pii: tobaccocontrol-2016-053007. doi: 10.1136/tobaccocontrol-2016-053007. [Epub ahead of print] https://www.ncbi.nlm.nih.gov/pubmed/27471111
[9] Hiilamo H, Glantz S. FCTC followed by tax increases, but implementation remains incomplete. (manuscript in peer review)

a Roadmap of Actions to make tobacco use a thing of the past in the entire Region,[10] while the WHO Pacific Region aims to push smoking prevalence below 5% by 2025.[11]

These targets are feasible and the policies are working. Global cigarette consumption, after steadily increasing for decades, is now declining. Globally, the volume of world cigarette sales stopped growing in 2008 and started dropping in 2012, rolling back below 2006 levels in 2015.[12]

If we exclude the Chinese market (which remains largely out of the reach of transnational tobacco companies that are available as CalPERS investments), the drop in global cigarette sales is even sharper: from 3,635 billion sticks (2007) to 3,067 billion sticks (2015). It is forecast to drop further, to 2,901 billion sticks in 2020 (graphs below).[13]





Tobacco companies may argue that their business is profitable and in line with public health goals due to their diversification into the e-cigarette market. However, strict regulations on e-cigarettes are fast becoming the norm (led by California). E-cigarettes are already strictly regulated in a number of countries, and further regulations are under review elsewhere.[14]

The tobacco industry undermines the health and infrastructure of California

CalPERS states that: *"To support our members, we also invest in the health and infrastructure of the Golden State itself … funding enterprises that directly influence and stimulate our state economy."*[15]

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[10] WHO Regional Office for Europe. Making tobacco a thing of the past: Roadmap of actions to strengthen implementation of the WHO Framework Convention on Tobacco Control in the European Region 2010-2025. 2015.http://www.euro.who.int/en/health-topics/disease-prevention/tobacco/publications/2015/making-tobacco-a-thing-of-the-past-roadmap-of-actions-to-strengthen-implementation-of-the-who-framework-convention-on-tobacco-control-in-the-european-region-2015-2025-2015

[11] WHO Western Pacific Region. Tobacco Free Pacific 2025. 2016. http://www.wpro.who.int/southpacific/programmes/healthy_communities/tobacco/page/en/

[12] Euromonitor data quoted by Matthew Myers, Campaign for Tobacco Free Kids.

[13] Euromonitor data quoted by Matthew Myers, Campaign for Tobacco Free Kids.

[14] Conference of the Parties to the WHO Framework Convention on Tobacco Control, 7th Session (2016) *Electronic Nicotine Delivery Systems and Electronic Non-Nicotine Delivery Systems (ENDS/ENNDS).* World Health Organization, Delhi.

[15] CalPERS. CalPERS story. 2016. https://www.calpers.ca.gov/page/about/organization/calpers-story

Investing in tobacco stocks is not a sound economic decision, not only because of the continual decline in the tobacco business but also because of the detrimental impacts that tobacco use has on the state economy. To invest in a tobacco business is to invest in a business which kills 40,000 Californians each year, with associated annual costs of over $27 billion in California as a result of increased healthcare expenditures (including the costs of insuring CalPERS members as well as state MediCal costs) as well as loss of productivity.[16] This kind of investment has obvious negative impacts on the Californian state economy, in clear conflict with CalPERS' mission to fund *"enterprises that directly influence and stimulate our state economy."*

Quite the contrary, because most money spent on tobacco products leaves the state, reductions in tobacco use will actually stimulate the economy because that money will be spent in the state.[17] Eighty cents of every dollar spent on cigarettes leaves California to tobacco companies (and a few farmers) back East. When people quit smoking, they don't burn the money, they spend it. And because less leaves the state, more of their money gets recycled in California, where it creates local economic activity and jobs. The billion dollars a year that would have not been spent on tobacco had the 2012 tax passed would have led to $1.9 billion in economic activity and 12,000 new jobs.

As outlined in the Master Plan for the California Tobacco Control Program,[18] denormalizing the tobacco industry has been a crucial element of California's successful tobacco control program since voters created it in 1988 by passing Proposition 99.

Industry denormalization is key to reducing smoking prevalence among young people,[19] and key to maintaining a healthy economy in California. Indeed, the fact that California's smoking rate is below the national average was associated with it spending $15.3 billion less on medical costs in 2009 alone.[20] Before 1998, the program was associated with a long-run price elasticity of demand of 0.3-0.7.[21] Between fiscal year 1989 and 2008, the California Tobacco Program led to cumulative savings in medical costs expenditure of $134 billion (approx. $7 billion/yr),[22] including money saved for CalPERS. California's program resulted in financial savings far higher than Arizona's tobacco control program (just over $2 billion between 1996 and 2004, or approx. $ 0.3 billion/yr), largely because Arizona's program did not focus on denormalizing the tobacco industry.[23]

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[16] Campaign for Tobacco-Free Kids. The toll of tobacco in California. 2016. https://www.tobaccofreekids.org/facts_issues/toll_us/california

[17] Glantz S. Economic Impact of the California Cancer Research Act Job Creation and Economic Activity. University of California eScholarship. 2012. http://escholarship.org/uc/item/73g8m5j5

[18] State of California Tobacco Education and Research Oversight Committee. *Changing Landscape, Countering New Threats 2015 -2017*. 2015 http://www.cdph.ca.gov/programs/tobacco/Documents/TEROC/Master%20Plan/MasterPlan_15-17.pdf

[19] Ling PM et al. The effect of support for action against the tobacco industry on smoking among young adults. *Am J Pub Health* 2007; 97(8): 1449-1456. http://ajph.aphapublications.org/doi/abs/10.2105/AJPH.2006.098806. Ling PM et al. Young adult smoking behavior: a national survey. *Am J Prev Med* 2009; 36(5): 389-94. http://www.sciencedirect.com/science/article/pii/S0749379709000956

[20] Lightwood J, Glantz SA Smoking behavior and healthcare expenditure in the United States, 1992-2009: panel data estimates. *PLoS Med* 2016; http://journals.plos.org/plosmedicine/article?id=10.1371/journal.pmed.1002020

[21] Lightwood JM, Dinno A, Glantz SA. Effect of the California tobacco control program on personal health care expenditures. PLos Medicine 2008; http://journals.plos.org/plosmedicine/article?id=10.1371/journal.pmed.0050178

[22] Lightwood J, Glantz SA. The effect of the California tobacco control program on smoking prevalence, cigarette consumption, and healthcare costs: 1989-2008. *PLoS One* 2013; http://journals.plos.org/plosone/article?id=10.1371/journal.pone.0047145

[23] Lightwood J, Glantz S. Effect of the Arizona tobacco control program on cigarette consumption and healthcare expenditures. *Social Science & Medicine* 2011; 72 (2): 166-172. http://www.sciencedirect.com/science/article/pii/S0277953610007999

Indeed, tobacco industry denormalization has been key to the $134 billion saved from tobacco control activities in California. A decision by CalPERS to reverse its current tobacco divestment policy would undermine this effort by sending a message that tobacco is a legitimate business in California, which would compromise *"the health and infrastructure of the Golden State."*

Investing in tobacco stocks is not "about people"

CalPERS states that, *"CalPERS is about people. It is about the dedicated individuals who serve, or have served, the State of California…"*[24]

To invest in tobacco stocks is to embrace interactions with an industry that kills 40,000 Californians per year and costs Californian households $ 777 per year in state and federal tax burdens from smoking-related government expenditures.[25] It undermines the efforts of the California tobacco control program and the Californians who voted to support it. This move finds no justification as being *'about people'*, and does a gross disservice to those who have worked hard to improve the health and quality of life of the people in California.

Tobacco companies are not committed to transparency, accountability and ethical standards

CalPERS states that, *"CalPERS is committed to enhanced transparency, accountability, and the highest ethical standards."*[26]

It is puzzling, then, that CalPERS is so much as considering investing in companies that are responsible for the premature deaths of 6 million people globally each year and established racketeers under the federal *Racketeer Influenced and Corrupt Organizations Act*, still under the supervision of Federal Judge Gladys Kessler. The *Sacramento Bee* summed up the situation appropriately when it wrote:

> In 2008, when the California State Teachers' Retirement System contemplated reinvesting in tobacco, then-Treasurer Bill Lockyer issued a statement that summed up why it shouldn't:
>
> "In this country, the tobacco industry has a history of fraud and disregard for public health. That culture of deception has been exported to Europe, Asia and other parts of the globe, where the industry's marketing targets children."
>
> Lockyer won then. His successor, Treasurer John Chiang, is taking the same stand, as is controller and fellow CalPERS board member Betty Yee.
>
> "No public pension fund should associate itself with an industry that is a magnet for costly litigation, reputational disdain, and government regulators around the globe," Chiang said in a statement. The rest of the CalPERS board ought to follow Chiang and Yee's lead.[27]

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[24] CalPERS. CalPERS story. 2016. https://www.calpers.ca.gov/page/about/organization/calpers-story
[25] Campaign for Tobacco-Free Kids. The toll of tobacco in California. 2016. https://www.tobaccofreekids.org/facts_issues/toll_us/california
[26] CalPERS. Organization. 2016. https://www.calpers.ca.gov/page/about/organization
[27] Editorial Board. CalPERS should not take up the tobacco habit again. *Sacramento Bee.* April 6, 2016. Available at http://www.sacbee.com/opinion/editorials/article70340952.html

In addition to these obvious issues, CalPERS needs to carefully address possible undisclosed conflicts of interest for its investment advisors, Wilshire Associates, who have also worked for Philip Morris in the past, including helping them muster arguments against divestment in the late 1990s.[28] This is particularly concerning because tobacco companies have a history of using seemingly 'independent' investment advisors to provide testimony that supports industry interests to policy makers. We know, for instance, that tobacco companies have used Wall Street analysts as third parties to support the tobacco industry's legislative agenda at both national and state levels in the USA, while these analysts present themselves as being 'independent' from tobacco companies.[29] To support an industry that regularly engages in such practices is far from CalPERS' commitment to *"enhanced transparency, accountability, and the highest ethical standards."*[30] At the very least, CalPERS needs to do a thorough investigation of conflicts of interest for Wilshire. It took me less than 5 minutes to find the two cited documents in the UCSF Truth Tobacco Documents Library (http://industrydocuments.library.ucsf.edu/tobacco).

CalPERS should conduct a comprehensive analysis of the impacts that investing in tobacco stocks would have on all of CalPERS' responsibilities. This should focus, at the very least, on maintaining its core values and mission as an organization and properly evaluating the impacts this investment would have on the State of California and its people.

At a time that the Legislature has ended years of domination by tobacco interests[31] and passed a package of five strong tobacco control bills, it is, frankly, astonishing, that CalPERS is even considering this retrograde policy.

Sincerely yours,

Stanton A. Glantz, PhD
Professor of Medicine
Truth Initiative Distinguished Professor in Tobacco Control
Director, Center for Tobacco Control Research and Education

Yvette Van Der Eijk, PhD
Postdoctoral Fellow

[28] https://www.industrydocumentslibrary.ucsf.edu/tobacco/docs/#id=jnjn0071 and https://www.industrydocumentslibrary.ucsf.edu/tobacco/docs/#id=mnjn0071

[29] Alamar BC, Glantz SA. The tobacco industry's use of Wall Street analysts in shaping policy. *Tob Control* 2004; 13(3):223-7. http://www.ncbi.nlm.nih.gov/pubmed/15333876

[30] CalPERS. 2016. Organization. 2016. https://www.calpers.ca.gov/page/about/organization

[31] Cox E, Barry R, Glantz S, Barnes RL (2014) *Tobacco Control in California, 2007-2014: A Resurgent Tobacco Industry While Inflation Erodes the California Tobacco Control Program.* UCSF Center for Tobacco Control Research and Education. http://escholarship.org/uc/item/4jj1v7tv

The Future of the Tobacco Industry

Stanton A. Glantz, PhD
Professor of Medicine
Director, Center for Tobacco Control Research and Education

Past performance is not a guarantee of future returns

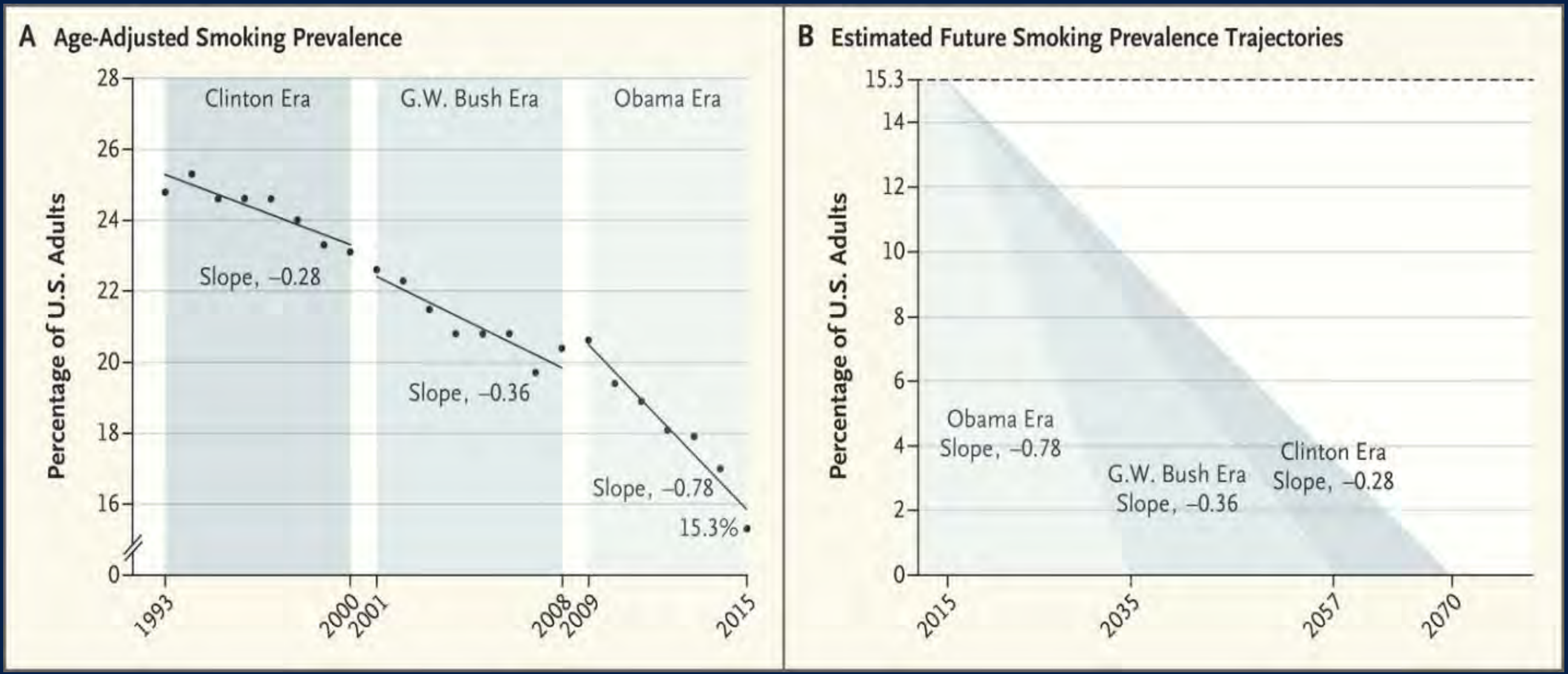
The tobacco industry has maintained profits

- Unethical behavior
  - Child labor
  - Environmental destruction
  - Political corruption
- Selling an addictive product
  - As consumption drops raise prices
  - But there are limits

Californians passed Proposition 56

- 63% yes
- Despite $71 million campaign by Philip Morris, RJ Reynolds, and other tobacco interests
- Will cut cigarette sales by $250 million a year
- Will quadruple California Tobacco Control Program
  - Industry denormalization is a key theme
- Will save $1 billion a year in health costs
- California could be a smokefree society in 5 years
- Will set global example

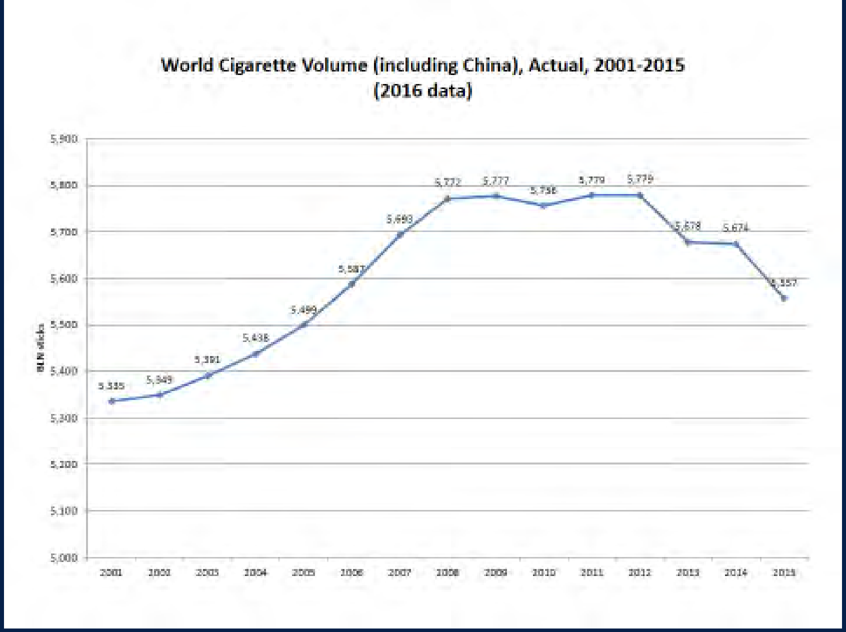
Tobacco sales falling in USA

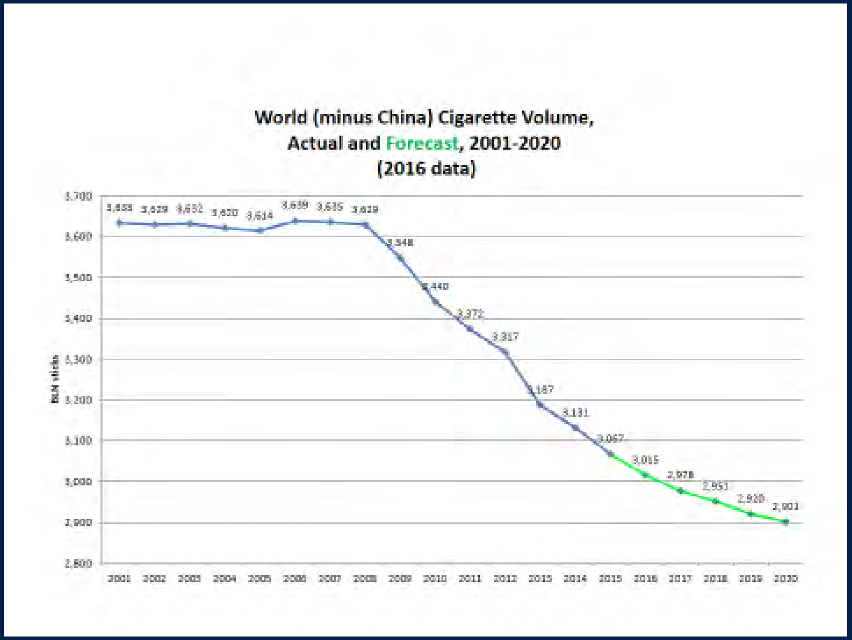


Source: Fiore, *NEJM* 2016

And Globally

- WHO Framework Convention on Tobacco Control





Investors are noticing

- October 2016

DJIA ▲ 18759.42 0.91% U.S. 10 Yr ▼ -15/32 Yield 2.118% Euro ▼ 1.0875 -0.33%

THE WALL STREET JOURNAL.

BUSINESS | EARNINGS

Philip Morris Earnings Flat as Cigarette Shipments Decline

International seller of Marlboro cigarettes hampered by antismoking rulings in Europe

By JOSHUA JAMERSON

Oct. 18, 2016 7:41 a.m. ET

Philip Morris International Inc. reported no earnings growth in the latest quarter as shipment volume declined in its geographic segments except Europe, where shipments increased slightly.

Philip Morris, which sells the leading Marlboro brand and others internationally, had seen its cigarette volumes grow amid an improving

BUSINESS INSIDER MARKETS

The maker of Camel and Newport cigarettes is sinking after saying it expects to sell fewer cigarettes next year

Bob Bryan

Oct. 19, 2016, 10:38 AM 1,007

FACEBOOK LINKEDIN TWITTER

Reynolds American, the parent company of cigarette brands such as Camel, Pall Mall, and Newport, is sinking in trading on Wednesday after the firm missed on earnings and announced its CEO is stepping down.

PLOS | MEDICINE

RESEARCH ARTICLE

Smoking Behavior and Healthcare Expenditure in the United States, 1992–2009: Panel Data Estimates

James Lightwood[1,2], **Stanton A. Glantz**[2,3,4]*

1 School of Pharmacy, University of California, San Francisco, San Francisco, California, United States of America, **2** Center for Tobacco Control Research and Education, University of California, San Francisco, San Francisco, California, United States of America, **3** Division of Cardiology, Department of Medicine, University of California, San Francisco, San Francisco, California, United States of America, **4** Philip R. Lee Institute for Health Policy Studies, University of California, San Francisco, San Francisco, San Francisco, California, United States of America

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Abstract

Background

Reductions in smoking in Arizona and California have been shown to be associated with reduced per capita healthcare expenditures in these states compared to control populations in the rest of the US. This paper extends that analysis to all states and estimates changes in healthcare expenditure attributable to changes in aggregate measures of smoking behavior in all states.

Methods and Findings

State per capita healthcare expenditure is modeled as a function of current smoking prevalence, mean cigarette consumption per smoker, other demographic and economic factors, and cross-sectional time trends using a fixed effects panel data regression on annual time series data for each the 50 states and the District of Columbia for the years 1992 through 2009. We found that 1% relative reductions in current smoking prevalence and mean packs smoked per current smoker are associated with 0.118% (standard error [SE] 0.0259%, $p < 0.001$) and 0.108% (SE 0.0253%, $p < 0.001$) reductions in per capita healthcare expenditure (elasticities). The results of this study are subject to the limitations of analysis of aggregate observational data, particularly that a study of this nature that uses aggregate data and a relatively small sample size cannot, by itself, establish a causal connection between smoking behavior and healthcare costs. Historical regional variations in smoking behavior (including those due to the effects of state tobacco control programs, smoking restrictions, and differences in taxation) are associated with substantial differences in per capita healthcare expenditures across the United States. Those regions (and the states in them) that have lower smoking have substantially lower medical costs. Likewise, those that have higher smoking have higher medical costs. Sensitivity analysis confirmed that these results are robust.

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Citation: Lightwood J, Glantz SA (2016) Smoking Behavior and Healthcare Expenditure in the United States, 1992–2009: Panel Data Estimates. PLoS Med 13(5): e1002020. doi:10.1371/journal.pmed.1002020

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Data Availability Statement: The cross-sectional time series data on smoking, healthcare costs, and demographics for the 50 states and District of Columbia are publicly available and the sources are detailed in the Methods section of the paper.

Funding: This work was funded by National Cancer Institute grant CA-61021, in part through an interagency agreement with the Centers for Disease Control and Prevention Office on Smoking and Health. The CDC Office on Smoking and Health arranged a meeting with several experts on time series analysis of panel data nonstationary processes to advise the authors on methodological issues. Neither those experts nor the funding agencies played any role in the design of the final analysis, data collection and analysis, decision to publish, or preparation of the manuscript.

Competing Interests: The authors have declared that no competing interests exist.

Abbreviations: BEA, US Bureau of Economic Analysis; BRFSS, Behavioral Risk Factor Surveillance System; CCE, common correlated effects; CMS, Centers for Medicare and Medicaid Services; SE, standard error.

Conclusions

Changes in healthcare expenditure appear quickly after changes in smoking behavior. A 10% relative drop in smoking in every state is predicted to be followed by an expected $63 billion reduction (in 2012 US dollars) in healthcare expenditure the next year. State and national policies that reduce smoking should be part of short term healthcare cost containment.

Author Summary

Why Was This Study Done?

- There have been many estimates of the medical costs of smoking at both the national and state levels, but these estimates do not capture the changes in health care expenditure over time that are associated with changes in smoking behavior and the effects of tobacco control programs.
- Estimates from California and Arizona have shown that medical savings accrue quickly as the prevalence and intensity of smoking decreases, when adjusted for the history of smoking reduction and tobacco control program activity in the United States.

What Did the Researchers Do and Find?

- This study examined the year-to-year relationship between changes in smoking and changes in medical costs for the entire United States, taking into account differences between different states and historical national trends in smoking behavior and healthcare expenditures.
- The study found that 1% relative reductions in current smoking prevalence and mean packs smoked per current smoker are associated with 0.118% and 0.108% reductions, respectively, in per capita healthcare expenditure (elasticities).
- Historical regional variations in smoking behavior (including those due to the effects of state tobacco control programs, smoking restrictions, and differences in cigarette taxation rates) are associated with substantial differences in per capita healthcare expenditures across the United States.
- A 10% relative drop in smoking in every state is predicted to be followed by a $63 billion reduction (in 2012 US dollars) in healthcare expenditure the next year.

What Do These Findings Mean?

- Changes in healthcare costs appear quickly after changes in smoking behavior.
- State and national policies that reduce smoking should be part of short term healthcare cost containment.

Introduction

Smoking causes a wide range of diseases, including cardiovascular and pulmonary disease, complications of pregnancy, and cancers [1,2]. While the risks for some of these diseases, such as cancer, evolve over a period of years when people start and stop smoking, the risks for other diseases begin to change within days or months following changes in smoking behavior. For example, the risk of heart attack and stroke fall by about half in the first year after smoking cessation [3], and the risk of having a low birth weight infant due to smoking almost entirely disappears if a pregnant woman quits smoking during the first trimester [4]. There is a substantial literature showing that reductions in smoking behavior have substantial short and long run health benefits that reduce real per capita healthcare expenditures, beginning with reductions in cardiovascular disease, particularly heart attack and stroke [3], and respiratory disease [5]. Smoking cessation and reduction in secondhand smoke exposure in pregnant women, mothers, and children produce both very short run and long run reductions in healthcare expenditures [4,6]. The 2014 Surgeon General's report *The Health Consequences of Smoking—50 Years of Progress* ([1], pp. 435–443) summarized 59 studies that reported immediate (often within 1 mo) 10%–20% drops in hospital admissions for acute myocardial infarction, other cardiac events, stroke, asthma, and other pulmonary events following implementation of smoke-free laws. These benefits extend to the elderly population [7], complications of pregnancy [8], and young children [8,9] and grow with time as the effects on slower-evolving diseases, such as cancer [10,11], emerge.

Previous research found that increases in per capita funding for population-based tobacco control programs in California [12,13] and Arizona [14] were associated with reductions in cigarette consumption and, in turn, with reductions in per capita healthcare expenditure in those states compared to control populations in the rest of the United States. These studies reached similar conclusions using two different aggregate measures of population smoking behavior: (1) per capita cigarette consumption in California and Arizona [12,14] and (2) smoking prevalence and cigarette consumption per smoker in California [13]. This paper extends the second approach to estimate the link between smoking behavior and healthcare expenditure for the entire United States.

Methods

This paper estimates how much on average a 1% relative reduction in smoking prevalence in a US state reduces health costs in that state a year later. The analysis estimates this association (elasticity) while controlling for the effects of a variety of other differences between states that may produce a spurious association between reduction in smoking prevalence and reduced health expenditure, e.g., changes in population composition and other health behaviors that may also reduce health expenditure. To obtain this estimate for each state, we use a regression approach, with various refinements that take account of correlated time series. In the main and supplemental sensitivity analysis, we control—as much as possible when using state aggregated data—for the effects of other variables that may influence health care expenditure at the state level in addition to smoking (e.g., demographic factors, such as population age composition and ethnic composition; other health risk behaviors in the population, such as alcohol use; and obesity). We also control for the possible effects of unmeasured variables (e.g., cross-state cigarette purchases) on the validity of the measure of cigarette consumption per smoker in each state.

The dependent variable in the regression model (Fig 1) is real (inflation-adjusted) annual per capita healthcare expenditure (including both public and private payers). The independent

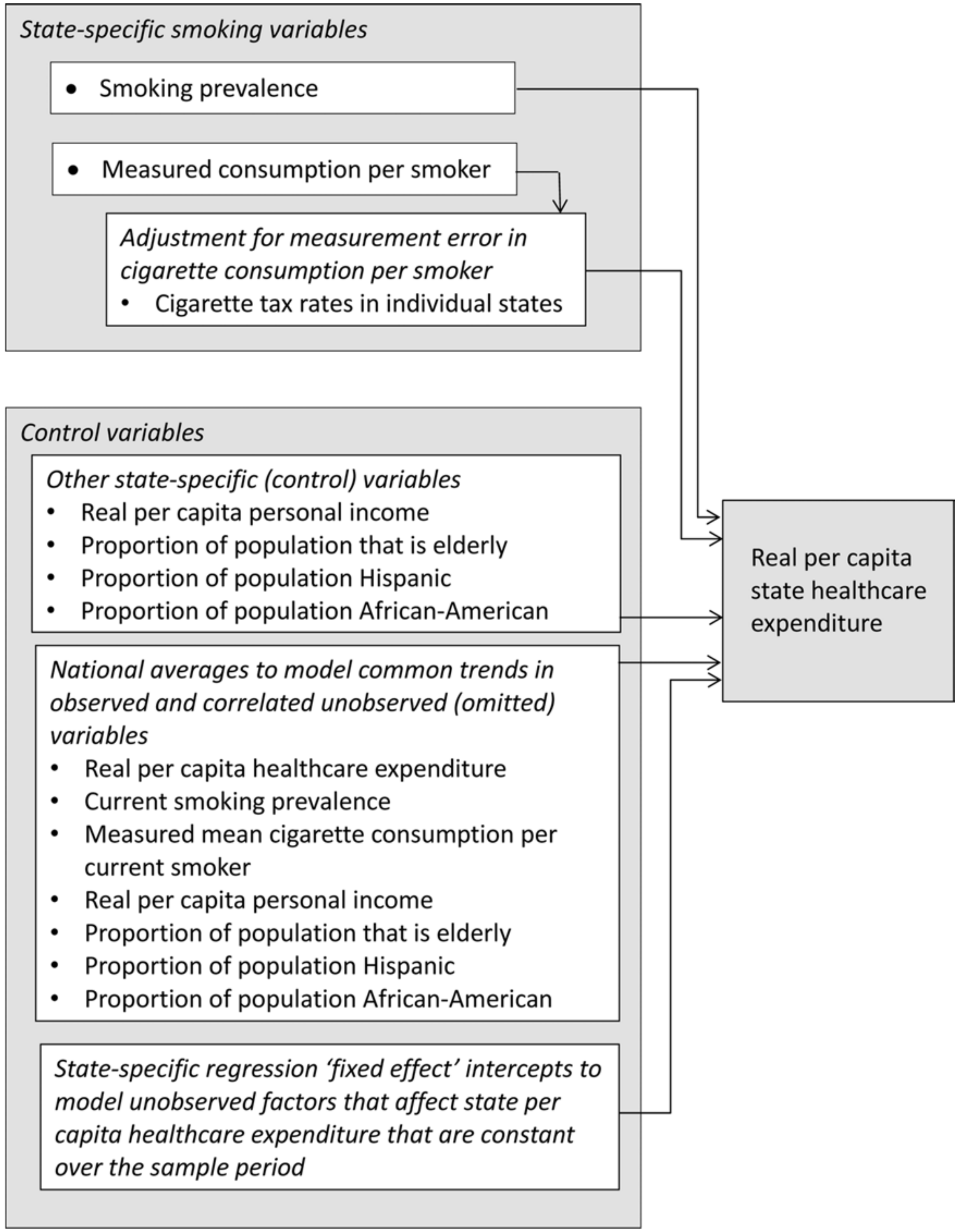

Fig 1. Real annual per capita state healthcare expenditure in each of the 50 states and the District of Columbia modeled as a function of smoking behavior (current smoking prevalence and mean annual cigarette consumption per smoker). Because available data on mean consumption per smoker may be contaminated with measurement error that increases over the sample period due to increasing interstate tax differentials, the individual state cigarette tax rates are included to adjust for the effects of this possible measurement error. Other state-specific control variables that might affect per capita healthcare expenditure are included. To account for long run trends in healthcare expenditure that are correlated with the observed state-specific explanatory variables as well other correlated but unobserved trends, the national averages of the dependent and explanatory variables are included in the regression. Finally, state-specific intercepts are included in the regression to model regional and state-specific factors that may affect

state healthcare expenditure and that remain constant over the sample period. All the independent (explanatory) variables are lagged by 1 y.

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(explanatory) variables include two state-specific measures of smoking behavior (prevalence of current smoking and mean cigarette consumption per current smoker) as well as other state-specific factors that could affect healthcare expenditure (real per capita income, proportion of the population that is elderly, proportion of the population that is Hispanic, and proportion of the population that is African-American). Finally, state-specific intercepts were included in the regression to account for other factors that affect state healthcare expenditure that, while constant over time, could differ across states.

Measures of smoking behavior, the other population factors we are considering, and healthcare costs change over time unpredictably because of changes in technology, access to care, and the nature of the population itself. From a statistical perspective, that means that the underlying process is nonstationary, and we need to account for this in the analysis. To do so, we also include the national cross-sectional averages of the dependent and independent variables as independent variables in the regression equation to account for their long run trends and trends in other correlated but unobservable variables associated with per capita healthcare expenditure that vary over the sample period [15–17]. Examples of overall national trends in per capita healthcare expenditure that are difficult or impossible to measure include developments in medical technology and the economic, regulatory, legal, or legislative environment that affect access to care and therefore utilization. Including the overall national trends as independent variables means that the regression coefficients for the state-specific explanatory variables are interpreted as the effects of the variation of the state-specific variables around the overall trends included in the model. For example, the coefficient of the prevalence of current smoking in each state can be interpreted as the effect of the departure of prevalence of smoking in that state from the overall national trend in prevalence of smoking on that state's per capita healthcare expenditure, after accounting for all the national trends included in the model.

There is also a possibility that the reported cigarette sales in a state (which we used to estimate annual per smoker cigarette consumption) might not be equal to the numbers of cigarettes smoked in a state. To adjust for possible measurement error in mean cigarette consumption per smoker, state-specific cigarette tax rates are also included in the regression model (Fig 1).

The independent variables are taken from the year before the healthcare expenditure data (i.e., lagged by 1 y), to allow for time for the independent variables to affect healthcare expenditure.

Data

The estimated effects of smoking on healthcare costs are based on cross-sectional time series (panel) data on smoking, healthcare costs, and demographics for the 50 states and the District of Columbia (considered and referred to hereafter as 51 "states") for the years 1992 through 2009.

Healthcare expenditures. The main results use the Centers for Medicare and Medicaid Services (CMS) estimates of total (public and private payer) healthcare expenditure by state of residence [18]. We chose the CMS state of residence measure because it measures healthcare expenditures consumed by residents of each state, rather than the expenditure of healthcare providers located in each state regardless of the state of the recipient. Previous research [12–14] used aggregate state data for California or Arizona compared to an aggregate population from many control states, and there was no practical or statistically significant difference in regression results using the resident- and provider-based measures. State per capita healthcare expenditure was calculated by dividing total real state expenditure by the state resident population from the US Census Bureau.

Smoking behavior. Prevalence of current smoking and state and federal cigarette tax data were from the Behavioral Risk Factor Surveillance System (BRFSS) provided by the Centers for Disease Control and Prevention (CDC) State Tobacco Activities Tracking and Evaluation (STATE) System [19]. State-specific per capita cigarette consumption and cigarette tax rates were from the *The Tax Burden on Tobacco* [20] provided by the CDC STATE System [19]. Cigarette consumption per smoker was calculated by dividing per capita cigarette consumption for each state's resident population by current smoking prevalence from the US Census Bureau.

Demographic control variables. Total state resident population data and the proportion of state resident population age 65 y or older were from the US Census Bureau [21–23]. The proportion of the population that is Hispanic and African-American was calculated from the BRFSS survey data [24]. The proportion of the population by race and ethnicity, used for sensitivity analysis, was calculated from the BRFSS data [24] rather than census data because complete data using consistent definitions were not available from the US Census Bureau over the whole sample period, and the effects of the adjustments following the decadal census on the annual census population estimates by race and ethnicity are so large that the estimates cannot be used in regression analysis without introducing spurious results due to breaks in the model-based trends across census years. State per capita personal income was taken from the US Bureau of Economic Analysis (BEA) regional economic accounts [25].

Adjusting for inflation. All monetary values are expressed in year 2010 US dollars using the regional medical care (for healthcare expenditures) and regional all-item (for cigarette taxes and personal income) Consumer Price Index for All Urban Consumers (CPI-U) [26].

Missing data. There were up to 18 annual observations for the individual 51 states, making 918 data points. There are only 27 missing data points (2.9%) because of individual states not participating in the BRFSS in some years. All but three missing observations are due to delayed entry of 11 states into the BRFSS or a BRFSS component. Fisher's exact test and continuity-corrected Spearman's and Kendall's tau-a correlation coefficients were used to evaluate the association between the presence and length of lagged state entry into BRFSS and each state's smoking behavior and socio-demographics used in the analysis, state population, and geographic region. No statistically significant geographical or socio-demographic or economic relationships were found to explain the patterns of delayed entry among the states, so we consider the missing observations to be missing completely at random.

Model

The regression model explains state per capita healthcare expenditure as a function of state per capita income, population age structure (proportion of the population that is elderly), proportion of the population that is African-American, proportion of the population that is Hispanic, and additional control variables that describe national trends in health care expenditure, such as changes in medical technology and the market for health care. Other variables that may affect the results were missing for some years and states, such as prevalence of insurance coverage and prevalence of other health risks (e.g., obesity and high blood pressure). A sensitivity analysis (detailed in S1 Text, Sensitivity Analyses) to determine whether inclusion of these variables would change the estimates substantially was conducted on the available observations.

Previous research compared smoking behaviors and per capita healthcare expenditures in California [12,13] and Arizona [14] to various control populations in the United States. Instead of selecting a distinct control population, this model uses the pooled common correlated effects (CCE) fixed effects estimator [15–17] on annual time series data for each of 51 cross-sectional units (the 51 states). The CCE fixed effects estimator uses the national cross-sectional averages (the arithmetic average of the 51 state-specific values for each year) of the dependent and explanatory variables to control for national trends in per capita healthcare expenditure, the other explanatory variables, and any correlated but unobservable common trends.

The model used for these national estimates has two parts (Fig 1). The details of the model appear in S1 Text (Detailed Description of the Model). The first part of the model is a first order autoregression (i.e., a regression that uses explanatory variables that are lagged one period) that models the effect of smoking behavior, adjusted for other explanatory variables, on state residential per capita healthcare expenditure. The first part of the model assumes that individual mean state cigarette consumption per smoker is observed without measurement error.

The natural logarithm of state per capita healthcare expenditure in each state is explained using the lagged natural logarithms of state smoking prevalence, mean cigarette consumption per smoker, per capita income, and several demographic variables and the lagged natural logarithms of their associated national averages across all the states. Using logarithms in this way yields regression coefficients that are interpreted as elasticities, which are dimensionless constants that give the percent change in the dependent variable associated with a 1% (relative) change in each explanatory variable. The logarithmic transformation produced better behaved residuals for individual state data than the linear specifications used in earlier work [12–14].

The second part of the model adds an adjustment for possible measurement error in individual state observations of mean cigarette consumption per smoker due to untaxed cigarette consumption induced by differences in state cigarette taxes. A state-specific model for this type of measurement error (that would use different coefficients for each of the 51 states) led to severe multicollinearity and model specification problems, so the eight BEA economic regions were chosen as the most appropriate grouping for modeling variations in the effect of the individual state-specific cigarette tax rates over time. In particular, we retained information on individual state variation in cigarette tax rates while restricting the associated coefficients' values regionally. The BEA regions were chosen for the regional pattern of cigarette tax adjustment effects because the BEA regions reflect economically homogenous groups of states [27]. (The BEA regions are New England, Mideast, Great Lakes, Plains, Southeast, Southwest, Rocky Mountain, and Far West; the component states are listed in the first table in S1 Text.) Each individual state tax rate is assumed to have the same effect on unmeasured cigarette consumption within each BEA region, but this effect was allowed to vary across BEA regions. The implicit assumption used in choosing regional coefficients for the tax variables but not for other variables is that regional characteristics that affect unmeasured consumption (such as average size of state, distance from population centers to state borders, and cross-border commuting and other travel patterns) vary more by region than the relationship between the other explanatory variables and healthcare expenditure. This assumption was relaxed in one of the sensitivity analyses reported in S1 Text (Sensitivity Analyses).

Sensitivity Analysis

Several sensitivity analyses were conducted to check the possibility that the estimates that attribute changes in population health to smoking are related to other risk factors than smoking (and secondhand smoke exposure). The results of these sensitivity analyses are summarized below. Detailed results appear in S1 Text (Sensitivity Analyses).

Other health risk factors. The prevalence of other health risk factors were measured in the BRFSS surveys (prevalence of high blood pressure and high cholesterol among

Table 1. Final regression results, Centers for Medicare and Medicaid Services state resident healthcare expenditure, 1992–2009.

Description of Variable	Variable	Coefficient (Elasticity)	Standard Error	*p*-Value
Prevalence of smoking	$\ln(s_{i,\ t-1})$	0.118	0.0259	<0.001
Cigarette consumption per smoker	$\ln(\mathrm{cps}_{m,\ i,\ t-1})$	0.108	0.0253	<0.001
Per capita personal income	$\ln(y_{i,\ t-1})$	0.224	0.0674	0.001
Percent of population age $\geq$ 65 y	$\ln(a_{i,\ t-1})$	0.530	0.0936	<0.001
Percent of population Hispanic	$\ln(\mathrm{hs}_{i,\ t-1})$	0.0108	0.00763	0.156
Percent of population African-American	$\ln(b_{i,\ t-1})$	0.0130	0.00632	0.039
Cigarette tax, New England	$\ln(\mathrm{tx}_{i,\ \mathrm{NE},\ t-1})$	0.0477	0.0103	<0.001
Cigarette tax, Mideast	$\ln(\mathrm{tx}_{i,\ \mathrm{ME},\ t-1})$	0.0203	0.0106	0.056
Cigarette tax, Great Lakes	$\ln(\mathrm{tx}_{i,\ \mathrm{GL},\ t-1})$	−0.00662	0.0151	0.660
Cigarette tax, Plains	$\ln(\mathrm{tx}_{i,\ \mathrm{PL},\ t-1})$	0.0358	0.0179	0.045
Cigarette tax, Southeast	$\ln(\mathrm{tx}_{i,\ \mathrm{SE},\ t-1})$	0.0190	0.0229	0.418
Cigarette tax, Southwest	$\ln(\mathrm{tx}_{i,\ \mathrm{SW},\ t-1})$	5.45×10^{-7}	0.0248	1.00
Cigarette tax, Rocky Mountain	$\ln(\mathrm{tx}_{i,\ \mathrm{RM},\ t-1})$	−0.0108	0.0131	0.409
Cigarette tax, Far West	$\ln(\mathrm{tx}_{i,\ \mathrm{FW},\ t-1})$	0.0178	0.0312	0.568
National average per capita healthcare expenditure	$\ln(\mathrm{hr}_{\mathrm{ue},\ t-1})$	0.864	0.0959	<0.001
Principal component term*	$\mathrm{pc3}_{\mathrm{ue},\ t-1}$	−0.564	0.132	<0.001

* The "principal component term" is the third principal component of the cross-sectional average terms other than per capita healthcare expenditure. It was the only principal component that entered the regression at the 5% significance level.

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respondentswho had those checked, prevalence of abusive drinking, no insurance coverage, no regular exercise, diabetes, and obesity), and these prevalence estimates were all added to the final model (Table 1), both singly and simultaneously. Inclusion of other health risk factors produced elasticity estimates that were almost identical to those shown in the final model in Table 1. In keeping with the CCE modeling strategy, these factors were added to the model as state-specific and cross-sectional trend variables. None of the variables approached statistical significance when entered into the model together or one by one (S1 Text, Sensitivity Analyses). Many states did not have observations on the other health risk factors for all years, so including these variables caused instability in the residual diagnostics. Therefore, these variables were omitted from the final analysis.

Public policies that affect smoking behavior. Changes in smoking behavior may be correlated to other public health measures and general population awareness of healthy lifestyles, environmental health, and public policies that affect access to care. A sensitivity analysis of possible confounding by these factors was conducted by adding available time series variables that would be correlated with these factors, in the same way as was done for other health risks (S1 Text, Sensitivity Analyses). Variables describing the proportion of each state population that was covered by 100% smoke-free laws (i.e., complete smoking bans at specific venues, such as workplace, restaurants, etc.) and prevalence of lack of health insurance were added to the model in this sensitivity analysis.

Other factors. Consistent time series are not available for other factors that may be correlated with unmeasured changes in health risks or public health programs and policies. Perhaps the most prominent such variable is educational attainment in the population. A robustness check of the omission of this variable was conducted by studying the stability of relative state levels of educational attainment across time. Another robustness check was conducted by estimating the correlation over time between state educational attainment and a variable that should be highly correlated: state real per capita personal income.

Sensitivity to selection of estimation technique. Additional sensitivity analyses were conducted to evaluate the results of instrumental variable estimation for cigarette consumption per smoker by including instruments for the variables mean consumption per smoker, prevalence of cigarette smoking, per capita income, and proportion of the population age 65 y or older (S1 Text, Sensitivity Analysis). Sensitivity analyses were also conducted to account for possible correlation in healthcare expenditure between states due to unobserved factors and for other departures from standard assumptions on regression errors.

Estimated Change in Regional Healthcare Expenditures Attributable to Smoking

The estimated elasticities in Table 1 were used to estimate the net average annual BEA regional healthcare expenditure attributable to regional cigarette smoking behavior deviations from the national average over the sample period. The unit of observation and analysis is the individual state. Therefore, the estimated changes in state expenditures were aggregated to the regional level using equal weights to calculate the aggregate results for the eight BEA economic regions. Using equal weights gives the average experience of each state in the region, which is relevant for evaluation of policy at the state level. The estimates of population-weighted changes presented in S1 Text (Effect of Weighting Scheme on Regional Healthcare Expenditures Attributable to Smoking) were used as a measure of changes in expenditure for the regional populations. The national panel regression coefficients were used for this analysis (Table 1) because eight estimates of coefficients in the model (one for each BEA region) were more reliable than 51 estimates (one for each state, with a small sample size for each regional panel regression—less than 20—for each state).

Deviations in per capita healthcare expenditures from the average national level (savings below or excess expenditures above) were calculated for each state in four steps, and then aggregated to the BEA regional level. First, for each state, the arc elasticity estimate of the deviation in state healthcare expenditure attributable to the two smoking behavior variables were calculated by multiplying the estimated elasticities of per capita healthcare for prevalence of current smoking and measured mean cigarette consumption per smoker by the average percent difference between the respective individual state and national averages of the smoking behavior variables over the sample period. The elasticities estimated in the coefficients are valid for modeling the effect of infinitesimal changes in the explanatory variables; the arc elasticity is an adjustment to account for finite differences in the data. Second, the adjustments to per capita healthcare expenditures due to state tax differentials were calculated in the same way: arc elasticities for the tax rates were calculated by multiplying the estimated elasticities of healthcare expenditure by the average percent difference between the respective individual state and national averages of the state cigarette tax variables over the sample period. Third, the net regional healthcare expenditure attributable to smoking adjusted for mismeasurement was calculated for each state by subtracting the results of the second step from the results of the first step, by state. Fourth, the excess per capita expenditures for each BEA region were calculated by taking the simple arithmetic average of each state in each respective region. Total aggregate values for each state and region were calculated by multiplying the state or regional per capita estimates by the state or regional residential populations.

As a check on the reasonableness of the results, the proportion of measured cigarette consumption per smoker due to estimated untaxed consumption was calculated. The calculation was done by dividing the healthcare expenditure due to tax differentials—and therefore attributable to mismeasurement of cigarette consumption (found in step two above)—by the average regional price of cigarettes to calculate the estimated unmeasured consumption in packs of cigarettes per capita. Estimated unmeasured consumption in packs of cigarettes per capita was then divided by the prevalence of current smokers to calculate the estimated unmeasured consumption in terms of packs per smoker. Then the estimated unmeasured consumption in terms of packs per smoker was divided by the measured mean cigarette consumption per current smoker to estimate the estimated unmeasured consumption as a proportion of measured consumption. This estimate gives the proportion of measured cigarette consumption in each region, which can be compared to survey estimates of the proportion of untaxed cigarettes consumed in the United States [28] and specific regions [29] to check the adequacy of our adjustment for measurement error in cigarette consumption and the plausibility of the resulting estimates of untaxed cigarette consumption.

Interval estimates for the excess expenditures and proportion of measured cigarette consumption that is untaxed were calculated using the covariance matrix of the elasticities (which for the logarithmic transformation is the same as the covariance matrix of coefficient matrix of the regression coefficients). The distributions of excess expenditures and proportion of unmeasured cigarette consumption were normally distributed, so formulas for the variances of functions of normal distributions were used to calculate standard errors (SEs).

Because we used the estimated elasticities to calculate the healthcare expenditure attributable to differences in smoking behavior, the estimates are independent of the sample distributions of the other variables in the model. The results can be thought of as quantifying the effects of changes in smoking behavior while holding all the other variables, such as per capita personal income and age distribution of the population, constant.

Results

The elasticities of healthcare expenditure with respect to smoking prevalence and measured mean cigarette consumption per smoker are 0.118 (SE 0.0259, $p < 0.001$) and 0.108 (SE 0.0253, $p < 0.001$), respectively (Table 1). What these elasticities mean is that 1% relative reductions in current smoking prevalence and in packs smoked per current smoker are associated with relative reductions of 0.118% and 0.108% of per capita healthcare expenditures, respectively. For example, the average prevalence of smoking, consumption per smoker, and per capita healthcare expenditure over the sample period were 21.2%, 372 packs per year, and $6,426, respectively. A 1% relative reduction in smoking prevalence from an absolute prevalence of 21.2% to 21.0% is associated with a $7.58 reduction in per capita healthcare expenditure. Likewise, a 5% relative drop in smoking prevalence (from 21.2% to 20.1% absolute prevalence) is associated with a reduction in per capita healthcare expenditure of $37.9. A 1% relative reduction in consumption per smoker from 372 packs per year to 368 packs per year is associated with a $6.94 reduction in per capita healthcare expenditure. A 5% relative drop in consumption per smoker (from 372 packs per smoker per year to 353 packs per year) is associated with a reduction in per capita healthcare expenditure of $34.7. The R^2 statistics indicate that the regression has good explanatory power, particularly for describing variations in per capita healthcare expenditure within each state over time (Table 2).

These estimates of decline in per capita healthcare expenditure associated with changes in smoking behavior are counterfactual predictions that assume that all other factors other than smoking behavior remain constant. The actual observed changes in healthcare expenditure in future years will also depend on additional state-specific variables such as per capita income and age structure of the population, in addition to their evolution via common trends across states.

Sensitivity Analyses

None of the sensitivity analyses for omitted variables produced a statistically significant or even barely noticeable change in the regression coefficients of the estimated model (S1 Text,

Table 2. R^2 and residual statistics for final regression results.

R^2		Error Structure	
Source	**Value**	**Statistics for Regression Residuals**	**Value**
Within	0.914	ρ	0.940
Between	0.258	corr(u_i, Xb)	−0.291
Total	0.495	RMSE	0.0295

ρ, proportion of regression error variance due to cross-sectional state-specific constants; corr (u_i, Xb), correlation between linear state-specific intercept and linear score; RMSE, root-mean-square error.

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Sensitivity Analyses). The other health risk factors and policy variables do not seem to be highly correlated, at least on a population level. In other conditions, there are significant state and regional differences—and therefore significant correlation between the variables and smoking behavior—at any one point in time, but there is little variation between states over time. For example, in the case of obesity, at any one point in time, some states with high smoking prevalence have a higher than average prevalence of obesity. However, the prevalence of obesity in all states is increasing at approximately the same rate over time, albeit from different starting levels. For this reason, state-level variations in obesity in a particular year do not confound state-level variations in smoking behavior over time. The robustness analysis on education showed that the correlation between states in educational attainment over time was high, particularly for the prevalence of bachelor degrees in the population over time. However, state prevalence of both high school completion and bachelor degrees was highly correlated over time with state real per capita personal income; therefore, we believe the possible direct effects of education on health care expenditure or indirect effects through correlation with smoking behavior are accounted for in the per capita income variable.

The results of the sensitivity analysis on instrumental variables did not produce evidence of serious bias produced by problems with the instruments used for cigarette consumption per smoker, except for proportion of the population age 65 y or over (S1 Text, Sensitivity Analyses). When the proportion of the population that was elderly was instrumented, the coefficient of that variable was reduced by about half, but the change in the coefficient was not statistically significantly different from that presented in Table 1. There were no substantial changes in the coefficients of the other variables. There was no trend in the coefficient estimates as a function of factors that could produce bias, such as the strength of autocorrelation in the regression residuals, and the SEs of the estimates presented in Table 1 were consistent with the point coefficient estimates of the sensitivity analysis.

Estimated Change in Regional Healthcare Expenditures Attributable to Smoking

Without adjustment for mismeasurement of cigarette consumption per smoker, the Far West region has the largest estimated savings in annual per capita healthcare expenditure associated with departures of its smoking behavior from the national average: $210 (SE $45.5); the Southeast region has the largest excess expenditure: $154 (SE $30.7) (Table 3).

After adjustment for state tax differentials, the Far West still has the largest total estimated annual per capita savings, $182 (SE $51.7), but the New England region now has the largest excess per capita expenditure, $104 (SE $25.4); the Southeast has the next largest, $94.4 (SE $90.2) (Table 3). Total annual estimated expenditure per year due to the differences between regional and national smoking behavior ranges from a savings of $9,470 million (SE $2,690

Table 3. Average excess expenditures associated with departures of regional smoking behavior and cigarette consumption from national average, 1992–2009.

Average Excess Expenditure	BEA Region							
	New England	Mideast	Great Lakes	Plains	Southeast	Southwest	Rocky Mountain	Far West
Attributable to prevalence of smoking								
Mean	–37.0	–34.8	62.5	–21.7	66.4	–6.54	–119	–34.5
SE	6.80	7.65	13.8	4.76	14.6	1.45	26.1	7.62
Attributable to mean cigarette consumption per smoker								
Mean	42.1	–68.6	–19.1	10.9	87.8	–134	–16.7	–175
SE	9.86	16.0	4.50	2.55	20.5	31.4	3.90	41.1
Attributable to differences in smoking behavior: prevalence and mean cigarette consumption per smoker								
Mean	5.30	–103	43.4	–10.7	154	–141	–135	–210
SE	9.00	21.0	12.1	4.09	30.7	32.1	28.3	45.5
Attributable to state tax differential effects								
Mean	98.5	30.0	–2.65	–34.0	–59.9	0.00104	14.6	28.0
SE	21.5	15.8	6.01	17.0	74.2	6.29	17.8	49.6
Implied proportional difference between measured and estimated true cigarette consumption per smoker (proportion)								
Mean	0.416	0.163	–0.0165	–0.141	–0.236	0.00000317	0.0791	0.164
SE	0.0906	0.0860	0.0374	0.0704	0.292	0.0192	0.0962	0.290
Total attributable to differences in smoking behavior including state tax differential effects								
Mean	104	–73.4	40.7	–44.8	94.4	–141	–121	–182
SE	25.4	25.4	11.5	17.5	90.2	34.0	32.7	51.7
Total regional difference, including state tax differential effects (millions of 2010 US dollars)								
Mean	1,500	–3,530	1,890	–910	7,330	–5,210	–1,310	–9,470
SE	370	1,220	367	356	7,010	1,260	355	2,690

Data are given as 2010 US dollars per capita unless otherwise indicated. Negative dollar amounts indicate savings compared to national average smoking behavior; positive dollar amounts indicate excess expenditures compared to national average smoking behavior. Negative proportions indicate that estimated true consumption is less than measured consumption; positive proportions indicate that estimated true consumption is less than measured consumption.

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million) in the Far West to a total excess expenditure of $7,330 million (SE $7.010 million) in the Southeast region (Table 3).

The difference between measured and estimated true cigarette consumption per smoker was less than 20% for all BEA regions except the Southeast, where estimated true consumption was 23.6% (SE 29.2%) less than measured consumption, and New England, where estimated true consumption was 41.6% (SE 9.06%) higher than measured (Table 3). These estimates are similar to estimates from survey data collected by examining the source of cigarette packs in different states in 2009 and 2010 [28]. The model's statewide estimates of the proportion of cigarette consumption that is untaxed track survey estimates [29] for major urban centers in the Mideast and New England reasonably well (Table 4). The comparisons are complicated by two factors: the difference in areas in the regions covered and that the survey estimates provide only ranges based on modeling assumptions. For example, untaxed consumption may be

Table 4. Survey and model estimates of percent of cigarette consumption that is untaxed.

Survey Estimates [29]			Model Estimates			
Metropolitan Area	**Range**		**Area**	**Point Estimate**	**95% Confidence Interval**	
	Low	**High**			**Low**	**High**
New York City	47.9%	49.9%	New York State	20.1%	8.02%	32.2%
Boston	36.8%	38.4%	Massachusetts	34.2%	27.5%	40.9%
Providence	29.6%	55.4%	Rhode Island	35.3%	28.1%	41.9%
Philadelphia	1.2%	1.3%	Pennsylvania	4.9%	2.8%	7.0%
District of Columbia	29.0%	59.9%	District of Columbia	13.1%	4.7%	21.5%

Survey estimates provide ranges based on modeling assumptions, rather than 95% confidence intervals.

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unusually high in New York City due to high local cigarette tax rates and may be higher there than on average in other areas of New York state. See S1 Text (State-Specific Healthcare Expenditures Attributable to Smoking) for population-weighted regional and individual state estimates of excess expenditure associated with smoking behavior.

Discussion

Our estimates provide strong evidence that reducing smoking prevalence and cigarette consumption per smoker are rapidly followed by lower healthcare expenditure. The model is dynamic and predicts per capita healthcare expenditures in the current year as a function of smoking behavior in the previous year. For example, 1% relative reductions in current smoking prevalence and mean cigarette consumption per smoker in one year are associated with a reduction in per capita healthcare expenditure in the next year of 0.118% + 0.108% = 0.226% (SE 0.0363%), with all other factors including common trends held equal. In 2012, total healthcare expenditures in the US were $2.8 trillion [30]; our results suggest that, holding other common trends and factors affecting health care expenditures constant, a 10% relative drop in smoking prevalence (about a 2.2% absolute drop) combined with a 10% relative drop in consumption per remaining smoker (about 37 fewer packs/year) would be followed in the next year by a $63 billion reduction in healthcare expenditure (in 2012 dollars).

These are short run 1- to 2-y predictions, and while they indicate that the effects of changes in smoking on healthcare expenditure begin to appear quickly, they do not imply that all changes in the costs and savings of smoking in the population are immediate. If all states reduce their prevalence of smoking and cigarette consumption per smoker, then the corresponding common trends will gradually change over time. The elasticity of the common trend for the prevalence of smoking (from the model estimated with all cross-sectional averages entered as separate variables, rather than using principal components) is relatively small and not statistically significant (−0.0545, SE 0.0581, $p = 0.348$), so it is unlikely to play a large role in longer run predictions. The elasticity of the common trend for cigarette consumption per smoker (−0.255, SE 0.0488, $p < 0.001$) is not small relative to the state-specific cigarette consumption per smoker variable. Over the longer run, changes in both smoking behavior variables will change the age structure of the population and trends in changes in healthcare expenditures related to the prevalence of elderly people in the population. Therefore, longer run predictions require a formal out-of-sample forecast study. The short run illustrative predictions presented here also assume the continuation of historical aggregate trends that have been associated with tobacco control policies, such as the declines in exposure to secondhand smoke and in prevalence of smoking during pregnancy.

These estimates are consistent with previous research on healthcare expenditures attributable to cigarette smoking in California [12,13] and Arizona [14]. The previous research used the aggregate population in control states to account for common trends in healthcare expenditure, while the present study used the cross-sectional average expenditure across states. The regression specifications also differ. In the previous research, specification searches were used to determine the best regression model to use to estimate the effects of smoking in California and Arizona versus the control states. Similar specification searches for each of the 51 cross-sectional units (i.e., states) in the present study were not feasible, and variables that are probably irrelevant for California and Arizona were left in the specification because they are required to be in the model for other states. However, inclusion of irrelevant variables for a state will not bias the estimated elasticities and permits estimating an average effect across all states with a simple panel regression specification.

This analysis uses aggregate measures of population characteristics to estimate the relationships between smoking behavior variables and per capita healthcare expenditures. The elasticity estimates are not directly comparable to estimates of the economic burden of cigarette smoking using cross-sectional data on individuals in national health surveys [31]. Those estimates use data on individuals to calculate the healthcare expenditure attributable to cigarette consumption in individual current smokers or ever-smokers, contrasted to individual non-smokers or never-smokers, respectively. Therefore, the expenditure estimates in the present study should not be interpreted as healthcare costs arising in, or due to, individual smokers or any specific individuals in the population. These estimates reflect all the healthcare expenditures associated with smoking that arise in a population, which include short and long term indirect effects on smokers and short and long term effects of second- and third-hand [32] smoking exposure in non-smokers. However, previously published aggregate estimates for California [13] that are similar to those presented here are somewhat larger than, but consistent with, cross-sectional estimates for that state using individual survey data [33], and the difference between these estimates is comparable to variation among different published cross-sectional estimates based on individual data [6,34,35].

Our estimates do avoid some problems of estimates based on cross-sectional data. An example is the "quitting sick" effect, which imputes expenditure savings to smokers who quit smoking after being diagnosed with a serious chronic tobacco-related disease, such as lung cancer or cardiovascular disease. The expected expenditure savings from quitting by a smoker who remains well will not be realized in those who quit sick because expensive and irreversible health effects of smoking have already occurred. The quitting sick effect is a consequence of incorrectly imputing missing information (the unobservable health status of the smoker at the time of cessation) that is not present in cross-sectional data. This study uses longitudinal data on measures of smoking behavior and healthcare expenditures on large populations and therefore is not subject to quitting sick effects because the excess health care costs of those who quit sick will be included in a state's total aggregate healthcare expenditure data along with the reduction in prevalence that occurs when the reduction in smoking of comparable people is recorded in surveys that represent the population of that state. It should be noted that some estimates of the health burden of cigarette smoking that account for quitting sick and other problems with estimates based on cross-sectional data find a higher burden of smoking-related disease and therefore higher smoking-attributable expenditures than most published cross-sectional estimates [36–40].

The estimates presented here cannot be used to reliably estimate the change in healthcare expenditure associated with complete elimination of cigarette consumption because the estimated elasticities apply only to modest variation around the status quo, but they do capture expenditures attributable to cigarette smoking in a large population that are difficult to measure from national health surveys (such as the effects of second- and third-hand smoke exposure, and long term effects of developmental problems from premature birth and low birth weight or asthma contracted during childhood, attributable to parental cigarette smoking).

Our methods may suffer from spurious regressions and attribute non-smoking public health factors that are correlated with smoking behavior to the smoking behavior. Specifically, this research does not estimate a smoking attributable fraction of healthcare costs for each state that corresponds to a measure that can be derived from individual survey data. Rather, it estimates the average national effect of variations in aggregate-level state-specific smoking behavior variables around the national trend in those variables on variations in state-specific real per capita healthcare expenditure around its national trend.

Limitations

The results of this study are subject to the limitations of analysis of aggregate observational data. A study of this nature that uses aggregate data and a relatively small sample size cannot, by itself, establish a causal connection between smoking behavior and healthcare costs, and that is not the goal of this study. Rather, this study should be evaluated in the context of the existing body of research that has already established that the relationship between smoking behavior and healthcare costs is causal using a variety of study designs [41–45].

These estimates do not address the issue of whether, over the whole life cycle, a population without any cigarette smoking would have higher healthcare expenditures due to longer lived non-smokers. Forecasting the very long run effects of reductions in smoking over the life cycle in a US population would require the construction of a model to forecast the eventual changes in the age structure of the population and resulting changes in per capita healthcare expenditures as a function of smoking behavior.

Conclusions

Lower smoking prevalence and cigarette consumption per smoker are associated with lower per capita healthcare expenditures. Historical regional variations in smoking behavior (including those due to the effects of state tobacco control programs, smoking restrictions, and differences in taxation) are associated with substantial differences in per capita healthcare expenditures across the United States. Those regions (and the states in them) that have implemented public policies to reduce smoking have substantially lower medical costs. Likewise, those that have failed to implement tobacco control policies have higher medical costs. Changes in healthcare costs begin to be observed quickly after changes in smoking behavior. State and national policies that reduce smoking should be part of short term healthcare cost containment.

Supporting Information

S1 Text. Model estimation, additional detailed results, and sensitivity analysis.
(PDF)

Author Contributions

Conceived and designed the experiments: JL SAG. Analyzed the data: JL SAG. Wrote the first draft of the manuscript: JL. Contributed to the writing of the manuscript: JL SAG. Agree with the manuscript's results and conclusions: JL SAG. All authors have read, and confirm that they meet, ICMJE criteria for authorship.

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The Effect of the California Tobacco Control Program on Smoking Prevalence, Cigarette Consumption, and Healthcare Costs: 1989–2008

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Abstract

Background: Previous research has shown that tobacco control funding in California has reduced per capita cigarette consumption and per capita healthcare expenditures. This paper refines our earlier model by estimating the effect of California tobacco control funding on current smoking prevalence and cigarette consumption per smoker and the effect of prevalence and consumption on per capita healthcare expenditures. The results are used to calculate new estimates of the effect of the California Tobacco Program.

Methodology/Principal Findings: Using state-specific aggregate data, current smoking prevalence and cigarette consumption per smoker are modeled as functions of cumulative California and control states' per capita tobacco control funding, cigarette price, and per capita income. Per capita healthcare expenditures are modeled as a function of prevalence of current smoking, cigarette consumption per smoker, and per capita income. One additional dollar of cumulative per capita tobacco control funding is associated with reduction in current smoking prevalence of 0.0497 (SE.00347) percentage points and current smoker cigarette consumption of 1.39 (SE.132) packs per smoker per year. Reductions of one percentage point in current smoking prevalence and one pack smoked per smoker are associated with $35.4 (SE $9.85) and $3.14 (SE.786) reductions in per capita healthcare expenditure, respectively (2010 dollars), using the National Income and Product Accounts (NIPA) measure of healthcare spending.

Conclusions/Significance: Between FY 1989 and 2008 the California Tobacco Program cost $2.4 billion and led to cumulative NIPA healthcare expenditure savings of $134 (SE $30.5) billion.

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Introduction

Previous research using aggregate state level data found a relationship between per capita funding for population-based tobacco control programs and reductions in per capita cigarette consumption, which were in turn associated with reductions in per capita healthcare costs in California [1]. These estimates are consistent with those found in a subsequent independent study [2] that estimated the average effect of tobacco control expenditures across states.

The California Tobacco Control Program was established in 1989. It adopted a comprehensive approach designed to change social norms to reinforce the nonsmoking norm rather than a frontal attack on smokers that markets cessation services. The social norm change approach seeks to indirectly influence current and potential future tobacco users by creating a social milieu and legal climate in which tobacco becomes less desirable, acceptable and accessible. The Program combines an aggressive media campaign with three consistent themes (the tobacco industry lies, nicotine is addictive, and secondhand smoke kills) with public policy change, particularly in the area of promoting smokefree environments. The Program has been premised on the fact that youth smoking will decline when more adults stop smoking [1].

Per capita cigarette consumption, which includes all the nonsmokers, is a very simple measure of smoking behavior. Tobacco control program funding may affect smoking prevalence and cigarette consumption per current smoker differently, and each, in turn, may have a different effect on healthcare expenditures. This paper refines our earlier model by replacing total per capita consumption with a two-dimensional measure of smoking behavior – prevalence of current smoking and cigarette consumption per smoker. This two dimensional measure may provide more insight into the mechanisms by which tobacco control programs work and how reductions in smoking reduces healthcare expenditures and may provide a better predictive model for use in forecasting the effect of policy changes on smoking and healthcare expenditure.

The estimates for the new model, which are based on a different sample period than the old model (due to limits on state specific data on prevalence), show that increased per capita cumulative tobacco control funding is associated with reductions in both prevalence and cigarette consumption per smoker, and reductions in both measures of smoking behavior reduce per capita healthcare expenditures in California compared to control states. Newly available data for a commonly used measure of healthcare expenditure from the Centers for Medicare and Medicaid Services allowed a true out of sample forecasting experiment; the new model using prevalence and average cigarette consumption per smoker produces better forecasts than the previously published per capita cigarette consumption model [1].

Methods

As in our earlier work [1], this analysis compares smoking behavior and healthcare time series variables for California with those for an aggregate population from thirty-eight control states that did not have substantial state tobacco control programs or cigarette tax increases of more than $0.50 before the year 2000 [3]. See our earlier paper [1] for details on the selection of control states and justification for using cumulative per capita control spending as the independent variable.

Model

The new model consists of three equations: one equation for the relationship between cumulative per capita tobacco control funding and current smoking prevalence; one for the relationship between tobacco control funding and cigarette consumption per smoker; and one for the relationship between smoking behavior (prevalence of smoking and cigarette consumption per smoker) and per capita healthcare expenditures.

Current Smoking Prevalence.

$$(prev_{c,t}-prev_{CA,t})=\alpha_0+\alpha_1(EC_{CA,t-1}-EC_{c,t-1}) + \alpha_2(p_{c,t-1}-p_{CA,t-1})+\alpha_3(y_{c,t-1}-y_{CA,t-1})+\varepsilon_{1,t} \quad (1)$$

Cigarette Consumption per Smoker:

$$(cps_{c,t}-cps_{CA,t})=\beta_0+\beta_1(EC_{CA,t-1}-EC_{c,t-1}) + \beta_2(p_{c,t-1}-p_{CA,t-1})+\beta_3(y_{c,t-1}-y_{CA,t-1})+\varepsilon_{2,t} \quad (2)$$

Current Smoking Prevalence, Cigarette Consumption per Smoker and Healthcare Expenditures:

$$n_{CA,t}=\gamma_0+\gamma_1 n_{c,t}+\gamma_2(prev_{c,t-1}-prev_{CA,t-1}) + \gamma_3(cps_{c,t-1}-cps_{CA,t-1})+\gamma_4(y_{c,t-1}-y_{CA,t-1})+\varepsilon_{3,t} \quad (3)$$

Where $prev_{j,t}$: Prevalence of current smoking in population j, for California and control states in year t, in percentage points, $cps_{j,t}$: Cigarette consumption per current smoker in population j, for California and control states in year t, in packs/year per smoker, $EC_{j,t}$: Cumulative per capita tobacco control funding in population j, for California and control states in year t, in dollars, $p_{j,t}$: Price per pack of cigarettes in population j, for California and control states in year t, in dollars, $y_{j,t}$: Per capita personal income in population j, for California and control states in year t, in thousands of dollars, $n_{j,t}$: Per capita healthcare expenditures in population j, for California and control states in year t, in thousands of dollars, $\varepsilon_{k,t}$: Stationary error terms for equation $k=1$ to 3, in year t, j: Index for population $j=CA$ for California (intervention), $j=c$ for control state populations, t: Time index, $t=1985$ to 2008 (24 annual observations).

All monetary values are expressed in year 2010 dollars using the Medical Care (healthcare expenditures) and All-Item (tobacco control funding, cigarette price and personal income) Consumer Price Index for Urban Consumers (CPI-U) [4]. Nominal dollars were converted to 2010 dollars using the Bureau of Labor Statistics CPI-U indices for each Census Region using the relevant Census Region price index [4]. State cigarette sales were used to aggregate individual control state average cigarette sales prices; population weights were used to aggregate the remaining control state variables.

Equation 1 explains the difference between current smoking prevalence in the control states and California $(prev_{c,t}-prev_{CA,t})$ as a function of the corresponding differences between cumulative per capita tobacco control funding $(EC_{CA,t-1}-EC_{c,t-1})$, cigarette price $(p_{c,t-1}-p_{CA,t-1})$ and per capita personal income $(y_{c,t-1}-y_{CA,t-1})$. Equation 2 explains the difference between control states and California cigarettes consumed per current smoker $(cps_{c,t}-cps_{CA,t})$ as a function of the same explanatory variables as Equation 1. Equation 3 explains per capita health expenditures in California $(n_{CA,t})$ as a function of per capita healthcare expenditures in the control states $(n_{c,t})$, and the differences between California and control states' current smoking prevalence $(prev_{c,t-1}-prev_{CA,t-1})$, cigarette consumption per smoker $(cps_{c,t-1}-cps_{CA,t-1})$ and real personal per capita income $(y_{c,t-1}-y_{CA,t-1})$.

Equations 1 to 3 are generalizations of the model estimated in previous research for California [1]. The major change from the previous model is that prevalence of current smoking and cigarette consumption per smoker constitute a two-dimensional measure of smoking behavior rather than the single dimension of per capita cigarette consumption. There are two additional modifications, based on related research on Arizona [5]: we use the difference in price between the control states and California (i.e., require that the sum of the price coefficients for the control states and California sum to zero) and we added the variables for income. (See description of statistical analysis below for details).

From published research on per capita cigarette consumption, we expect that cigarette consumption per current smoker (Equation 2) will be negatively related to per capita tobacco control funding [6,7] and the price of cigarettes [8,9]. Previous time series estimates have shown cigarette consumption to be positively related to measures of per capita income [8]. We found one publication with aggregate time series regression estimates for prevalence of smoking (Equation 2), which found a negative price elasticity and a positive elasticity for per capita income, and mixed results for tobacco control funding [10]. Cross-sectional estimates based on individual survey responses show a positive relationship between prevalence and income for lower income individuals, which is consistent with aggregate time series estimates if the effect of income changes among lower income individuals dominates that of higher incomes over time [11]. Per capita healthcare expenditure for California should be positively related to per capita healthcare expenditure for the control states (reflecting common trends in advances in medical technology) and income [12]. Over time, per capita healthcare expenditure may or may not be positively related to smoking behavior; the sign will be determined by whether the effect of lower expenditures associated with less smoking in a population of fixed size is greater than higher expenditures due to longer lived non-smokers and smokers who consume fewer cigarettes [13].

Data

Consumption per smoker was calculated by dividing per capita cigarette consumption for the respective populations by current smoking prevalence. The definition of tobacco control funding used for the main analysis included state and federal funding; private funding was omitted, though including it makes almost no difference in the results. Cumulative real per capita tobacco control funding was constructed by summing annual real per capita funding.

The main results use the National Income and Product Account (NIPA) measure of per capita healthcare expenditure. Sensitivity analyses used an alternative measure of healthcare expenditure from the Centers for Medicare and Medicaid Services (CMS) [14,15] that was used in our earlier work [1]. The NIPA and CMS measures differ mainly in that the former omits items such as medical equipment, prescription drugs, administrative expenditures and insurance premiums [16]. The two measures are highly correlated over time, and both include expenditures for hospital services, medical procedures and healthcare personnel [16].

Per capita healthcare expenditures were calculated by dividing totals by the state resident populations. For sensitivity analysis the population was adjusted for race (African-American, white and other) and ethnicity (Hispanic and non-Hispanic).

The sample for the model connecting per capita tobacco control funding to smoking behavior consists of 24 annual observations from 1985 to 2008 (The 1984 observation was lost due to lagging the explanatory variables one period).

The 38 control states are Alabama, Arkansas, Colorado, Connecticut, Delaware, Georgia, Idaho, Illinois, Indiana, Iowa, Kansas, Kentucky, Louisiana, Maine, Minnesota, Mississippi, Missouri, Montana, Nebraska, Nevada, New Hampshire, New Mexico, North Carolina, North Dakota, Ohio, Oklahoma, Pennsylvania, Rhode Island, South Carolina, South Dakota, Tennessee, Texas, Utah, Vermont, Virginia, West Virginia, Wisconsin, and Wyoming.

Estimates of smoking prevalence are not available for all of the 38 control states starting in 1985; data from 13 states were available as of 1984 and all were available by 1994. As a result, each of the 38 control states contributed to the control population as annual estimates of state smoking prevalence became available.

See the online Supporting Information S1 for all data sources and additional details of variable construction.

Statistical Analysis

The variables were tested to determine whether they were stationary or nonstationary. The main statistical analysis used a regression specification called a reduced form vector autoregression (VAR) in which the explanatory variables are expressed as a function of the lagged explanatory variables. The reduced form VAR can be used for unbiased estimates regardless of whether the data are stationary or nonstationary [17,18]. As reported in the Results section, it was difficult to determine whether smoking prevalence was stationary or nonstationary, therefore the reduced form VAR was the most robust approach to estimation.

Equations 1 to 3 were estimated using an instrumental variables technique that assured that bias would not result from correlation between the explanatory variables and the regression error terms in Equations 1 to 3; the instrumental variables did not use observed data, but were calculated using a formula that produces the required properties for unbiased estimation when the data are nonstationary [19,20]. The regression coefficient standard errors were estimated using a robust technique to guard against bias due to violations of the usual assumptions on regression errors [19,20,21]. The regression residuals were tested to determine whether they were stationary or nonstationary; if the regression errors are nonstationary then the regression coefficients may not be consistent, and may indicate associations when the variables are actually independent [18]. The behavior of the regression residuals was checked for normality, serial correlation, heteroskedasticity, influential outliers and structural breaks [22].

See the online Supporting Information S1 for additional details on the statistical analysis.

Oracle Crystal Ball [23], OxMetrics 6.10 [24] and Stata version 12.0 [25] were used for estimation.

Estimated Program Effect

The effect of the California Tobacco Control Program was estimated using model predictions of the historical time series and predictions of a counterfactual history with all California tobacco control funding set to zero from FY1989 through FY2008. Monte Carlo simulations, using the regression results, estimated the effect of the California Tobacco Control Program. Predictions for prevalence (Equation 1) and consumption per smoker (Equation 2) were used as explanatory variables in the per capita healthcare expenditure model (Equation 3) instead of observed values. The dependent variables in Equations 1 and 2 are expressed as differences between California and control states; predictions of California prevalence and cigarette consumption per smoker were calculated by subtracting the corresponding observed control state values from the predicted difference between California and the control states. The total reduction in prevalence of smoking, person years of smoking, cigarette consumption per smoker, value of lost sales of cigarettes to the tobacco companies, and reduction in healthcare expenditure and other statistics were calculated by subtracting the difference between the model predictions using historical California tobacco control funding and predictions with the history of funding set to zero.

Sensitivity Analysis

Several sensitivity analyses were conducted to check the robustness of the methods and estimation results. See the Online Supporting Information S1 for additional details.

Validation of model specification using a specification search algorithm. It may be difficult to determine the best specification of a regression with a relatively small sample (up to 24 annual observations in this study). Therefore an automatic model selection algorithm, the Autometrics module in Oxmetrics [22], was used to explore the robustness of the regression specification and validate the adequacy of Equations 1 to 3. Autometrics [22] chooses the best model specification from a list of explanatory variables in a way that preserves the validity of the final estimates of standard errors of the regression coefficients, and therefore validity of the significance level for hypothesis tests on the coefficients. Autometrics also screens regression specifications for acceptable performance of regression residuals.

Use of alternative estimators. If the data are nonstationary, then the estimates using the VAR specification should be consistent with those from a static regression (called a "cointegrating regression") [17,26], using either an ordinary least squares or instrumental variables estimates. The coefficients in the static specification represent the long run relationship between the explanatory and dependent variables, while the coefficients from the VAR specification contain information about the long run relationship and the short run adjustment process [18]. In this sensitivity analysis Equations 1 to 3 were re-estimated using a static regression using the same instrumental variables estimator used for the main analysis, ordinary least squares, and robust regression in order to compare for consistency with the reduced form VAR results.

The prevalence (Equation 1) and cigarette consumption per smoker (Equation 2) regressions were also re-estimated assuming that the variables were stationary and that there was exponential decay in the effect of annual tobacco control funding on smoking behavior in order to explore alternatives to the assumption that there was no detectable decay in effectiveness of annual tobacco control expenditures over the sample period.

Alternative Selection of control states. The model was estimated using different groups of control states to explore the sensitivity of the results to control states that would reflect different regional trends in the explanatory variables, particularly healthcare expenditure and smoking behavior.

Alternative specification for consumption per smoker. The automatic selection procedure, Autometrics, used to check the specifications of Equations 1 to 3, found an alternative specification for Equation 2 (cigarette consumption per smoker) that was also acceptable and nearly equivalent by the selection criterion. The analysis was redone using this alternative regression model for cigarette consumption per smoker (Equation 2).

Race and Ethnicity. The model was re-estimated with variables for racial and ethnic composition of California and control populations, using estimates of the proportion of Hispanic, Black and All Other races from BRFSS survey data, added to the Equations 1 to 3 in order to determine the sensitivity of the regression estimates to these population characteristics.

Including private tobacco control funding. The model was estimated with alternate measures of tobacco control funding that included private nonprofit funding.

Estimates using Centers for Medicare and Medicaid Services (CMS) Healthcare Expenditure Data

The CMS provides a commonly used measure of healthcare expenditure for the U.S. and individual states, though state specific estimates are not released at regular intervals. CMS healthcare expenditure data were used to estimate Equation 3 for the sample periods 1984 to 2004 that was used in our previous research [1] in order to check robustness of the results to different measures of healthcare expenditure and to estimate results for total healthcare expenditures. The CMS measure of healthcare expenditure is denoted by $h_{CA,t}$ (for California) and $h_{c,t}$ (for control states) to distinguish it from the NIPA measure (which is denoted by $n_{CA,t}$ for California and $n_{c,t}$ for control states). Program effects were calculated using the estimates to determine whether the results of the new model were consistent with those of the old model. Estimates for 1984 to 2008 and program effects were calculated.

Out of sample forecasts of the CMS measure for healthcare

CMS healthcare expenditure data ($h_{CA,t}$ and $h_{c,t}$) for the years 2005 to 2008 became available during December, 2011, after the other analysis presented in this paper was completed. We used these additional data to compare the out-of-sample forecast performance of the old model (that used per capita cigarette consumption) and the new model (that used smoking prevalence and cigarette consumption per smoker). We re-estimated the model from our previous research that used per capita cigarette consumption as the measure of smoking behavior (Equations 1 and 2 in [1]), and Equations 1 to 3 in the new model presented in this study using prevalence and cigarette consumption per smoker, using a similar sample period (years 1984 to 2004) to that in the earlier paper, and using the reduced form VAR specification. We calculated forecasts for per capita cigarette consumption, per capita healthcare expenditure, and four measures of forecast accuracy (root mean square error, mean absolute error, mean absolute percentage error, and the regression slope coefficient of the forecast on observed values) for the years 2005 to 2008 to compare the forecast performance of the two models (Table S1, Supporting Information S1).

Results

Time Series Properties of the Variables

The unit root tests indicated that all the variables except for prevalence of current smoking were nonstationary with autoregressive unit roots; the results for prevalence were unstable and difficult to interpret. Smoking prevalence may be stationary, so estimation using cointegrating regressions (which were used in previous research) may be inappropriate. These results imply that that the reduced form VAR specification is more robust than the cointegrating regression estimates (used in earlier research [1,5]) since the VAR can be used with both stationary or nonstationary data.

Model Estimates

The reduced form VAR estimates of Equations 1 and 2 show statistically significant associations between cumulative per capita tobacco control funding and both measures of smoking behavior (prevalence and cigarette consumption per smoker). Holding other variables constant, an additional dollar in cumulative per capita California tobacco control funding reduces California prevalence by 0.0497 (SE 0.00347; $P<0.01$) percentage points and reduces cigarette consumption per smoker by 1.39 (SE 0.132; $P<0.01$) packs/year. Equation 3 shows statistically significant associations between and between both measures of smoking behavior and per capita healthcare expenditures (Table 1). A one percentage point reduction in smoking prevalence and one pack/year reduction in cigarette consumption per smoker in California reduces per capita healthcare expenditures by \$35.4 (SE \$9.85) ($P<0.01$) and \$3.14 (SE \$0.786; $P<0.01$), respectively (Table 1).

All of the other explanatory variables are statistically significant at the one percent level except the price of cigarettes (α_2) in Equation 1 ($P=0.049$) and per capita income (β_3) ($P=0.023$) in Equation 2 (Table 1). The signs of the other explanatory variables are as expected according to economic theory and previous research: prevalence and cigarette consumption per smoker were negatively related to cigarette price. Cigarette consumption per smoker is positively related to per capita income which is consistent with existing time series and addictive models for consumption [2,8,9,27]. Per capita healthcare expenditure is positively associated with per capita income. The residuals show no violations of assumptions that would affect the interpretation of the regression estimates.

The in-sample predictions for prevalence (Equation 1) and healthcare expenditure (Equation 3) show good agreement with the observed data (Figure 1). Cigarette consumption per smoker (Equation 2) does not seem to model turning points in the data well, though it is a better model for longer run trends (Figure 1).

Tobacco Control Program Effect

The dynamic simulation of the time paths of prevalence of smoking, consumption per smoker and per capita healthcare expenditures (Figure 2) is similar to those for the in-sample fits for Equations 1 to 3. The reductions in prevalence, cigarette consumption per smoker and per capita healthcare expenditure attributable to the Program increase steadily beginning in FY 1992 (Figure 2).

Table 1. Estimated California smoking prevalence, cigarettes per capita, and per capita healthcare expenditures.

Eq.	Sample Period	Dependent Variable	Statistic	Estimate	dimension
1	1985–2008, 24 obs	$(prev_{c,\ t} - prev_{CA,\ t})$	α_0	6.30 (0.610)	
			α_1	0.0497 (0.00347)	/$ per capita
			α_2	−1.00 (0.477)	/$ per pack
			α_3	0.416 (0.0730)	/$1000 per capita
			R^2 (%)	77	
			r_1	0.154	
2	1985–2008, 24 obs	$(cps_{c,\ t} - cps_{CA,\ t})$	β_0	67.9 (10.2)	
			β_1	1.39 (0.132)	/$ per capita
			β_2	−26.6 (6.80)	/$ per pack
			β_3	2.97 (1.21)	/$1000 per capita
			R^2 (%)	81	
			r_1	0.148	
3	1985–2008, 24 obs	$n_{CA,\ t}$	γ_0	−550 (433)	$
			γ_1	1.15 (0.180)	
			γ_2	−35.4 (9.85)	$/%point
			γ_3	−3.14 (0.786)	$ pack per smoker
			γ_4	−108 (6.79)	$/$1000 per capita
			R^2 (%)	80	
			r_1	0.262	
3*	1985–2008, 24 obs	$h_{CA,\ t}$	γ_0	1056 (112)	$
			γ_1	0.847 (0.0542)	
			γ_2	−67.8 (7.31)	$/%point
			γ_3	−5.48 (0.928)	$ pack per smoker
			γ_4	−107 (22.3)	$/$1000 per capita
			R^2 (%)	89	
			r_1	0.486†	
3*	1985–2004, 20 obs	$h_{CA,\ t}$	γ_0	1001 (967)	$
			γ_1	0.856 (0.227)	
			γ_2	−69.8 (12.6)	$/%point
			γ_3	−5.59 (1.77)	$ pack per smoker
			γ_4	−112 (17.5)	$/$1000 per capita
			R^2 (%)	78	
			r_1	0.483†	

*Equation 3 with $h_{CA,\ t}$ as dependent variable instead of $n_{CA,\ t}$ and $h_{c,\ t}$ as explanatory variable instead of $n_{c,\ t}$.
†significant at the 5% level.
r_1: first order autocorrelation coefficient.
$prev_{j,\ t}$: Prevalence of current smoking in population *j*, for California and control states in year *t*,(percentage points).
$cps_{j,\ t}$: Cigarettes consumption per current smoker in population *j*, for California and control states in year *t*, (packs/year per smoker).
$EC_{j,\ t}$: Cumulative per capita funding in population *j*, for California and control states in year *t*, (dollars).
$p_{j,\ t}$: Price per pack of cigarettes in population *j*, for California and control states in year *t*, (dollars).
$y_{j,\ t}$: Per capita personal income in population *j*, for California and control states in year *t*, (thousands of dollars).
$n_{j,\ t}$: Per capita healthcare expenditures in population *j*, for California and control states in year *t*, (thousands of dollars).
$h_{j,\ t}$: Per capita healthcare expenditures in population *j*, for California and control states in year *t*, (thousands of dollars).
doi:10.1371/journal.pone.0047145.t001

In fiscal year 2008, 19 years after the Program started, smoking prevalence was 3.46 (SE 0.242) percentage points and cigarette consumption per smoker was 96.3 (SE 13.7) packs/year, and per capita healthcare expenditures were $411 (SE $92.0) below what is predicted in the absence of the California Tobacco Control Program.

From FY1989 to FY2008, the Program is associated with a cumulative reduction in 8.79 (SE 0.616) million person-years of smoking, 6.79 (SE 0.605) billion packs of cigarettes worth $28.5 (SE $2.55) billion in pre-tax sales to the cigarette companies. The cumulative savings in the NIPA measure of healthcare expenditures is $134 (SE $30.5) billion for the years 1989 to 2008.

The reduction in prevalence is responsible for 36.4% (SE 4.06%) of the reduction in cumulative total cigarette consumption per smoker and 31.2% (SE 3.48%) of the reduction in NIPA healthcare expenditures, respectively. The rest of the reductions are due to reductions in consumption per smoker.

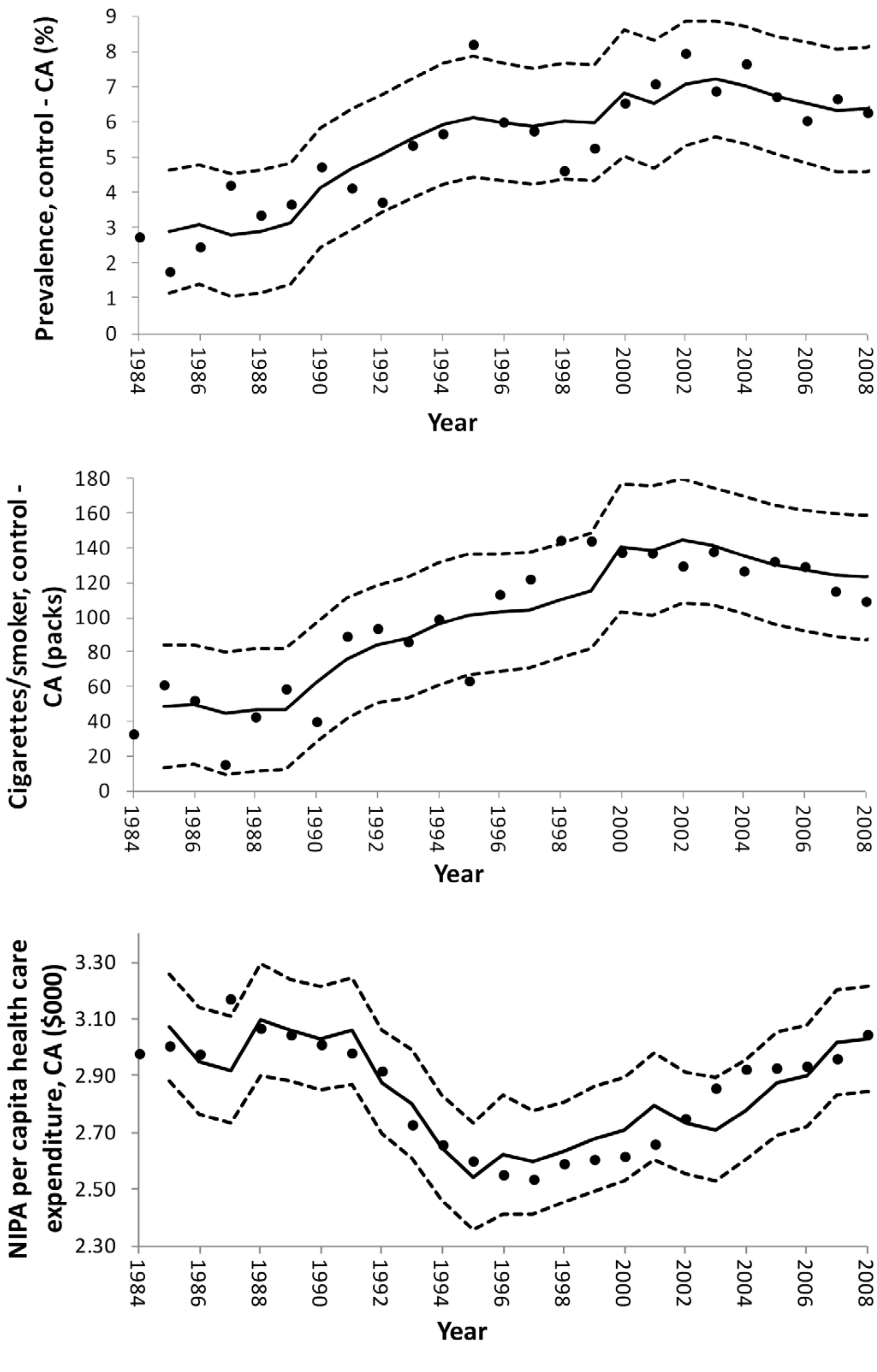

Figure 1. Observed and predicted smoking prevalence, cigarette consumption per smoker and per capita healthcare expenditures. Top panel: Difference between California and control state current smoking prevalence (Equation 1), middle panel: difference between California and control state cigarette consumption per smoker (Equation 2), bottom panel: California per capita healthcare expenditures using the NIPA measure (Equation 3). Black circles: observed, solid line: in-sample predictions from regression estimates, dashed lines: 95 percent forecast confidence intervals for prediction of individual observations.

doi:10.1371/journal.pone.0047145.g001

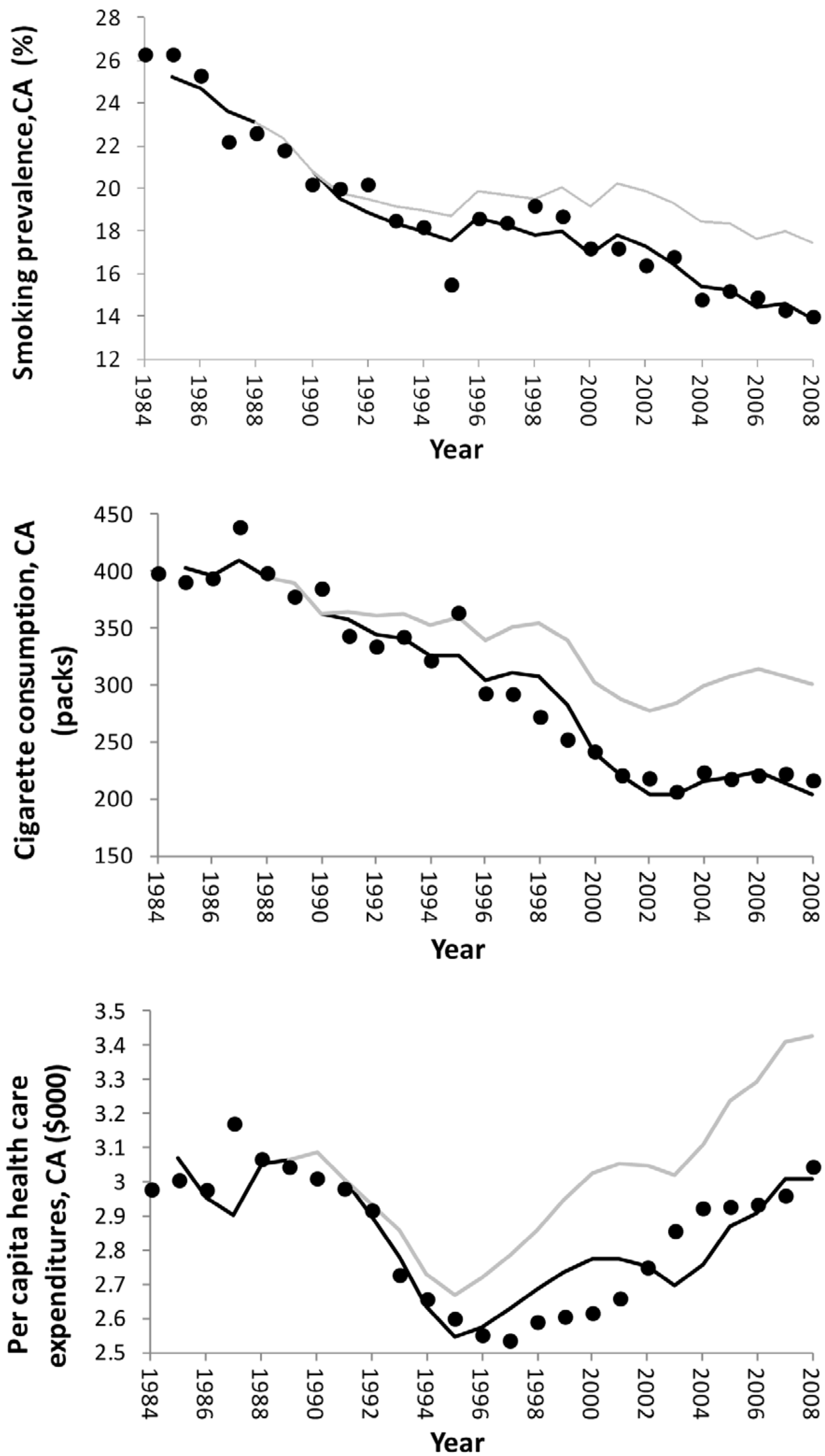

Figure 2. Prevalence of current smoking, cigarette consumption per smoker and per capita healthcare expenditures with and without California tobacco control funding, Top panel: California current smoking prevalence, middle panel: California cigarette consumption per smoker, bottom panel: California per capita healthcare expenditures using the NIPA measure. Black circles: observed, black line: predictions with California tobacco control program (using historical data on tobacco control funding), gray line: predictions without California tobacco control program (California tobacco control funding set to zero).

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See online Supporting Information S1 for the additional details of calculation of the tobacco control program effect.

Sensitivity Analysis

Validation of model specification using a specification search algorithm. Autometrics selected regression specifications are similar to those for prevalence (Equation 1) and per capita healthcare expenditure (Equation 3) and the algorithm found no competing specifications that substantially changed the coefficient values for per capita tobacco control funding (Equation 1) or prevalence and cigarette consumption per smoker (Equation 3).

Autometrics did select a regression specification for Equation 2 that contained only California and control tobacco control funding variables and California cigarette price when the variables were entered individually. This alternative specification produces a statistically significant relationship between California tobacco control funding and cigarette consumption per smoker. However, this alternative specification results in very large estimates of program effects because it does not include the effect of common trends represented by variables for control states (such as cigarette consumption per smoker), therefore the initial specification was chosen to produce lower estimates of program effect.

Alternative estimators and control states. The results of the OLS and robust regression estimates of the VAR and cointegrating regressions are consistent with those of the reduced form VAR estimates and the residuals are stationary. This result provides more evidence that data are nonstationary and that the results are robust to different regression specifications.

Models that estimated an exponential decay in the effect of tobacco control did not produce statistically significant regression relationships and the residuals showed significant autocorrelation.

Alternative Selection of Control States. The estimates for Equations 1 to 3 using alternative control populations are similar to the main results. Estimates for all the alternative groups of control states show statistically significant relationships between California tobacco control funding and both prevalence and cigarette consumption per smoker and between those measures of smoking behavior and per capita healthcare expenditure. The principal difference is for the healthcare expenditure (Equation 3): when the Western states were used as controls, the coefficient for consumption per smoker is \$0.92 (SE \$0.283) which is significantly different and lower than in the main analysis ($P = 0.011$).

Alternative specification of consumption per smoker. The estimated coefficients of the alternative model chosen by Autometrics are -2.96 (SE 0.232) for the difference California and control state tobacco control funding and -15.46 (SE 5.00) for the price of cigarettes in California. Tobacco control funding has a statistically significant effect on cigarette consumption per smoker in California in the alternative model.

Race and Ethnicity. The variables for proportion of the population that African-American or Hispanic do not enter the regressions (all P values >0.10) and their inclusion do not change the values of the other coefficients substantially. The variable for Other Race (neither White nor African-American) enter the regressions for prevalence (Equation 1) and cigarettes consumption per smoker (Equation 2) at the 5 percent significance level with a positive sign for prevalence and a negative sign for consumption per smoker. California Tobacco control funding is more effective holding the prevalence of Other Races constant, implying that tobacco control funding is less effective in Other Races than the rest of the population.

Centers for Medicare and Medicaid Services (CMS) Healthcare Expenditure

Estimates of healthcare expenditure using the CMS measure of healthcare expenditure (rather than the NIPA measure) from 1989 to 2004 show a reduction of one percentage point in prevalence of current smoking and consumption of one pack per year per smoker in California reducing per capita healthcare expenditures by \$69.8 (SE \$12.6) and \$5.59 (SE \$1.77), respectively (Table 1). The California Tobacco Program is associated with a cumulative reduction of \$142 (SE \$22.4) billion in CMS healthcare expenditures between 1989 and 2004. Estimates of healthcare expenditure using the CMS measure of healthcare expenditure (rather than the NIPA measure) from 1989 to 2008 show that reductions of one percentage point in prevalence of current smoking and in consumption of one pack per year per smoker in California reduce per capita healthcare expenditures by \$67.8 (SE \$7.31) and \$5.48 (SE \$0.928), respectively (Table 1). The California Tobacco Control Program is associated with a steady increase in annual savings (Figure 3) and a cumulative reduction of \$243 (SE \$38.5) billion in CMS healthcare expenditures between 1989 and 2008.

Out-of-sample forecasts. The out-of-sample forecasts using the model estimated in this paper that uses current smoking prevalence and cigarette consumption per smoker as the measure of smoking behavior performs better than the previously estimated model that used per capita cigarette consumption. The new model performs better on all forecast performance measures, particularly for per capita cigarette consumption. (See Table S1 in the Supporting Information S1 for the results of out of sample forecasts).

Discussion

The results show that the California Tobacco Control Program had a substantial effect on both smoking prevalence and cigarette consumption per smoker, and both in turn had a substantial effect on per capital healthcare expenditure. The out-of-sample forecasts of the model (using the CMS measure of healthcare expenditure) presented in this study using prevalence and cigarette consumption per smoker are superior to the previously published model that uses per capita cigarette consumption.

From 1989 to 2008, the California Tobacco Control Program cost \$2.4 billion and resulted in \$243 billion (SE \$38.5 billion) in CMS health expenditure savings by reducing total cigarette consumption by a total of 6.79 billion (SE 0.605 billion) packs of cigarettes worth \$28.5 billion (SE \$2.55 billion) in pre-tax sales to the tobacco industry. 36.4% (SE 4.06%) of this effect was due to reductions in prevalence and 63.6% (SE 4.06%) was due to reductions in consumption among continuing smokers. The fact that such a large fraction of the total effect was due to reductions in consumption points to the importance of considering per smoker consumption in addition to changes in prevalence when evaluating the effects of tobacco control programs. The California Tobacco Control Program has been shown in other research to reduce the prevalence of heavy (>20 cigarettes per day) and moderate smoking (10 to 19 cigarettes per day), and increase the prevalence of light (<10 cigarettes per day) smoking [28,29].

Comparison with Existing Estimates

The estimated NIPA healthcare expenditures attributable to smoking using the new model are \$548 (SE \$27.8) per capita and between \$2,262 (SE \$121) and \$2,904 (SE \$184) per smoker. About one third of the smoking-related cost is due to smoking prevalence and the rest due to consumption per smoker.

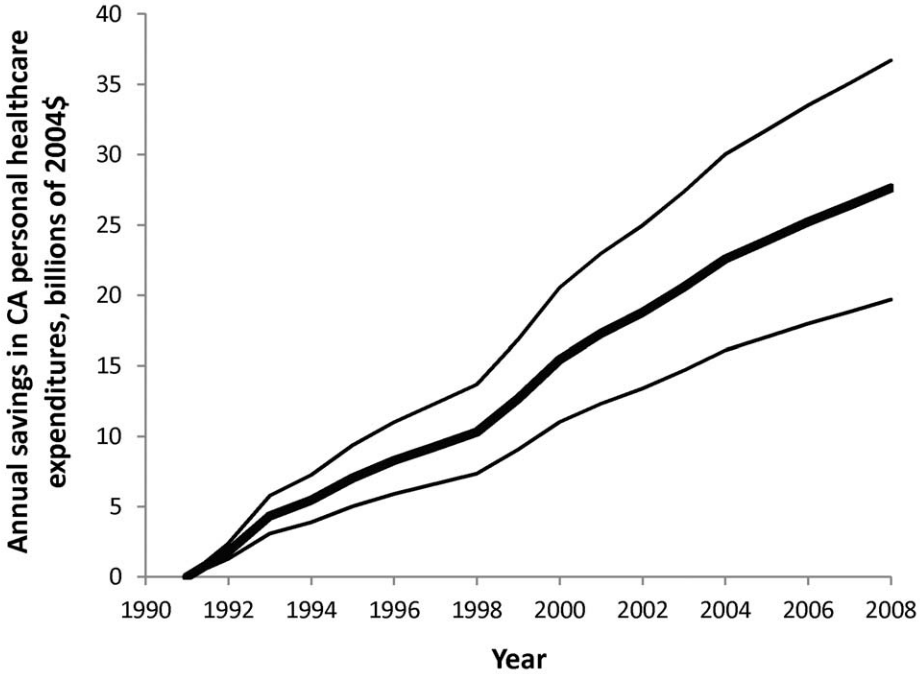

Figure 3. Annual savings in total personal healthcare expenditures in California attributable to the California Tobacco Control Program, billions of 2010 dollars.
doi:10.1371/journal.pone.0047145.g003

The estimated annual per capita excess per capita healthcare expenditure (using the CMS measure) attributable to differences in per capita cigarette consumption in our earlier paper [1] was $1,154, which is consistent with $4,910 (SE $373) and $5,982 (SE $411) per smoker, estimated over the sample period 1980 to 2004. Using the new model in this paper, the per capita healthcare expenditure (CMS measure) attributable to an additional smoker who smokes the average number of cigarettes per year as other smokers is $949 (SE $173) per capita, and consistent with between $3,968 (SE $727) and $5,108 (SE $957) per current smoker, which are similar to our earlier paper. NIPA is a better source of healthcare expenditure data for statistical time series analysis because it omits some expenditures categories that are low quality, for example, drug expenditure data for which actual nationally representative survey data are not available for all years. The CMS measure is more comprehensive and more commonly used to measure the burden of healthcare expenditure in the US. The two measures are highly correlated, but the measured per capita expenditures differ in levels [30,31].

The cumulative reduction in packs sold attributable to the California Tobacco Control Program (between 1989 and 2004) is 4.2 (95% CI 3.4, 4.9) million packs, which is not significantly higher than the 3.6 (95% CI 1.5, 5.9) million packs estimated in using our previous model [1] ($P = 0.63$ assuming normality). This nonsignificant difference may be due to the use of per capita cigarette consumption in the old model, which included a deterministic time trend [1], and underestimated the reduction in packs consumed attributable to the Program (the new model avoided the need to introduce a time trend). Recursive estimates, starting in 1985, of the old per capita model showed that the coefficient for tobacco control funding increased, while the time trend coefficient approached zero and became statistically insignificant; corresponding recursive estimates of the new model were stable over different subsamples. The new model with prevalence and consumption per smoker is more stable over different sample periods, and therefore we believe more reliable, than the old model using per capita consumption. Our earlier per capita model may have underestimated the effect of California Tobacco Control Program funding on both smoking behavior and healthcare expenditure because the California Tobacco Control Program affects prevalence and cigarette consumption per smoker differently; estimates of program effect that use per capita cigarette consumption is a poorer approximation than using prevalence and consumption per smoker.

The average price elasticity over the sample period of prevalence is −0.198 (SE 0.0951) and of cigarette consumption per smoker is −0.352 (SE 0.164). The total elasticity of cigarette demand is −0.474 (SE 0.164). The results are more consistent with existing price elasticity estimates for cigarette demand [8] than the old model using per capita cigarette consumption, so the new model is more consistent with existing estimates of demand.

The VAR regression approach used in this study is consistent with the cointegrating regression estimates in previous research, and produces a similar long run relationship as the cointegrating regression approach. The prevalence of smoking may be stationary with high autocorrelation, or nonstationary with a unit root. If the data are nonstationary, then the dynamic VAR equations can be solved estimate the combined cointegrating equation and error correction model that should equal the static cointegrating regressions. If the data are stationary, but with high autocorrelation, the VAR estimates are still consistent; the consistency of the static cointegrating regressions can be questioned. Thus, the VAR are more robust if the data are really stationary, and will give the same result for the long relationships as the cointegrating regressions if the data are nonstationary.

Limitations

This analysis uses aggregate measures of population characteristics to estimate the relationships between per capita tobacco control funding, smoking and per capita healthcare expenditures.

The estimated relationship between smoking and healthcare expenditures reflects differences in smoking behavior and healthcare expenditures in different state populations with different histories of aggregate population measures of smoking and resulting cost estimates should not be interpreted as healthcare costs arising in, or due to, an individual smoker. These estimates reflect all the healthcare expenditures associated with smoking that will arise in a population: short and long term direct effects on the smoker, and short and long term effects of second- and third-hand [32] smoking exposure in nonsmokers, not just the effects of smoking on the individual smoker.

The results of this study are subject to the limitations of analysis of aggregate observations using observational data. A study of this nature that used aggregate data and a relatively small sample size cannot, by itself, establish a causal connection between tobacco control programs, smoking behavior and healthcare costs, and is not the goal of this study. Rather, it should be evaluated in the context of the existing body of research that has already established that this relationship is causal using a variety of study designs [33,34,35,36]. There is also a well-established causal relationship between smoking behavior and healthcare costs [13]. It is not currently known if or when the net effect of reduced healthcare expenditures due to fewer smokers might be outweighed by increased expenditures due to longer lived nonsmokers, though our estimates indicate that after more than 25 years of reduced smoking in California compared to the rest of the U.S., reduced smoking was associated with lower per capita healthcare expenditures, and 25 years is a long time horizon for many policy decisions.

The best regression specification for cigarette consumption per smoker (Equation 2) is uncertain given the relatively small number of available annual observations; however, the specification search using Autometrics was unable to identify a specification that was clearly superior to that used for the main analysis. The alternative specification chosen by Autometrics for cigarette consumption per smoker contained California tobacco control funding is a statistically significant explanatory variable, consistent with the hypothesis that tobacco control funding reduced consumption in continuing smokers. Therefore, we are confident that tobacco control funding belongs in the regression, despite uncertainty about other aspects of the specification.

Data were not available to conduct a detailed analysis of the possible independent effect of regional variations in local smoke-free policies or sales regulations for tobacco on smoking behavior. However, existing research has shown that these factors should be considered intermediating variables for the effects of large scale state tobacco control programs, which operate, in part, through such changes in state tobacco control policy [7]. Therefore simply including them in a single regression specification would produce a downwardly biased estimate of the effect of the state Program.

Omission of exogenous trends that play no intermediating role in determining smoking behavior or healthcare expenditures could produce bias in the estimated regression coefficients. Examples are prevalence of obesity, abusive alcohol consumption, diabetes, prevalence of racial and ethnic populations, regional capacity of healthcare providers, and penetration of managed care organizations. An extensive sensitivity analysis of the possible effect of these factors, reported in previous research for California [7] showed that they did not have a noticeable effect on the results [1].

Conclusions

The results extend previous results for California [1] that used per capita cigarette consumption to measure smoking behavior to a similar model that uses a two dimensional measures of smoking behavior: prevalence of smoking and cigarette consumption per smoker. The results indicate that the California Tobacco Control Program was effective in reducing both prevalence of smoking and average cigarette consumption per smoker, and that both measures of smoking behavior have a significant relationship to per capita healthcare expenditures.

Because of the study design, the coefficients for prevalence and consumption per smoker for the health expenditure (Equation 3) cannot identify healthcare costs to smokers themselves due to direct smoking versus costs to others from second and third hand passive smoking, and cannot be used to evaluate the comparative importance of smoking status versus consumption in an individual smoker. The effects of reduced passive smoking due to lower prevalence and consumption may be more important than previously thought: a meta-analysis estimated substantial reductions in hospital admissions for coronary events, other heart disease, stroke, and respiratory disease attributable to increased protection against passive smoking exposure [37], which may partly explain the quick effect of variations in smoking behavior on per capita healthcare expenditure.

The results suggest that tobacco control is very effective at reducing consumption in smokers in addition to reducing prevalence, and that reduction in consumption in continuing current smokers also makes an important contribution to reducing healthcare expenditure for the overall population. Tobacco control programs should evaluate their effectiveness using both changes in prevalence and consumption in current smokers. At the same time, since even low levels of cigarette consumption substantially increase the risk of some diseases, particularly cardiovascular disease [38,39,40,41,42,43,44], eliminating tobacco use should be the ultimate goal.

Supporting Information

Supporting Information S1 Details of data sources, modeling methods and sensitivity analysis.
(DOCX)

Table S1 Out of sample forecast performance measures for models with alternative measures of forecast performance.
(DOCX)

Author Contributions

Conceived and designed the experiments: JL SG. Analyzed the data: JL. Contributed reagents/materials/analysis tools: JL SG. Wrote the paper: JL SG.

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Attachment 3 Component

The New England Journal of Medicine
December 14, 2000

"Association of the California Tobacco Control Program with Declines in Cigarette Consumption and Mortality from Heart Disease"

Authors: Caroline M. Fichtenberg, M.S., and Stanton A. Glantz, Ph.D.

This article is available at the New England Journal of Medicine website here: http://www.nejm.org/doi/full/10.1056/NEJM200012143432406#t=article

A number of copies will be provided at the meeting.

CalPERS

Investment Committee

December 19, 2016

Attachment 3 Component

Business Insider
October 19, 2016

"The maker of Camel and Newport cigarettes is sinking after saying it expects to sell fewer cigarettes next year"

Author: Bob Bryan

This article is available at the Business Insider website here:
http://www.businessinsider.com/reynolds-american-camel-newport-cigarettes-earnings-q3-2016-2016-10

A number of copies will be provided at the meeting.