A WORKING MODEL FOR
PREDICTING THE CONSUMPTION AND
REVENUE IMPACTS OF LARGE
INCREASES IN THE U.S. FEDERAL
CIGARETTE EXCISE TAX

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ABSTRACT

This report describes an easily computable model of the relation between cigarette prices

and cigarette consumption in the United States. The model is used to predict the revenue impacts

of Federal excise tax hikes ranging from $0.45 to $1.76 per pack.

Proposed Federal Excise Tax Increase (and Sponsor)	Percent of Adults who smoke cigarettes in 1999	Gain in Net Federal Revenues during 1995-1999 (billions $)
Baseline (No tax increase)	22.0	---
$0.45/pack over 5 years (House Ways & Means Committee)	21.1	20.4
$0.75/pack on 1/1/95 (Administration's Health Secur. Act)	20.4	52.1
$1.00/pack on 1/1/95 (Senate Finance Committee)	20.0	65.9
$1.50/pack on 1/1/95 (Senate Labor & Human Resources Comm.)	19.1	89.1
$1.76/pack on 1/1/95 (Senate Finance Committee Chairman)	18.6	98.9

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SUMMARY

This report describes an easily computable model of the relation between
cigarette prices and cigarette consumption in the United States. The
model is used to predict the revenue impacts of Federal excise tax hikes
ranging from $0.45 to $1.76 per pack.

The key idea is to split annual cigarette consumption per adult
into the product of two components: the proportion of the adults that
currently smoke cigarettes (the "prevalence of smoking"); and the
average number of cigarettes consumed per smoking adult ("consumption
per smoker"). Each component is modeled and predicted separately.

The prevalence of smoking is determined by two factors: the price
of cigarettes; and a long-term, downward secular trend that refects
increasing health concerns, the declining social acceptability of
smoking, and growing legal restrictions on smoking in public places.
Consumption per smoker is likewise determined by the price of
cigarettes. However, it is also inversely related to the average
nicotine delivery per cigarette.

Based upon a statistical analysis of national-level data for the years 1964 through 1993, the model gives the following two prediction equations:

$$V = 31.166 - 0.173*P - 0.0162*Y \; ; \; \text{and}$$
$$W = 3.710 - 0.171*P - 0.1290*N \; ,$$

where "V" denotes the natural logarithm of the proportion of adults who smoke; "W" denotes the natural logarithm of the average number of cigarettes consumed by an adult smoker each day; "P" denotes the average retail price of cigarettes in constant (1982-84) dollars; "Y" represents the calendar year; and "N" is the sales-weighted average FTC-measured nicotine per cigarette (in milligrams).

The model's first equation implies that, apart from the effects of price, the proportion of adults who smoke has been declining at a rate of 1.62 percent annually. The second equation indicates that, for each 0.1 milligram decline in average nicotine per cigarette, consumption per smoker has risen by about 1.29 percent. Overall, for the year 1993, the model gives a point price elasticity of demand for cigarettes of -0.47.

To predict the effects of alternative tax-hike proposals, the following were assumed for the years 1994 through 1999: state and local tax rates will grow at 15 percent annually; cigarette manufacturers and wholesalers will moderate their price increases at 2 percent annually; the general price level rise at 4.1 percent annually; and the average cigarette will yield 0.975 milligrams of nicotine. The main results were as follows:

Proposed Federal Excise Tax Increase (and Sponsor)	Percent of Adults Who Smoke Cigs. in 1999	Gain in Net Federal Revenues during 1995 through 1999 (billions $)
Baseline (No tax increase)	22.0	---
$0.45/pack over 5 years (House W. & M.)	21.1	20.4
$0.75/pack on 1/1/95 (Administration)	20.4	52.1
$1.00/pack on 1/1/95 (Senate Fin. Comm.)	20.0	65.9
$1.50/pack on 1/1/95 (Senate Lab & H.R.)	19.1	89.1
$1.76/pack on 1/1/95 (Senate Fin. Chair)	18.6	98.9

This is a working model. It can be revised to accommodate new data when they are available. It can be modified to incorporate larger reactive tax increases by state governments; accelerated growth in the market share of discount cigarettes; deeper reactive cuts in wholesale prices charged by cigarette manufacturers; and Federal restrictions on the nicotine contents of cigarettes. Some specific modifications of the basic model, and their effects on predicted tax revenues and cigarette consumption, are discussed.

INTRODUCTION: Many economists have analyzed the effects of state excise tax increases on cigarette consumption. While these studies may shed light on the impact of a one-time tax hike as large as 25 cents per pack, there is no direct experience in the United States with one-time nation-wide cigarette tax increases of 75 cents per pack or more, as proposed in the Administration's Health Security Act and other bills recently issued from Congressional committees.

This report provides a simple working model of the effects of large Federal excise taxes on cigarette consumption and tax revenues. The model has two components, which are analyzed and predicted separately. The first component predicts the proportion of the U.S. adult population that regularly smokes cigarettes (the "prevalence" of smoking); while the second component predicts the average number of cigarettes consumed by current smokers ("consumption per smoker"). The two components are combined to estimate the overall effect of a tax increase on total cigarette consumption and Federal tax revenues.

The first component of the model specifically takes into account the long-run secular decline in smoking rates that has prevailed in the U.S. since at least the mid 1960s. A statistical study that failed to consider such secular trends would falsely attribute the entire past decline in smoking to price increases, and thus overstate the deterrent effect of taxes on smoking prevalence.

The second component of the model specifically takes into account the changing nicotine deliveries of cigarettes during the past three decades. As the nicotine yields of most cigarettes fell during the late 1960s and 1970s, the average smoker consumed more cigarettes each day. Failure to consider this "compensation effect" would obscure the effect of cigarette prices on smoking rates.

DATA: The basic data are reproduced in Table 1 (page 9). Data sources are reported in the notes to Table 1. Figures 1 and 2 (pages 15-16), which are described in detail below, chart trends in the basic data.

STATISTICAL METHODS: Constrained linear regressions were performed as described in Table 2 (page 11). Table 3 (page 12) shows the baseline and alternative tax scenarios that were used to make consumption and revenue projections.

RESULTS: Table 4 (page 13) gives the estimates of the statistical model. Table 5 (page 13) shows the consumption and revenue predictions for alternative tax scenarios. In addition, for illustrative purposes, Figures 3 through 5 (pages 17-19) chart the predicted effects of one particular scenario: a one-time Federal excise tax increase of $1.76 per pack on January 1, 1995.

COMMENT:

LONG-TERM SECULAR DECLINES IN SMOKING: Figure 1 (page 15) charts trends in two variables during 1964-1993: the percentage of adults who

currently smoke cigarettes (open circles, left-hand scale); and the
constant-dollar price of cigarettes (connected line, right-hand scale).
Since surveys of smoking practices have been performed only
sporadically, data on the prevalence of smoking are available for only
17 years during the 30-year period charted in Figure 1. By contrast, a
continuous price series can be estimated. The prices in Figure 1 have
been converted to constant dollars, based upon the Consumer Price Index
for 1982-84. (To convert to 1994 constant dollars, multiply the prices
by 1.5.)

     As Figure 1 shows, the proportion of adults who smoke has
persistently declined, at least from 1966 through 1990. By contrast,
the real price of cigarettes has risen, fallen, and risen again in three
distinct phases. During 1964-70, increasing state taxes drove retail
cigarette prices higher. During 1970-82, by contrast, state tax hikes
and manfacturers' wholesale price increases failed to keep pace with
inflation. From 1983-93, Federal and state excise tax increases, and
especially increases in manufacturers' wholesale prices, pushed up the
average retail price of cigarettes at an annual rate of 4.7 percent over
general inflation.

     Figure 1 illustrates the pitfall in attributing the long-term
decline in the percentage of smokers entirely to a rise in cigarette
prices. The proportion of adults who smoked-- particularly male
smokers-- continued to drop during the 1970s, even while cigarette
prices failed to keep pace with inflation. A statistical model that
predicted smoking rates from price alone would not only fit the data
poorly, but also far overstate the quantitative influence of price.

     The inclusion of an income variable (such as real disposable per
capita income) in the statistical model would markedly reduce the effect
of price. However, such a model would show a strong negative influence
of rising personal income on smoking prevalence, an effect that runs
contrary to the standard economic theory of so-called normal goods.
Basically, any variable that showed a rising trend during the last three
decades-- not just personal income-- would predict what is in reality a
complex mixture of social influences: growing health concerns about
smoking; declining social acceptablity of smoking; and increasing
restrictions on smoking in public places, including the workplace.

     Some analysts have tried to tease out the separate effects of each
governmental policy concerning smoking-and-health (such as the 1964
Surgeon General's Report, the 1969 televised anti-smoking messages, and
the 1971 ban on broadcast cigarette advertising). One might incorporate
a variable to reflect the numbers of states and major cities that have
legislated restrictions on smoking in public places. Still another
candidate would be the sales of nicotine replacement products (gum and
patch), which grew rapidly during the early 1980s. It is hardly obvious
that complex multivariate models would capture the overall secular
decline in American smoking prevalence any better than a simple,
constant-trend equation.

Some economists have adopted the convenience of using past values of cigarette consumption to predict current smoking rates. This practice may improve the statistical fit of the model. Unfortunately, it leads the analyst to conclude that a one-time cigarette price increase has a long-term effect that grows ever larger with time, often requiring a decade to have its full negative impact on consumption. (Consider a male smoker who quit in 1993 because his wife and children finally convinced him to stop, or because his doctor prescribed a nicotine patch, or because it became impossible to smoke at work. Now imagine an economist explaining to him that the 1983 Federal excise tax hike was an important contributor to his decision to quit.) In reality, in the year or two immediately following a price increase, consumption tends to rebound. The possible effects of such a "rebound" phenomenon on Federal revenue estimates are considered below.

Figure 1 further shows an apparent leveling in the proportion of adult smokers after 1990. This phenomenon reflects a reversal of smoking trends among young adults aged 18-24 years, and is mimicked by recent school-based surveys of trends in teenage smoking rates. This leveling-off phenomenon has not been incorporated into the basic model of this report, but it can be incorporated in an alternative model. The possible effects of such an alternative model on Federal revenue estimates are considered below.

NICOTINE AND CONSUMPTION PER SMOKER: Figure 2 (page 16) charts trends in two variables: the average number of cigarettes smoked daily per current adult smoker; and the sales-weighted average nicotine delivery per cigarette, as measured by the Federal Trade Commission (FTC) method. Smoking rates rose from 28 cigarettes per day in the mid 1960s; peaked at 32 per day in 1978-1980; and declined thereafter.

Figure 2 shows why previous statistical analyses have failed to relate daily smoking rates to changes in cigarette prices. Consumption per smoker rose during 1964-70, even while real cigarette prices were rising. As the Figure shows, however, the rise in consumption per smoker during that time period paralleled the shift toward lower-nicotine cigarettes. This reciprocal relation between consumption per smoker and cigarette nicotine delivery goes way back. In the early 1950s, when the average FTC-based nicotine yield was closer to 1.6-1.8 milligrams per cigarette, the average smoker consumed about 24-26 cigarettes per smoker per day.

When a smoker quits permanently, the prevalence of smoking falls. A temporary, failed attempt to quit, however, shows up as a drop in consumption per smoker. To some extent, the decline in consumption per smoker during the 1980s may reflect an increasing tendency of current smokers to try to quit. From recent surveys, perhaps as many as 40 percent of current smokers now make a serious but unsuccessful attempt to stop each year. In fact, the apparent dip in consumption per smoker in 1983 may reflect a round of quit attempts soon after Federal excise

tax was hiked and manufacturers concurrently boosted wholesale
prices.

Whatever the explanation for the 1980s decline in consumption per
smoker, Figure 2 shows that the downtrend was associated with a
stagnation-- better still, a slight increase-- in average nicotine
yields. This rise in nicotine per cigarette reflects not only the
reformulation of existing brands, but also the growing market share of
higher-nicotine generic and discount-brand cigarettes during the 1980s.

Figure 2 and Table 1 use data on the sales-weighted average
nicotine delivery per cigarette. Apart from potential inaccuracies in
the FTC method of nicotine measurement, the average nicotine level does
not capture the range of nicotine deliveries. Since the mid-1960s, many
so-called low-tar and aerated-filter brands have been introduced, while
the share of nonfilter cigarettes has plummeted. While cigarette "tar"
deliveries have declined, nicotine-to-"tar" ratios have risen. It is
hardly obvious, however, that more complex indicators of these changes
in product mix will perform any better than a simple sales-weighted
nicotine index.

FEDERAL TAX HIKES AND THE PREVALENCE OF SMOKING: Figure 3 (page
17) illustrates the ability of the model to predict the effect of
alternative Federal excise tax policies. The open circles show National
Health Interview Survey data on the adult prevalence of smoking, as
reported in column "A" in Table 1. The solid line shows the fit of the
statistical model to these historical data, based upon Equation 1 in
Table 4. The dashed lines compare the predicted effects of two
different scenarios: a baseline scenario with no further Federal tax
hikes; and an alternative scenario in which the Federal tax rises from
$0.24 to $2.00 per pack on January 1, 1995. These predicted effects on
the prevalence of smoking are also given in Table 5.

Figure 3 predicts that, with no Federal excise tax increase, the
percentage of adults who smoke will drift downward from its 1993 level
of 25.6 percent to a 1999 level of 22.0 percent. With a $1.76/pack tax
increase, by contrast, the prevalence of smoking will fall to 18.6
percent by 1999. The lower prevalence in the tax-hike scenario
translates into 6.7 million fewer adult cigarette smokers by 1999.

As noted, the present model does not incorporate the apparent
leveling off in the percentage of smokers that was observed in the
National Health Interview Surveys during 1990-1992. When such a
leveling-off phenomenon is incorporated in the model, the baseline no-
tax scenario predicts that 24.3 percent of adults will still be smokers
in 1999, while the tax-hike scenario pegs the prevalence of smoking at
20.5 percent in the same year. In that case, a $1.76/pack tax hike
translates into 7.5 million fewer smokers. (The net 5-year gain in
Federal revenues would be $106 billion, as compared to $99 billion given
in Table 5.)

FEDERAL TAX HIKES AND CONSUMPTION PER SMOKER: Figure 4 (page 18) illustrates the model's predictions of consumption per smoker. The open circles represent the basic historical data on the average number of cigarettes smoked each day by current smokers, which are derived from column "S" in Table 1. The solid line shows the fit of the statistical model, based upon Equation 2 in Table 4. The dashed lines compare the predicted effects of two different scenarios: a baseline scenario with no further Federal tax hikes; and an alternative scenario in which the Federal tax rises from $0.24 to $2.00 per pack on January 1, 1995. Under the baseline no-tax scenario, consumption per smoker will drift slightly downward toward 28.1 cigarettes per day in 1999. Under the tax-hike scenario, consumption per smoker will fall to 23.9 cigarettes per day in 1999.

Figure 4 shows that the present statistical model did not accurately predict the dip in daily consumption per smoker that was seen in 1993. Accordingly, an alternative model was formulated, in which real-price increases (but not decreases) caused a short-term overreaction in daily consumption per smoker, followed by a rapid rebound. In such a model, the one-time $1.76/pack Federal tax hike caused consumption per smoker to dip to 16.3 cigarettes per day in 1995. The model predicted that smoking rates would then rebound to 18.6 per day in 1996, and then to 26.9 per day in 1997-1999. (The net 5-year gain in Federal revenues would be $94 billion, as compared to $99 billion given in Table 5.)

FEDERAL TAX HIKES AND PER CAPITA CONSUMPTION: Figure 5 (page 19) illustrates the model's predictions for per capita cigarette consumption. The open circles are historical USDA data, taken from column "C" in Table 1. The solid, connected line shows the model's fit. The dashed lines show the comparative predictions of the baseline and $1.76/pack tax-hike scenarios. With no further Federal tax increase, per capita consumption will drift downward to 2,257 per adult in calendar 1999. With a $1.76/pack one-time tax in 1995, per capita consumption will fall to 1,623 cigarette per adult-- a level not seen in the United States since the mid 1930s.

As Figure 5 shows, the present model predicted per capita consumption more accurately during 1978-1993 than in the years from 1964-1977. (The prediction errors in the early 1970s were responsible for the serial correlation of residuals described in the econometric note to Table 4.) During 1964-1977, the overall decline in adult smoking prevalence was mostly a male phenomenon. In fact, during the late 1960s and early 1970s, the percentage of women who smoked cigarettes temporarily rose. After 1978, however, both men and women stopped smoking at about equal rates. Accordingly, an alternative model was formulated to capture these gender-specific differences. Such a model produced an improved statistical fit for 1964-1977, but the predictions of consumption and revenue under alternative tax proposals for 1995-1999 remained unchanged.

CRITIQUE: As noted in Table 3, the present model assumes that state tax rates will grow at 15 percent annually during 1994-1999, compared with an average 11 percent growth rate during 1988-1993. It is, at best, an educated guess as to how state governments will react to declining cigarette tax revenues that will result from reduced demand. However, early indicators from 1994 suggest that state tax hikes will accelerate. More states will include cigarettes within their general sales taxes. Larger one-time tax increases (such as California's and Massachusetts' 25-cent hikes and Michigan's 50-cent boost) may appear on state-wide ballots.

As further noted in Table 3, the present model assumes that manufacturers will moderate the growth of wholesale prices at 2 percent annually. Again, it can be no more than an educated guess as to how cigarette companies will respond. It appears that manufacturers' 1993 cuts in wholesale prices of premium brands are already being cancelled out by large increases in state and local taxes. While further wholesale price cuts might bolster cigarette demand, they would reduce manufacturers' profitability-- and stock prices-- considerably. If manufacturers' cut price and "swallowed" a good portion of any Federal excise tax increase, there would be a smaller drop in cigarette consumption, but a larger gain in Federal revenues.

The present model assumes that the average nicotine yield per cigarette will rise slightly to 0.975 milligrams per cigarette during 1994-1999. Since generic cigarettes and discount brands have slightly higher nicotine yields, and since the market shares of these lower-priced offerings are expected to rise further, a projection for slightly higher nicotine yields seems like a good bet. Federal regulation of cigarette nicotine contents, however, may alter this prediction drastically. The present model predicts that Federally mandated reductions in nicotine would push daily smoking rates back up. A rough calculation suggests that if all cigarettes delivering more than 0.9 milligrams of nicotine were outlawed, then the typical consumer might smoke an average of 1 or 2 more cigarettes per day. This sort of "compensation" effect would put billions into the Federal fisc.

TABLE 1.   BASIC DATA AND DATA SOURCES

Calendar Year	Cigarette Consumption per Person Aged 18 Yrs. or More/1	Percentage of Adults Currently Smoking Cigarettes/2	Cigarettes Consumed per Adult Smoker per Day/3	Ave. Retail Price per Pack in Constant (1982-84) Dollars/4	Sales- Weighted Average Nicotine per Cig. (mg)/5
"Y"	"C"	"A"	"S"	"P"	"N"
1964	4194	--	--	0.886	1.370
1965	4258	42.4	27.51	0.914	1.430
1966	4287	42.6	27.57	0.925	1.480
1967	4280	40.1	29.24	0.935	1.450
1968	4186	38.6	29.71	0.958	1.410
1969	3993	--	--	0.969	1.379
1970	3985	37.4	29.19	1.004	1.311
1971	4037	--	--	0.982	1.324
1972	4043	--	--	0.993	1.387
1973	4148	--	--	0.941	1.323
1974	4141	37.1	30.58	0.899	1.243
1975	4123	--	--	0.872	1.213
1976	4092	36.7	30.55	0.865	1.161
1977	4051	--	--	0.848	1.116
1978	3967	34.1	31.87	0.827	1.105
1979	3861	33.5	31.58	0.782	1.067
1980	3849	33.2	31.76	0.746	1.040
1981	3836	--	--	0.729	0.919
1982	3739	--	--	0.769	0.890
1983	3488	32.1	29.77	0.898	0.880
1984	3446	--	--	0.922	0.890
1985	3370	30.1	30.67	0.947	0.960
1986	3274	--	--	0.994	0.920
1987	3197	28.8	30.41	1.028	0.940
1988	3096	28.1	30.19	1.077	0.940
1989	2926	--	--	1.159	0.970
1990	2817	25.5	30.27	1.219	0.930
1991	2713	25.6	29.03	1.283	0.940
1992	2640	25.6	28.25	1.363	0.948
1993	2539	--	--	1.376	0.955

NOTES TO TABLE 1:

1.   Source: U.S. Department of Agriculture, Economic Research Service.
     TOBACCO SITUATION AND OUTLOOK REPORT, TBS-226, April 1994, Table 2,
     and earlier issues.

2.   Source: For all years except 1966-68 and 1976, data are based on
     National Health Interview Survey of persons aged 18 years or more,
     as provided by the Office on Smoking and Health, U.S. Centers for

Disease Control.   For 1966-68, the data are based upon the Current
Population Survey, as reported in Jeffrey E. Harris, "Cigarette
Smoking in the United States, 1950-1978," pages A1-A29 in: SMOKING
AND HEALTH. A REPORT OF THE SURGEON GENERAL. (Washington DC: USDHEW
Publication (PHS) 79-50066, 1979.) The datum for 1976 is based on
persons aged 20 or more, as reported in Table 1 of J.E. Harris,
idem.   All estimates reflect responses to the question: "Do you
smoke now?" In 1992, the CDC changed its definition of "current
smoker" to include persons who smoke only "on some days." By such
a definition, 26.5 percent of U.S. adults were smokers in 1992.
For consistent comparison with earlier estimates of smoking
prevalence, the data-point for 1992 is the "1992 Original CCS"
estimate, as reported in "Cigarette Smoking Among Adults-- United
States, 1992, and Changes in the Definition of Current Cigarette
Smoking," MORBIDITY AND MORTALITY WEEKLY REPORT 43 (May 20, 1994):
342-6.

3.   Computed as S - (C/365)/(A/100).

4.   Nominal average retail price per pack was computed by dividing
     total U.S. expenditures on cigarettes (as reported, for example, in
     TOBACCO SITUATION AND OUTLOOK REPORT, TS-220, Sept. 1992, Table 30)
     by total U.S. cigarette consumption (as reported, for example, in
     TS-220, Table 1). In TBS-226, April 1994, Table 34, the USDA
     changed its method of reporting total U.S. expenditures so as to
     exclude state sales tax payments. Accordingly, for 1991 and 1992,
     state sales tax payments (as given in TBS-226, Table 33) were added
     back to total U.S. expenditures. The resulting time series of
     nominal cigarette was then converted to real prices by means of the
     Consumer Price Index, where 1982-84 equals 100. Some might argue
     that the estimate for 1993 does not accurately reflect
     manufacturers' wholesale price cuts on premium brands, especially
     in August of that year. However, the Federal excise tax was
     increased from 20 to 24 cents per pack on January 1, 1993, while 14
     states and the District of Columbia raised taxes in 1993 an average
     of 10.8 cents per pack. Moreover, manufacturers raised wholesale
     prices in January and March, 1993, and again in November of that
     year. While the price series reported by The Tobacco Institute
     (THE TAX BURDEN ON TOBACCO, Volume 28, 1993) implies a 10 percent
     drop in real price, these data are based on point-in-time
     comparisons of prices on November 1 of each year. USDA data on
     cigarette prices for calendar 1994 will likely show a real-price
     decline of 4 to 8 percent.

5.   Source: Data are based on nicotine deliveries per cigarette, as
     determined by the FTC method. For 1968-81, data were derived from
     Federal Trade Commission, REPORT TO CONGRESS PURSUANT TO THE
     FEDERAL CIGARETTE LABELLING AND ADVERTISING ACT FOR THE YEAR 1981
     (Washington, DC: July, 1984), Table 12, Nicotine Column "A". For
     1981-91, comparable unpublished data were provided by the Federal
     Trade Commission. For 1965-67, the data were based on H. Wakeham's

estimates, as reproduced in Figure 16 on page 14-111 of SMOKING AND
HEALTH. A REPORT OF THE SURGEON GENERAL, op.cit., note 2. For
1992-93, the data are the author's estimates, based on FTC reports
of nicotine by brand and Maxwell Reports of sales by brand. (John
C. Maxwell, "Maxwell Report Part II, USA: Marlboro Still No. 1,"
TOBACCO REPORTER, 121 (April, 1994): 16-20.)

TABLE 2. VARIABLE DEFINITIONS AND STATISTICAL REGRESSION MODEL

VARIABLE DEFINITIONS:

Name	Description
Y	Calendar Year. See Table 1.
N	Sales-Weighted Average FTC Nicotine per Cigarette. See Table 1.
P	U.S. Average Retail Price per Pack, in Constant (1982-84) Dollars. See Table 1.
V	$\log(A/100)$. Natural logarithm of the proportion of adults who currently smoke. For definition of "A", see Table 1.
W	$\log(S)$. Natural logarithm of cigarette consumption per adult smoker per day. For definition of "S", see Table 1.
Z	$\log(C/365)$. Natural logarithm of cigarette consumption per adult per day. For definition of "C", see Table 1. Note that $Z = V + W$.

REGRESSION MODEL: The following model was postulated:

Equation 1: $V = a + b*P + c*Y$
Equation 2: $W = q + r*P + s*N$

where (a,b,c,q,r,s) are unknown parameters to be estimated from the
data. As a result of the identity $Z = V + W$, we have:

Equation 3: $Z = (a+q) + (b+r)*P + c*Y + s*N$

During the 30-year period from 1964 to 1993, data points for V and
W were available only for the following 17 years: 1965-68; 1970; 1974;
1976; 1978-80; 1983; 1985; 1987-88; and 1990-92. For the remaining 13
years, data for Z were used. Accordingly, a total of 47 observations
(consisting of 17 observations each on V and W, as well as 13
observations on Z) were stacked into a linear regression model that was
constrained so that, in equation 3, the intercept equalled (a+q), while
the coefficient of P equalled (b+r).

TABLE 3.   BASELINE ASSUMPTIONS AND ALTERNATIVE TAX SCENARIOS

BASELINE ASSUMPTIONS: To predict the effects of alternative Federal tax scenarios, the following assumptions were made for the years 1994-1999: (1) non-Federal cigarette taxes (consisting of state and local excise and sales taxes) will rise at a rate of 15 percent annually; (2) the non-tax component of cigarette price (consisting of manufacturers' wholesale prices and other wholesale and retail markups) will fall 5.2 percent in 1994, and thereafter rise at 2 percent annually; (3) the sales-weighted average nicotine per cigarette will rise to 0.975 milligrams in 1994, and remain constant thereafter; and (4) the Consumer Price Index will rise at 4.1 percent annually.

Under a baseline scenario in which the Federal excise tax rate remains unchanged, the above assumptions imply the following:

Year	Federal Excise Tax ($/pack)	State & Local Taxes ($/pack)	Non-Tax Component ($/pack)	Nominal Price ($/pack)	Consumer Price Index	Real Price ($/pack)
1993	0.240	0.381	1.367	1.988	144.4	1.376
1994	0.240	0.438	1.296	1.974	150.3	1.283
1995	0.240	0.504	1.320	2.064	156.5	1.319
1996	0.240	0.579	1.373	2.193	162.9	1.346
1997	0.240	0.666	1.429	2.335	169.6	1.377
1998	0.240	0.766	1.487	2.493	176.5	1.412
1999	0.240	0.881	1.547	2.668	183.8	1.452

During 1988-1993, combined state and local excise and sales taxes on cigarettes rose at an average rate of 11 percent annually. The model's baseline assumption of a 15 percent growth rate during 1994-1993 thus implies an accelerated growth of state and local sales taxes. So far in 1994, six states have announced or levied cigarette excise tax increases averaging $0.12 per pack. On May 1, Michigan raised its tax by 50 cents to 75 cents per pack, the highest in the nation. Forty-three states now impose sales taxes on cigarettes, a number that is expected to grow.

ALTERNATIVE TAX SCENARIOS: In addition to a baseline scenario, in which the Federal excise tax remained unchanged at $0.24 per pack, five tax-hike scenarios were considered: (1) a $0.45/pack increase over 5 years (15 cents in 1995, and 10 cents each in 1997, 1998, and 1999), as proposed in the current House Committee on Ways and Means health-care reform bill; (2) a $0.75/pack increase on 1/1/95 (as embodied in the Administration's proposed Health Security Act; (3) $1.00/pack increase on 1/1/95, proposed at this writing by the Senate Finance Committee; (4) a $1.50/pack increase on 1/1/95, proposed at this writing by the Senate Labor and Human Relations Committee; and (5) a $1.76/pack tax-increase on 1/1/95, proposed at this writing by the Chairman of the Senate Finance Committee. In each scenario, the real price of cigarettes was

recomputed to reflect higher Federal excise taxes. The remaining
components of cigarette price (state and local taxes and the non-tax
component) were derived from the aforementioned baseline assumptions.

TABLE 4. REGRESSION RESULTS

The regression results, with standard errors in parentheses were:

Equation 1: $V = 31.166 - 0.173*P - 0.0162*Y$
$(0.046)(0.0008)$

Equation 2: $W = 3.710 - 0.171*P - 0.129*N$
$(0.039)(0.031)$

Equation 3: $Z = 34.876 - 0.344*P - 0.0162*Y - 0.129*N$
$(0.046)(0.0008)(0.031)$

   ECONOMETRIC NOTE: The root mean squared error was 0.0289. The
standard R-squared statistic was 0.99. Because the dependent variables
were logarithmic, the residual errors in each equation had a comparable
statistical distribution. Their respective means were: 0.0000129;
-0.0000437; and 0.0000874. Their respective standard deviations were:
0.0218; 0.0268; and 0.0393. The somewhat larger spread of residuals in
the third equation was almost entirely the result of a single outlier,
equal to +0.09, for the year 1964. Since many serial observations were
missing, the standard Durbin-Watson statistic was not calculated.
However, direct examination of residuals showed significant serial
correlation of errors in the third equation, during the 1970s. This
serial correlation resulted from underprediction (by 1-5 percent) of per
capita consumption during the early 1970s, and is depicted in Figure 5.

TABLE 5. CONSUMPTION AND REVENUE PREDICTIONS

   The model predicts the following trends (by calendar year) in the
percentage of adults who smoke cigarettes:

| Federal Excise | -------- Prevalence of Smoking (%) -------- | | | | | |
Tax Scenario	1994	1995	1996	1997	1998	1999
Baseline (no increase)	24.6	24.0	23.5	23.0	22.5	22.0
$0.45/pack 1995-1999	24.6	23.6	23.2	22.4	21.8	21.1
$0.75/pack on 1/1/95	24.6	22.1	21.7	21.3	20.9	20.4
$1.00/pack on 1/1/95	24.6	21.5	21.2	20.8	20.4	20.0
$1.50/pack on 1/1/95	24.6	20.3	20.1	19.7	19.4	19.1
$1.76/pack on 1/1/95	24.6	19.8	19.5	19.2	18.9	18.6

   The model predicts the following trends (by calendar year) in
total U.S. cigarette consumption per capita:

| Federal Excise | Cigarettes Consumed per Person Aged 18 or More | | | | | |
Tax Scenario	1994	1995	1996	1997	1998	1999
Baseline (no increase)	2595	2522	2458	2393	2326	2257
$0.45/pack 1995-1999	2595	2440	2381	2274	2172	2075
$0.75/pack on 1/1/95	2595	2138	2097	2054	2009	1961
$1.00/pack on 1/1/95	2595	2023	1989	1953	1913	1871
$1.50/pack on 1/1/95	2595	1812	1790	1764	1736	1704
$1.76/pack on 1/1/95	2595	1712	1694	1673	1650	1623

These estimates of per capita consumption were multiplied by
population projections in order to obtain projections of total U.S.
cigarette consumption. The population projections, by calendar year,
were as follows:

|	1994	1995	1996	1997	1998	1999
Population Aged 18 years or more (millions)	192.2	193.5	194.6	195.6	196.4	197.2

U.S. Federally taxable consumption was assumed to equal 97.6
percent of total consumption. Gross Federal tax revenues were computed
as the product of Federally taxable consumption and the Federal excise
tax rate. The gross gain in Federal tax revenues was then computed as
the difference between a particular tax-hike scenario and the baseline
no-tax increase scenario. To take into account offsetting income tax
losses, net Federal revenue gains were assumed to equal 75 percent of
gross excise-tax gains. (This is the convention used by the
Congressional Budget Office, the Joint Committee on Taxation, and the
U.S. Treasury). The projected net Federal revenue gains, by calendar
year, were as follows:

| Federal Excise | Net Gain in Federal Tax Revenues (Millions $) | | | | | |
Tax Scenario	1995	1996	1997	1998	1999	Total
$0.45/pack 1995-1999	2,452	2,412	3,866	5,201	6,421	20,352
$0.75/pack on 1/1/95	10,700	10,586	10,448	10,287	10,102	52,123
$1.00/pack on 1/1/95	13,479	13,366	13,221	13,045	12,837	65,848
$1.50/pack on 1/1/95	18,044	17,975	17,860	17,698	17,487	89,064
$1.76/pack on 1/1/95	19,952	19,925	19,844	19,707	19,514	98,943

The above results have been computed for successive calendar
years. As necessary, conversion to Federal fiscal years (ending
September 30) can be performed by simple interpolation. A tax hike
imposed on 1/1/95 would be in effect for only three-quarters of Federal
fiscal year 1995. However, a standard floor-stocks provision would
bring the total revenue gains for fiscal 1995 quite close to those shown
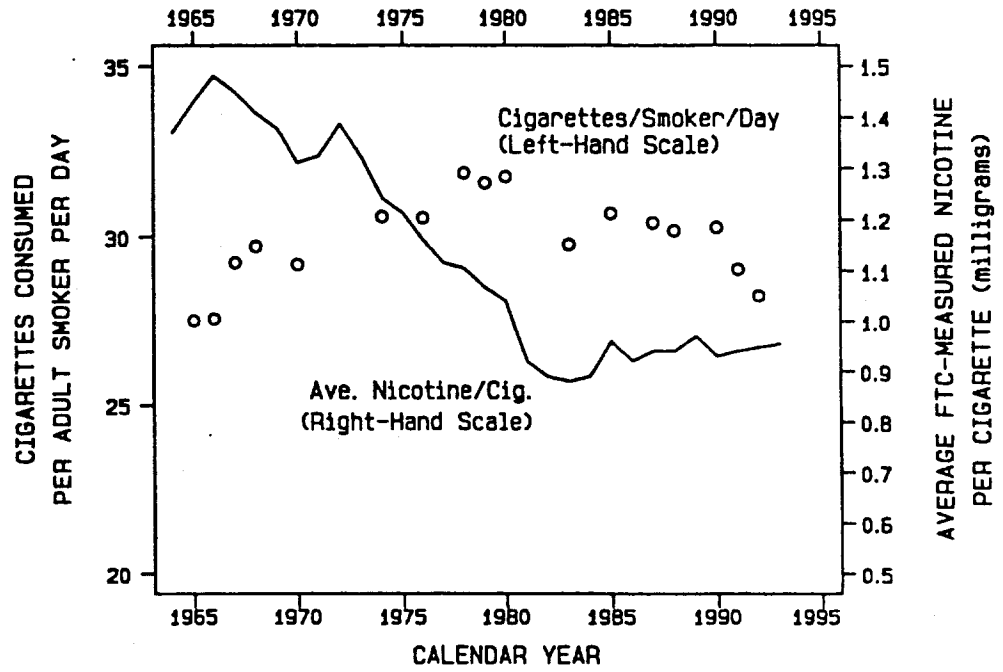above for the calendar year.

FIGURE 1.   TRENDS IN THE PREVALENCE OF CIGARETTE SMOKING
AND THE REAL PRICE OF CIGARETTES, UNITED STATES, 1964-1993
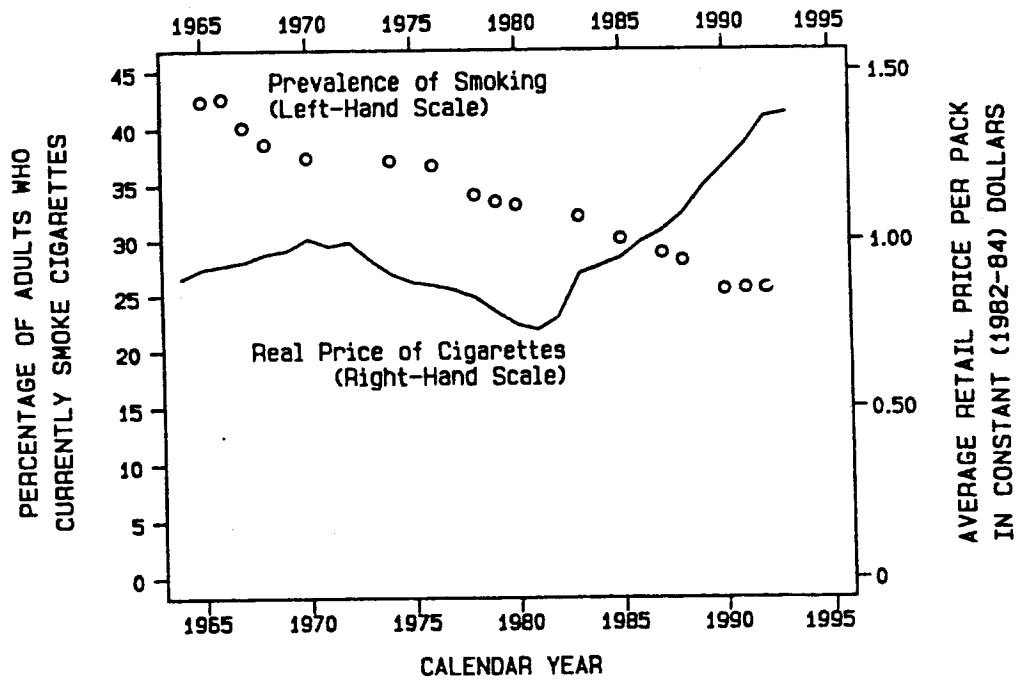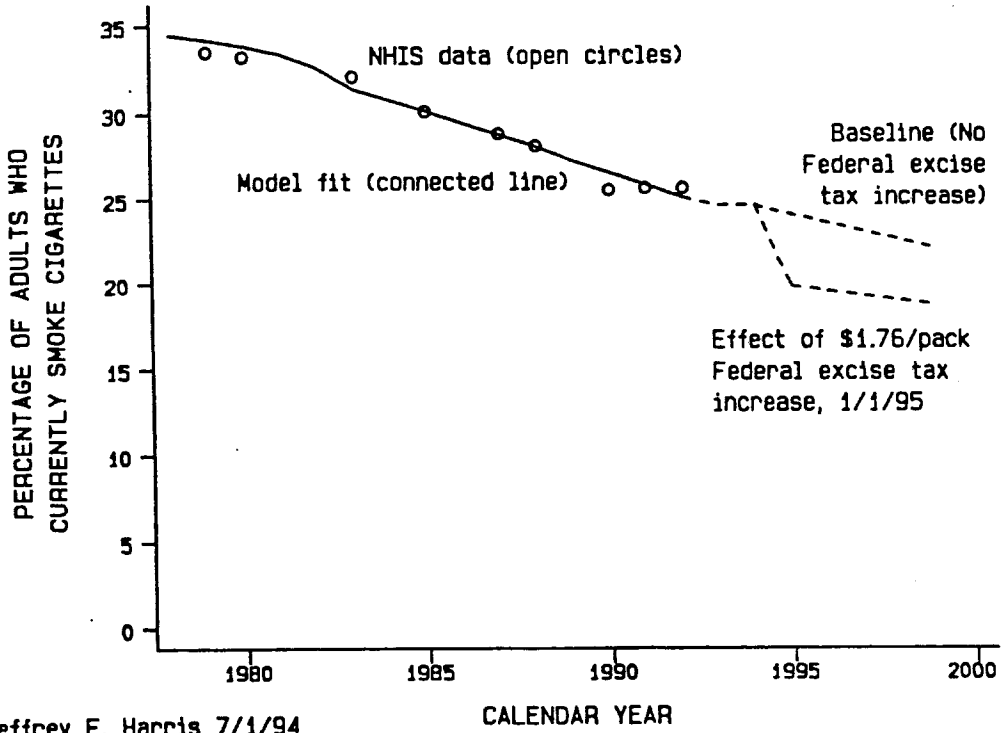

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FIGURE 2. TRENDS IN CIGARETTE CONSUMPTION PER SMOKER
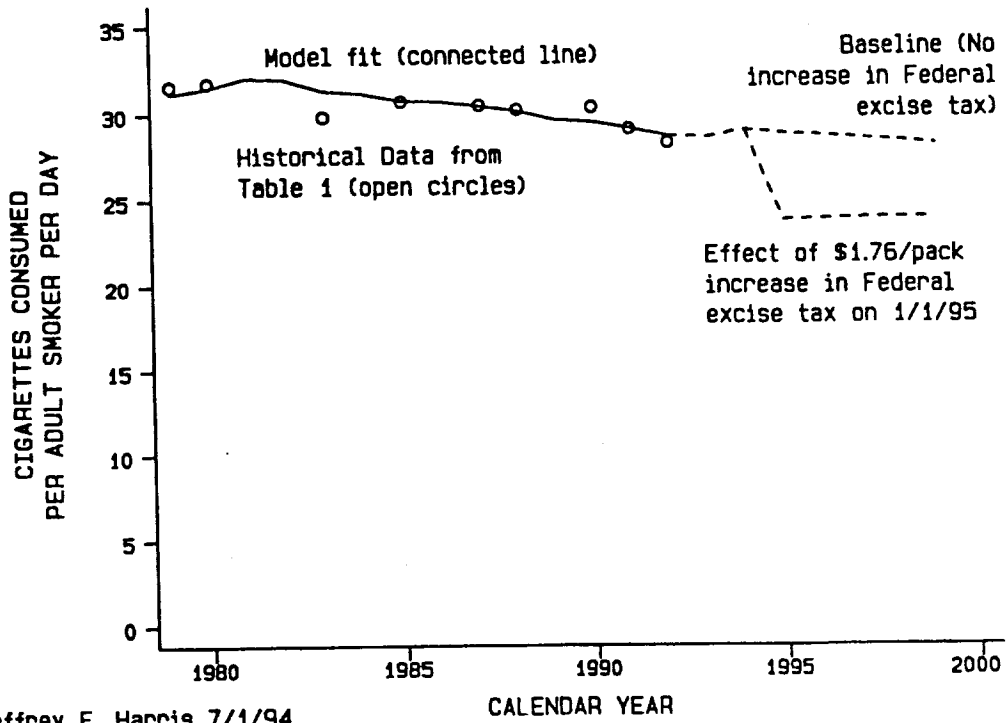AND AVERAGE NICOTINE YIELDS, UNITED STATES, 1964-1993

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FIGURE 3. PREDICTED TRENDS IN THE PREVALENCE OF SMOKING
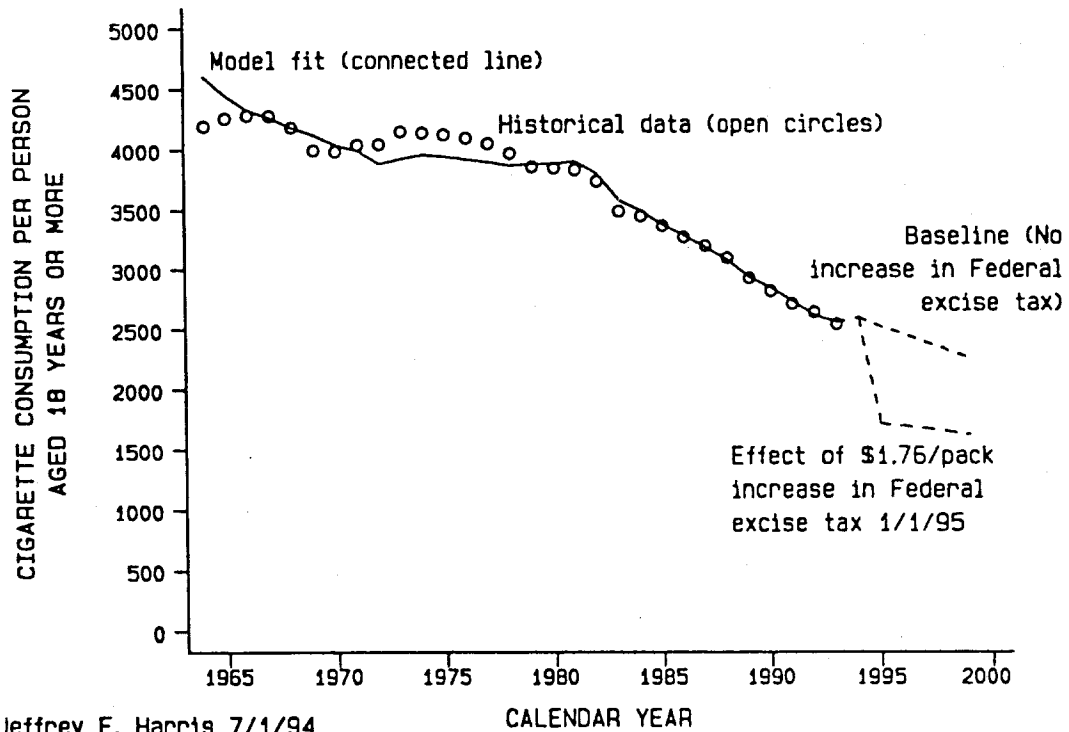UNDER TWO DIFFERENT FEDERAL EXCISE TAX SCENARIOS

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FIGURE 4. PREDICTED TRENDS IN CIGARETTE CONSUMPTION PER SMOKER
UNDER TWO DIFFERENT FEDERAL EXCISE TAX SCENARIOS

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FIGURE 5. PREDICTED TRENDS IN PER CAPITA CIGARETTE CONSUMPTION
UNDER TWO DIFFERENT FEDERAL EXCISE TAX SCENARIOS

Jeffrey E. Harris 7/1/94   CALENDAR YEAR