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U.S. Cigarette Demand: 1944–2004

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Introduction

In the title of his recent book, historian Allan Brandt (2007) refers to the 20th century as the "Cigarette Century." Brandt traces key events in the rise of the U.S. cigarette industry,

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[1]In the first part model of smoking participation, using maximum likelihood probit instead of the linear probability model yields similar results (available upon request). A line of research in health economics explores the choice between the two part model and alternatives such as tobit and the sample selection model; for reviews, see Jones (2000) and Madden (2008). After reviewing theoretical, practical, and statistical grounds, Madden concludes that the two-part model is generally favored for estimating models of smoking and drinking.

[2]In most survey years, the cigarette consumption categories are in terms of half-packs (10, 20, 30, and so on). The categorical data do not seem too problematic, because even when a continuous measure is collected, smokers tend to consume (or at least tend to report consuming) increments of half-packs or packs per day. In fact, for their analysis Wasserman et al (1991) convert a continuous measure of cigarettes per day into packs per day by dividing by the standard pack size of 20 cigarettes.

[3]The size of the income categories varies across survey years, with wider ranges in later years. Because within-category income variation is missed, our use of the category midpoints introduces measurement error. This might create attenuation bias in our estimate of the effects of income on cigarette demand.

[4]Within states, some localities impose additional taxes on cigarettes. Because we lack data on locality of residence, our tax measure does not reflect local taxes. This does not create much measurement error for our study, because local taxes were neither common nor sizeable for most of our study period. For example, before the widely publicized 2002 hike to $1.50 per pack, the local tax in New York City was only $0.08 per pack.

[5]If a state restricts smoking in private worksite, the regulation index takes a value of one. If a state restricts smoking in restaurants and not in private worksite, the index takes a value of 0.75. If a state restricts smoking in private schools, public schools, public transit, recreational facilities, and shopping malls and not in private worksite or restaurants, the index takes a value of 0.5. If a state only restricts smoking in some places, such as child care centers, government worksites, and health care facilities, the index takes a value of 0.25. If a state does not restrict smoking in any places, the index takes a value of 0.

[6]Our approach in these models follows Wasserman *et al.* (1991). As they point out, the results for age in these models must be interpreted carefully. Because the models include year and birth-cohort indicators, the models identify the effect of within-cohort age variation.

[7]The result for the 1880s birth cohort might reflect differential mortality among smokers. By the earliest Gallup Poll on smoking in 1944, members of this birth cohort were already at least 55 years old. More of the 1880s male birth cohort might have smoked but might not have survived to be interviewed in 1944 or later. Differential mortality should play less of a role for the other birth cohorts, because most of the mortality differential between smokers and nonsmokers occurs after the age of 50 (Gilpin and Pierce 2002).

[88]We thank an anonymous referee for suggesting the gradual switching regression model.

[9]Warner (1982) notes a similar pattern: he points out that from 1921 – 1952 tobacco-producing states and other states taxed cigarettes similarly; but as public awareness of the smoking-and health issue grew, other states were much more likely to increase cigarette taxes than were the tobacco states.

[10]In a multiple regression estimated with the 21 data points in Figure 1, after controlling for a linear and quadratic time trend, the coefficient on price is +0.03 (t=1.94).

[11]See for example, Levy and Meara (2006) and Tauras (2006). Data limitations prevent us from estimating the effects of the specific tobacco control policies that constitute the anti-smoking campaign. Specific events include the 1964 Surgeon General's Report, the 1971 ban on television cigarette advertising, and the 1998 Master Settlement Agreement with the tobacco industry. The influences of these events are picked up by the year indicators in our models, so we can not distinguish their effects from other changes over time.

including the entrepreneurial efforts of James Duke and his adoption of the Bonsack machine that automated cigarette-rolling. Although Duke himself thought cigarette smoking was another "fad" and that the market was near saturation in 1912 (Brandt, p.43), the industry continued to flourish. Cigarettes became the predominant form in which tobacco was consumed, and U.S. per capita cigarette consumption increased from 35 cigarettes per year in 1900 to over 2,000 cigarettes per year in 1950 (Orzechowski and Walker 2007). In the 1950s, however, scientific research on the health hazards of smoking began to be published. This research, and the tobacco control policies enacted in its wake, would eventually lead to the cigarette industry's decline (and perhaps some day, its fall). By the end of the 20th century: smoking was widely recognized as the leading preventable cause of death; U.S. per capita consumption had fallen to about two-thirds its 1950 level; the federal government and many state governments were sharply increasing cigarette taxes; smoking was banned in many worksites and other public places; and the industry had agreed to pay the states $246 billion in a record-setting legal settlement.

In this paper, we analyze individual-level data on cigarette smoking that span the last half of the "Cigarette Century." We use data from 23 national cross-sectional surveys conducted by the U.S. Gallup Poll from 1944 through 2004. We estimate standard two-part models of cigarette demand as a function of demographics, income, and cigarette prices. The demand for cigarettes in the U.S. has been explored using a variety of data sources (Gallet and List 2003). Most studies focus on recent data, but some previous studies examine cigarette demand over longer time horizons. Sloan, Smith and Taylor (2002) analyze national data on annual cigarette consumption for1900 to 1998. Keeler *et al.* (2001) analyze state-level data for 1960 to 1990. Because they use aggregate data, these studies can not distinguish smoking participation from demand conditional upon participation, and they have limited ability to study the role of demographic factors in cigarette demand. More similar to our approach, Wasserman *et al.* (1991) analyze data from nine cross-sectional National Health Interview Surveys conducted from 1970 through 1985. Because our data cover a much longer time span we are able to study cigarette demand before and during the early years of tobacco control efforts, as well as during the most recent period.

Data

Our data come from surveys conducted by the Gallup organization (Gallup Polls). Gallup Polls are commercial public opinion polls that ask about politics, social circumstances, and a variety of other topics. Gallup Polls are probably best known for their questions about U.S. presidential elections, where they have been highly accurate from the 1936 election on (Newport, Saad, and Moore 1997). Glenn and Frisbie's (1977, p. 84) review notes that data from commercial polls, including the Gallup Poll, compare well "with comparable data collected by the most respected of the academic survey organizations…." Although Gallup Polls are perhaps more familiar in the mass media, data from U.S. and international Gallup Polls are also used in academic research (e.g. Blendon *et al.* 1990, Viscusi 1992, Deaton 2008).

We use data from 23 U.S. Gallup Polls conducted between 1944 and 2004 that collected information on smoking. The Gallup Poll surveys a random sample of the non-institutionalized U.S. population aged 18 and over. The earlier Gallup Polls we use (through 1981) were face-to-face surveys; the later Gallup Polls were telephone surveys. Gallup switched to telephone surveys after a sufficient proportion of U.S. households had at least one telephone to make this a viable and less expensive alternative to face-to-face surveys (Newport, Saad, and Moore 1997).

We use the Gallup Poll data to estimate the standard two-part model of adult smoking: a linear probability model of smoking participation; and conditional upon participation, an ordinary least squares model of the number of cigarettes smoked per day.[1] With somewhat more than 1,000 observations per year, the data from the 23 Gallup Polls provides a pooled sample size of 26,684 for the models of smoking participation. In a few years (1957, 1971, and 1972), Gallup Polls that asked about smoking participation did not ask smokers how many cigarettes they smoked per day. Dropping those years and limiting the sample to smokers provides a pooled sample size of 7,026 for the models of conditional cigarette demand. Before 1997 the Gallup Polls collected categorical data asked about cigarettes smoked per day; for these years our measure of conditional demand is based on the midpoints of the categories.[2]

The explanatory variables in our cigarette demand models include standard demographics, income, cigarette taxes, and an index of state regulations that restrict smoking in public places. The Gallup Polls routinely collected the respondent's age, gender, race, and schooling. Based on the survey year and the respondents' ages, we measure their birth cohort by decade, from the 1880s or before through the 1980s or later. From 1969 on, the Gallup Polls collected categorical data on annual household income. Our measure of income is based on the midpoints of the categories.[3] We used information on the respondents' state of residence to merge data on state cigarette taxes and the regulation index. Because the standard source of cigarette prices per state does not cover years before 1954 (Orzechowski and Walker 2007), we use cigarette taxes to proxy for prices in our demand model. Taxes should be a good proxy for prices because it is well-established that state tax differences account for much of the differences in average prices across states.[4] The use of taxes instead of prices in the demand model also avoids potential measurement error and simultaneity bias. Cigarettes taxes and annual household incomes are deflated to 1982 dollars using the Consumer Price Index for All Urban Consumers. The regulation index is defined as in Wasserman *et al.* (1991) and takes a higher value in states that restrict smoking in places where people spend a larger portion of time.[5] The regulation index is based on reports of the U.S. Department of Health and Human Services (1986a, b), ImpacTeen, and the Center for Disease Control's STATE system.

The descriptive statistics for each survey year are listed in Table 1. Smoking participation drops from almost 50 percent in the first surveys in the 1940s, to under 25 percent in the 2000s. Conditional upon smoking participation, the average number of cigarettes smoked per day is around 18 to 20 cigarettes from the 1940s through the 1980s, but in the 1990s and 2000s drops to around 15 to 16 cigarettes per day. The demographic composition of the samples is mainly consistent across survey years, but reflects national trends towards higher levels of schooling. Where possible (1970 and later), we have compared the estimates of smoking prevalence from the Gallup Poll data to estimates from the U.S. National Health Interview Survey (NHIS). The trends over time are very similar, but estimated smoking prevalence in the Gallup Poll data is consistently a few percentage points higher than in the NHIS.

Results

Table 2 presents results for a two-part model of cigarette demand using the pooled data from 1944 through 2004. The pooled data allow us to explore trends over time and across birth cohorts.[6] In addition to a general time trend, the results show strong birth cohort differences in smoking participation that vary by gender. The coefficients on the birth-cohort indicators capture the cohort differences for women; the coefficients on the cohort*male interactions capture the cohort differences for men. Compared to men in the most recent birth cohort (the omitted category, born in the 1980s or later), men in the earlier birth cohorts are more likely

to smoke. For example, men born in the 1890s or 1900s are almost 20 percentage points more likely to smoke. With the exception of the oldest birth cohort born in the 1880s or before, smoking participation among men falls fairly steadily with birth cohort.[7] Male smokers in the earlier birth cohorts also report smoking more cigarettes per day. In contrast, women in the earliest birth cohorts from the 1880s and 1890s are about 15 percentage points less likely to smoke, and report smoking fewer cigarettes per day conditional on smoking.

Table 3 presents the results for additional specifications of the two-part models of cigarette demand. The results in Table 2 show the 1944 – 2004 average influence of the demographic and economic variables. For Table 3, we continue to use the pooled data for 1944 – 2004, but now we estimate gradual switching regression models that explicitly allow all of the determinants of cigarette demand to change over time.[8] Our approach uses the gradual switching regression model developed in Ohtani and Katayama (1985) and Ohtani, Kakimoto and Abe (1990), as applied to consumer demand in Gallet and List (1998). The traditional approach to test for temporal change in the structure of a demand (or other behavioral) equation assumes parameter adjustments to structural breaks are instantaneous. As Gallet and List (1998) emphasize, for a habit-forming or addictive good like cigarettes, consumers may respond slowly to a structural break caused by a factor such as new information about health risks.

The gradual switching regression models of cigarette demand allow the slope parameters on the determinants of cigarette demand to gradually change over a linear transition path from an initial Regime 1 to a new Regime 2. We impose the a priori assumption that the start-point of the regime switch is 1964. This assumption is motivated by the widespread view that the 1964 Surgeon General's Report on smoking and health was a watershed event in attitudes and policies towards smoking (Warner 1977). We treat the end-points of the gradual switches as endogenous. As in Ohtani and Katayama (1985), Ohtani, Kakimoto and Abe (1990), and Gallet and List (1998), we estimate the gradual switching regression models iterated across all possible end-points. The results and end-points reported in Table 3 are those from the iteration which optimizes the regression objective function.

Table 3 presents results from two specifications of the gradual switching models of cigarette demand. The first specification takes a standard approach and includes state fixed effects, to control for time-invariant state-level influences such as anti-smoking sentiment or social norms. The second specification instead uses the direct measure of state-level anti-smoking sentiment developed by DeCicca *et al.* (2008). Previous research suggests this measure reflects influences similar to what are captured by state fixed effects (DeCicca *et al.* 2008, Carpenter and Cook 2008). The effect of state anti-smoking sentiment on cigarette demand is allowed to gradually switch from Regime 1 to Regime 2.

The results reported in Table 3 show that many cigarette demand influences indeed change over time. Many of the general patterns are similar across both specifications and in both parts of the two-part model presented in parts a and b of Table 3. First, the results show that a strong negative gradient between schooling and smoking developed over time. For example, college graduates are only about 6 percentage points less likely to smoke in Regime 1 (before 1964), but by Regime 2 (1986 and later) this has grown to about 15 percentage points. To help illustrate the gradual switching regression model, Figure 1 shows how the first specification's estimated coefficients for college education change over time. These trends are consistent with the findings of Kenkel and Liu (2008). Consistent with a causal role for schooling through health information, Kenkel and Liu find that the schooling-smoking gradient emerged in the 1950s and 1960s in tandem with a schooling-health knowledge gradient. However, they point out that the persistence and growth of the

schooling-smoking gradient over the latter part of the 20th century points to other, possibly non-causal, roles for schooling.

In addition to schooling, the results in Tables 3a and 3b suggest that the influence of sex, race, and income on cigarette demand also changed dramatically over time. For example, the gender gap in smoking participation mainly disappears: in Regime 1 men are 17 percentage points more likely to smoke, but this falls to 3 percentage points in Regime 2. The racial gap in smoking participation actually reverses: in Regime 1 whites are between 15 percentage points less likely to smoke, but by Regime 2 whites are about 5 percentage points more likely to smoke. The results for gender and race generally confirm and extend the findings of Fiore *et al.* (1989), who use data for the years 1974 – 1985.

The results in Tables 3a and 3b also suggest a negative income elasticity of cigarette demand, that has grown (in absolute value) over time with the switch from Regime 1 to Regime 2. Both parts of the two-part model show similar patterns, but income is only statistically significant in the first-part model of smoking participation. The pattern in our results is generally similar to Wasserman *et al.* (1991), who estimate that between 1970 and 1986 the income elasticity of cigarette demand changed from positive to negative.

The switching regression models reported in Table 3 provide somewhat mixed evidence about the effects of cigarette taxes and the regulation index on the demand for cigarettes. The two specifications show different patterns in the first-part model of smoking participation (Table 3a), but more similar patterns in the second-part model of conditional demand (Table 3b). In the specification that includes state fixed effects, the results imply that the price elasticity of smoking participation grows from insignificantly different from zero in Regime 1 to −0.4 in Regime 2. In this specification, the regulation index is also statistically significant and negative. However, in the specification that includes the direct measure of state anti-smoking sentiment, the effects of tax and the regulation index on smoking participation are small and statistically insignificant in both Regimes 1 and 2. The effect of state anti-smoking sentiment itself on participation switches from being unexpectedly positive in Regime 1, to having the expected negative effect in Regime 2. In the second-part models, both specifications imply that in Regime 2 cigarette taxes and the regulation index are associated with lower conditional demand for cigarettes per day.

Many previous economics studies focus on the price elasticity of cigarette demand. In their meta-analysis Gallet and List (2003) find that the mean of price elasticity estimates from 86 studies is −0.48, with a range from −3.12 to +1.41. Chaloupka and Warner (2000) describe a narrower range of −0.3 to −0.5 described by Chaloupka and Warner (2000). Several more recent estimates suggest that the Chaloupka-Warner range may have over-stated the price-elasticity of cigarette demand (Tauras 2006, Levy and Meara 2006, Colman and Remler 2008). In the only previous study that uses individual-level data to estimate the demand for cigarettes over a long time period in the U.S., similar to our results Wasserman *et al.* (1991) also find that “the price elasticity of demand is unstable over time, ranging from +0.06 in 1970 to −0.23 in 1985.” Our switching regression results tend to show a similar pattern towards a more strongly negative price effect after 1988 in Regime 2.

Keeler *et al.* (2001) stress the need to control for omitted state-level variables in cigarette demand, especially anti-smoking sentiment which may tend to be correlated with higher cigarette taxes and prices. Keeler *et al.* use panel data methods including state fixed effects to control for such omitted variables. Given the long time period we study, an interesting question is whether it makes sense to assume that unobserved state-level influences on cigarette demand are fixed from 1944 to 2004. Table 4 presents the results from 23 state-level regressions, one for each year of our Gallup Poll data. The sample size for each model

is the number of states (including D.C.) in the relevant year that taxed cigarettes. The dependent variable is the state's cigarette tax rate. The models include two explanatory variables: an indicator for states that produce tobacco; and the measure of state anti-smoking sentiment.

The results in Table 4 show that in the 1940s through 1954, cigarette taxes are not statistically significantly different in the tobacco states than in other states. From the 1970s on, the estimated coefficients on the tobacco state indicator are consistently negative and statistically significant and imply that cigarette prices in the tobacco states are $0.10 – $0.15 (in 1982 $) lower.[9] From the mid to late 1990s and especially in the 2000s, the estimated coefficients on the measure of anti-smoking sentiment are positive and statistically significant. The estimated coefficients generally increase over time and suggest that a one-unit increase (which is about a standard deviation of the index) is associated with about $0.50 to $0.70 higher taxes per pack in the 2000s.

The patterns in Table 4 suggest caution when interpreting the cigarette demand models reported in Table 3. The Table 4 patterns suggest that the potential for omitted variable bias in estimates of the effect of taxes on cigarette demand might be increasing over the time period we study. The Table 3 specification that includes state fixed effects might not be flexible enough to capture the changing state-level influences. The Table 3 switching regression model that includes the direct measure of anti-smoking sentiment in principle should control for this type of changing state-level influences. However, state anti-smoking sentiment is measured based on responses to surveys conducted in the 1990s (DeCicca et al 2008). Consequently, this specification is also not entirely satisfactory. Because of the inherent data limitations, we do not view our results as being very informative about the price-elasticity of cigarette demand.

Discussion

Over the sixty year time span covered in our data, smoking participation falls from almost 50 percent to 22 percent. Although prices are the focus of many studies of cigarette demand, as is suggested by Figure 2 differences in cigarette prices over time do not explain all of the longer-run downward trend in smoking participation.[10] Warner (1977) emphasizes the combined influence of public and private sector activities he calls the “anti-smoking campaign.” Subsequent health economics studies tackle the difficult challenges of identifying the causal effects of the specific tobacco control policies that made up the anti-smoking campaign. Many of these studies appropriately focus on the last few decades, a time period over which the real price of cigarettes more than doubled (see Figure 2), and various other tobacco control policies were enacted.[11]

While the longer time period we study does not provide definitive results about the role of cigarette taxes or prices, our results show that it is important to recognize that the influences of key demographic factors on cigarette demand change over time. From 1944 to 2004: the gender difference in smoking rates almost disappears; the Black-white difference reverses; and a strong gradient with schooling emerges. As discussed in special Surgeon General's Reports, other social and behavioral sciences explore gender and racial differences in smoking (USDHHS 1998, 2001). The various and varying demographic influences on cigarette demand are potentially fruitful areas for future health economic research as well. In particular, better understanding the schooling-smoking gradient, and the perhaps related negative income elasticity of cigarette demand, remain key challenges.

Our study shares key limitations in common with other studies that use repeated cross-sectional data and do not incorporate cigarette addiction. The use of individual-level data

allows us to decompose cigarette demand into two parts -- smoking participation and the conditional demand for cigarettes by smokers. But as DeCicca, Kenkel, and Mathios (2008) emphasize, smoking participation itself can be decomposed into smoking initiation and cessation. Similar to the empirical specification of the rational addiction model (Becker, Grossman and Murphy 1994), DeCicca, Kenkel and Mathios show that to incorporate addiction, a model of smoking participation should include past as well as current cigarette taxes or prices.

Alternatively, future work could focus directly on smoking initiation and cessation. Some public health and economic research uses retrospectively collected data to explore the determinants of initiation and cessation. For example, Fiore *et al.* (1989) suggest that the convergence in the smoking rates of men and women appears to be due to differences in smoking initiation rather than cessation. de Walque (2004) and Kenkel and Liu (2008) find that schooling is associated with less smoking initiation and more cessation. Future research could use longitudinal data to provide a more complete picture of the demographic and policy influences on smoking initiation and cessation decisions.

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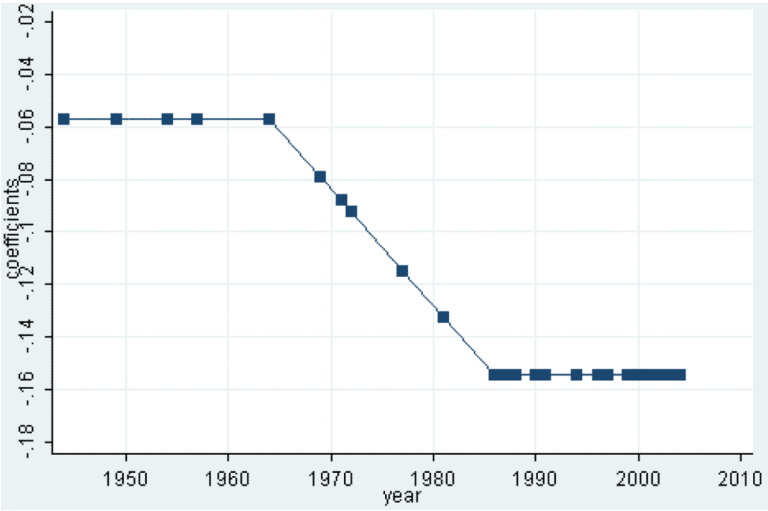

Figure 1.
Coefficients on College in Smoking Status Eqution

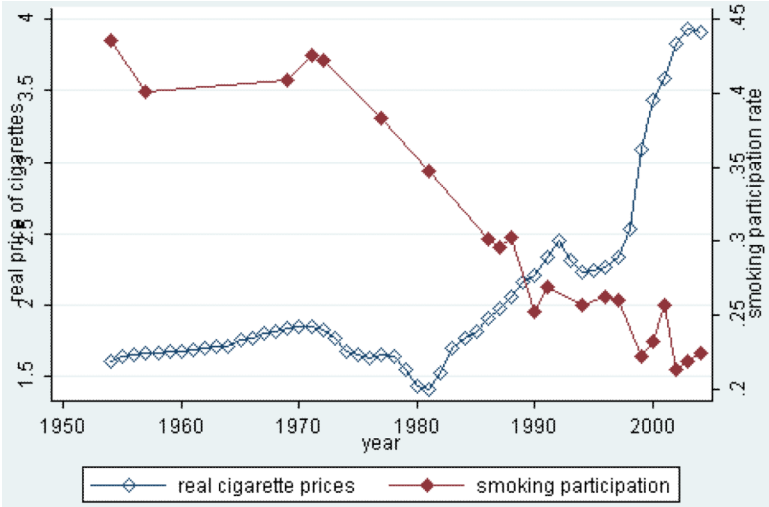

Figure 2.
Smoking Participation and Cigarette Prices, 1954–2004

Table 1

Descriptive Statistics

Year	Current smokers	Number of cigarettes per day	Male	Age	White	Less than high school	High school dropout	High school graduates	Two year college	College graduate or above	Sample size
1944	0.49	17.49	0.58	46.71	0.80	0.44	0.16	0.17	0.08	0.13	3261
1949	0.46	17.81	0.50	43.30	0.92	0.31	0.22	0.27	0.10	0.11	1354
1954	0.44	19.72	0.50	42.54	0.94	0.32	0.25	0.24	0.09	0.10	1370
1957	0.40	N/A	0.48	44.87	0.89	0.34	0.22	0.24	0.11	0.09	1499
1969	0.41	17.74	0.50	45.41	0.89	0.20	0.18	0.33	0.18	0.12	1469
1971	0.43	N/A	0.48	44.22	0.90	0.18	0.17	0.33	0.19	0.12	1451
1972	0.42	N/A	0.48	44.76	0.89	0.16	0.20	0.32	0.19	0.13	1531
1977	0.38	21.27	0.49	44.22	0.87	0.12	0.15	0.33	0.25	0.15	1484
1981	0.35	20.20	0.50	45.12	0.87	0.10	0.15	0.33	0.23	0.19	1513
1986	0.30	19.09	0.50	41.40	0.87	0.04	0.09	0.36	0.26	0.25	1004
1987	0.30	17.07	0.50	43.21	0.86	0.05	0.09	0.35	0.24	0.26	1003
1988	0.30	18.83	0.50	43.53	0.91	0.04	0.07	0.34	0.26	0.29	996
1990	0.25	16.49	0.50	44.58	0.87	0.04	0.09	0.31	0.28	0.28	1213
1991	0.27	16.90	0.51	45.06	0.88	0.05	0.09	0.33	0.27	0.26	996
1994	0.26	16.99	0.51	44.41	0.82	0.02	0.07	0.35	0.28	0.27	997
1996	0.26	17.18	0.51	44.56	0.82	0.02	0.08	0.27	0.30	0.32	994
1997	0.26	17.40	0.49	44.98	0.78	0.02	0.07	0.31	0.28	0.32	1015
1999	0.22	14.51	0.48	45.88	0.82	0.02	0.07	0.27	0.28	0.37	997
2000	0.23	14.02	0.48	46.62	0.83	0.02	0.07	0.26	0.28	0.38	1024
2001	0.26	14.57	0.47	47.27	0.83	0.02	0.06	0.30	0.27	0.35	1033
2002	0.21	16.08	0.49	47.01	0.83	0.01	0.05	0.27	0.30	0.37	1003
2003	0.22	15.17	0.46	47.99	0.87	0.01	0.06	0.25	0.27	0.40	1002
2004	0.22	15.88	0.48	50.24	0.86	0.01	0.05	0.26	0.30	0.38	997

Table 2

Two-part model of cigarette demand, pooled data 1944 – 2004

	Smoking participation	Smoking level
Age	0.004	0.346
	[0.001]**	[0.049]**
Age-squared	−0.010	−0.391
	[0.001]**	[0.054]**
Less than high school	−0.012	1.344
	[0.012]	[0.361]**
High school dropout	0.040	0.396
	[0.009]**	[0.313]
Two year college	−0.047	−0.508
	[0.007]**	[0.323]
College graduate or above	−0.142	−2.152
	[0.007]**	[0.387]**
White	−0.009	3.066
	[0.012]	[0.443]**
Cigarette tax	0.024	−3.170
	[0.020]	[1.170]**
Regulation index	−0.002	−0.189
	[0.001]*	[0.044]**
Year	−0.003	0.071
	[0.001]*	[0.046]
1880 cohort	−0.084	4.365
	[0.103]	[4.153]
1890 cohort	−0.077	5.975
	[0.099]	[3.864]
1900 cohort	−0.021	4.387
	[0.093]	[3.129]
1910 cohort	0.049	6.387
	[0.085]	[2.945]*
1920 cohort	0.045	6.617
	[0.079]	[2.586]*
1930 cohort	0.057	7.372
	[0.063]	[2.115]**
1940 cohort	0.057	6.818
	[0.058]	[1.758]**

	Smoking participation	Smoking level
1950 cohort	0.013	5.552
	[0.052]	[1.488]**
1960 cohort	0.010	4.218
	[0.052]	[1.340]**
1970 cohort	0.007	1.720
	[0.046]	[1.238]
Male	0.008	2.617
	[0.054]	[1.293]*
1880 cohort × male	0.112	1.463
	[0.058]+	[2.282]
1890 cohort × male	0.203	0.132
	[0.058]**	[1.771]
1900 cohort × male	0.184	3.434
	[0.061]**	[1.570]*
1910 cohort × male	0.127	1.234
	[0.062]*	[1.398]
1920 cohort × male	0.093	1.731
	[0.059]	[1.506]
1930 cohort × male	0.043	1.055
	[0.056]	[1.670]
1940 cohort × male	0.071	−0.258
	[0.052]	[1.390]
1950 cohort × male	0.053	0.079
	[0.053]	[1.538]
1960 cohort × male	−0.016	−1.155
	[0.057]	[1.482]
1970 cohort × male	0.004	0.017
	[0.059]	[1.404]
Constant	5.395	−137.990
	[2.208]*	[90.702]
Observations	28407	7728
R-squared	0.10	0.08

The numbers in brackets are robust standard errors, adjusted for state-level clustering

+ significant at 10%;

* significant at 5%;

** significant at 1%

Table 3a

Linear probability models of smoking participation, gradual switching

	Model with SFE		Model with sentiment	
	Regime 1	**Regime 2**	**Regime 1**	**Regime 2**
Age	−0.007	0.014	−0.007	0.013
	[0.002]**	[0.001]**	[0.002]**	[0.001]**
Age-squared	0.000	−0.018	0.000	−0.018
	[0.002]	[0.001]**	[0.002]	[0.001]**
Less than high school	−0.023	0.030	−0.026	0.029
	[0.016]	[0.021]	[0.016]	[0.021]
High school dropout	−0.002	0.091	−0.004	0.094
	[0.015]	[0.012]**	[0.015]	[0.012]**
Two year college	−0.004	−0.062	−0.007	−0.061
	[0.019]	[0.009]**	[0.019]	[0.009]**
College grad or above	−0.057	−0.155	−0.058	−0.154
	[0.015]**	[0.009]**	[0.015]**	[0.009]**
Male	0.168	0.032	0.168	0.032
	[0.013]**	[0.009]**	[0.013]**	[0.009]**
White	−0.149	0.050	−0.148	0.047
	[0.016]**	[0.013]**	[0.017]**	[0.014]**
Cigarette tax	−0.016	−0.072	0.033	−0.016
	[0.050]	[0.025]**	[0.055]	[0.026]
Household income	−0.020	−0.069	−0.021	−0.069
	[0.010]*	[0.012]**	[0.010]*	[0.011]**
Regulation index [d]	−0.011	−0.015	0.003	0.003
	[0.002]**	[0.003]**	[0.003]	[0.004]
Anti smoking sentiment			0.013	−0.008
			[0.004]**	[0.003]*
Tax elasticity [b]	−0.004	−0.069**	0.009	−0.015
Price elasticity [a]	−0.029	−0.418**	0.065	−0.091
Income elasticity [b,c]	−0.047*	−0.286**	−0.049*	−0.286**
Average tax (unit: 1982 $)	0.118	0.244	0.118	0.244
Average price (unit: 1982 $)	0.855	1.481	0.855	1.481
Average regulation index (range: 0 – 10)	0.051	6.939	0.051	6.939
Ratio of tax to price	0.138	0.165	0.138	0.165
Start-point of gradual switch	1964	1964	1964	1964
End-point of gradual switch	1986	1986	1986	1986

All models also include survey year indicators. The numbers in brackets are robust standard errors, adjusted for state-level clustering.

[a] Price elasticity is calculated with the formula: $\eta_{price} = \eta_{tax}(\alpha Tax/Price)^{-1}$.$\eta_{tax}$ is tax elasticity in the associated regime, the ratio of Tax/Price is measured at the average, and we assume $\alpha = 1$ that cigarette taxes are passed through to prices at the one-to-one ratio.

[b] Tax elasticity is calculated by the formula of $\beta_{tax}\times$(Tax/Smoke) at the average; income elasticity is calculated by $\beta_{income}\times$(Income/Smoke) at the average.

[c] Income elasticities in regime 1 for both models are estimated in the year of 1969 which is the first year when income information is available.

[d] Coefficients on regulation index in regime 1 for both models are for the year of 1969 which is the first wave when index is available.

[+] significant at 10%;

[*] significant at 5%;

[**] significant at 1%.

Table 3b

OLS models of smoking level, gradual regime switching

	Model with SFE		Model with sentiment	
	Regime 1	**Regime 2**	**Regime 1**	**Regime 2**
Age	−0.082	0.687	−0.094	0.676
	[0.091]	[0.065]**	[0.091]	[0.065]**
Age-squared	0.092	−0.678	0.102	−0.667
	[0.094]	[0.074]**	[0.094]	[0.074]**
Less than high school	1.248	1.295	1.207	1.267
	[0.501]*	[0.863]	[0.507]*	[0.867]
High school dropout	0.381	1.246	0.420	1.180
	[0.510]	[0.511]*	[0.526]	[0.501]*
Two year college	0.591	−0.866	0.492	−0.932
	[0.608]	[0.421]*	[0.600]	[0.414]*
College grad or above	0.333	−2.994	0.410	−3.025
	[0.610]	[0.523]**	[0.608]	[0.512]**
Male	4.749	2.507	4.746	2.491
	[0.380]**	[0.339]**	[0.379]**	[0.338]**
White	−2.436	5.644	−2.419	5.532
	[0.625]**	[0.459]**	[0.654]**	[0.453]**
Real cig tax	−1.606	−5.465	0.815	−4.616
	[2.695]	[1.417]**	[2.226]	[1.302]**
Household income	−0.070	−0.648	−0.133	−0.678
	[0.398]	[0.563]	[0.379]	[0.543]
Regulation index [d]	−1.640	−1.979	−1.318	−1.604
	[0.089]**	[0.098]**	[0.088]**	[0.105]**
Anti smoking sentiment			0.094	−0.029
			[0.190]	[0.087]
Tax elasticity [b]	−0.010	−0.072**	0.005	−0.061**
Price elasticity [a]	−0.072	−0.424**	0.036	−0.359**
Income elasticity [b,c]	−0.004	−0.038	−0.007	−0.039
Average real tax (unit: dollars)	0.118	0.232	0.118	0.232
Average real price	0.855	1.365	0.855	1.365
Average regulation index (range 0 – 10)	N/A	6.301	N/A	6.301
Ratio of tax to price	0.138	0.170	0.138	0.170
Start-point of gradual switch	1964	1964	1964	1964
End-point of gradual switch	1977	1977	1977	1977

The numbers in brackets are robust standard errors, adjusted for state-level clustering.

[a] Price elasticity is calculated with the formula: $\eta_{price} = \eta_{tax}(\alpha Tax/Price)^{-1}$. η_{tax} is tax elasticity in the associated regime, the ratio of Tax/Price is measured at the average, and we assume $\alpha = 1$ that cigarette taxes are passed through to prices at the one-to-one ratio.

[b] Tax elasticity is calculated by the formula of $\beta_{tax}\times$(Tax/Cigarettes) at the average; income elasticity is calculated by $\beta_{income}\times$(Income/Cigarettes) at the average.

[c] Income elasticities in regime 1 for model 1 and 2 are estimated in the year of 1969 which is the first year when income information is available.

[d] Coefficients on regulation index in regime 1 for both models are for the year of 1969 which is the first wave when index is available.

[+] significant at 10%;

[*] significant at 5%;

[**] significant at 1%.

Table 4

State-level models of cigarette taxes

Dependent variables: state-level cigarette taxes								
	1944	**1949**	**1954**	**1957**	**1969**	**1971**	**1972**	**1977**
Tobacco states	0.02	−0.03	−0.04	−0.07	−0.08	−0.14	−0.15	−0.12
	[0.06]	[0.04]	[0.03]	[0.03]*	[0.04]+	[0.04]**	[0.05]**	[0.03]**
Anti smoking sentiment	0.21	0.05	−0.04	−0.06	0.19	−0.02	0.02	0.02
	[0.15]	[0.09]	[0.08]	[0.08]	[0.11]+	[0.11]	[0.12]	[0.08]
Constant	0.16	0.31	0.11	0.12	0.28	0.27	0.29	0.22
	[0.03]**	[0.02]**	[0.02]**	[0.02]**	[0.02]**	[0.02]**	[0.02]**	[0.02]**
Observations	49	49	49	49	51	51	51	51
R-squared	0.04	0.03	0.04	0.08	0.21	0.2	0.21	0.27

	1981	**1986**	**1987**	**1988**	**1990**	**1991**	**1994**	**1996**
Tobacco states	−0.09	−0.1	−0.1	−0.12	−0.11	−0.12	−0.14	−0.15
	[0.05]**	[0.03]**	[0.03]**	[0.03]**	[0.03]**	[0.03]**	[0.05]**	[0.05]**
Anti smoking sentiment	−0.01	0.06	0.06	0.06	0.14	0.12	0.16	0.22
	[0.05]	[0.07]	[0.06]	[0.07]	[0.08]+	[0.08]	[0.11]	[0.13]+
Constant	0.15	0.18	0.17	0.18	0.2	0.21	0.24	0.26
	[0.01]**	[0.01]**	[0.01]**	[0.01]**	[0.02]**	[0.02]**	[0.02]**	[0.03]**
Observations	51	51	51	51	51	51	51	51
R-squared	0.29	0.33	0.34	0.34	0.36	0.34	0.29	0.28

	1997	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**
Tobacco states	−0.14	−0.13	−0.13	−0.13	−0.15	−0.26	−0.31
	[0.06]*	[0.07]+	[0.07]+	[0.07]+	[0.10]	[0.12]*	[0.14]*
Anti smoking sentiment	0.26	0.52	0.52	0.51	0.69	0.65	0.54
	[0.14]+	[0.17]**	[0.18]**	[0.18]**	[0.25]**	[0.29]*	[0.35]
Constant	0.27	0.35	0.35	0.35	0.44	0.54	0.54
	[0.03]**	[0.03]**	[0.04]**	[0.04]**	[0.05]**	[0.06]**	[0.07]**
Observations	51	51	51	51	51	51	51
R-squared	0.28	0.33	0.31	0.3	0.26	0.27	0.21

Standard errors in brackets

+ significant at 10%;

* significant at 5%;

** significant at 1%