U.S. Cigarette Smoking and Health Warnings: New Evidence From Post World War II Data

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Abstract

A framework was developed in order to specify a model for annual U.S. per capita consumption of cigarettes. Three separate time related variables were utilized to measure the effects of health related information regarding smoking. The empirical results from the post World War II data set reveal that while prices and income are important determinants of cigarette consumption, the estimates for both were in the inelastic range. The age distribution of the adult population is also an important variable. While the development of the filter tip has been successful in stimulating smoking, the low tar and nicotine innovation has not had a statistically significant effect. Health information has repeatedly produced substantial short and long run effects. Current consumption is falling at an annual rate of between 3 to 4 percent.

Key Words: cigarettes, demand, elasticity, empirical estimation.

Introduction

Cigarette smoking has remained one of the most controversial social, political and economic issues in the United States in recent years. As recently as three decades ago, over half of the United States adult population smoked. The advent of the "health scare" has produced mounting information which has indicated that disease and mortality caused by smoking imposes massive costs to society in terms of soaring health care costs, lost productivity, the lives of smokers, and most recently perhaps even the lives of non-smokers through "passive smoking". Federal and state government efforts to reduce cigarette consumption have taken the form of increasing excise taxes, increased dissemination of anti-smoking information, and increased constraints on when and where individuals may light up. The economic impact of reduced cigarette consumption is felt primarily in a concentrated geographic and business area. Four firms produce over 90 percent of United States cigarettes, and over 90 percent of all tobacco utilized in cigarettes is grown in five states. These facts, combined with the linkage of the federal government to the industry through the price support and quota programs, make it little wonder that cigarettes, tobacco and smoking are steeped in such a tumultuous environment. Neither is it surprising that the econometric estimation of cigarette demand has such a rich history in the economics literature.

Since Schoenberg (1933) estimated United States cigarette demand for the 1913-31 period, numerous studies have appeared with a variety of specifications and results. (Lyon and Simon, 1968; Vernon, Rives, and Naylor, 1969; Hamilton, 1972;

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Fujii, 1980; Warner, 1981; Lewit and Coate, 1982; Baltagi and Levin, 1986; Blaylock and Blisard, 1992).

The purpose of this paper is to present an estimation of the aggregate annual United States demand for cigarettes for the Post World War II period. Enough years have elapsed to provide a rich data set in terms of length, without the enormous structural change imposed by World War II, and with years prior to and since the advent of health scare information. The objectives are:

(1) to specify a model of cigarette consumption based upon neoclassical consumer demand theory;

(2) to estimate the price and income elasticities of demand for cigarettes for the postwar era; and

(3) to estimate the impacts of the health scare upon cigarette consumption in the United States.

The section which immediately follows details the history of the smoking-health controversy as a basis for considering the specification of the impact of the health scare upon cigarette consumption over time. Section III involves a theoretical model of consumption of cigarettes over time. Section IV includes the empirical model and results.

A History of the Smoking-Health Controversy

Several studies of cigarette demand claimed that the first information shock concerning cigarettes and health occurred in the early to mid 1950s. There is disagreement, however as to when this announcement actually came, and dummy variables inserted to take it into account were specified as early as 1953 (Hamilton). None of the studies cite the actual source of the information. Neither do they elaborate on its nature, as they do the later scares. Yet the precipitous decline in per capita and overall sales of cigarettes during the 1953-55 period marked the largest annual declines in the Post World War II era. (See Figure 1). Apparently, this pronouncement came as a complete shock to the American public. Borgatta (1968) states that the pronouncement that was at the root of the scare was a paper by Hammond and Horn, presented at the June 21, 1954 San Francisco American Medical Association. A book published by Koskowski the following year (1955) gave more publicity to the findings which indicated that cigarette smokers over fifty have virtually twice the death rate of non-smokers and that death proportion rises with the number of cigarettes smoked.

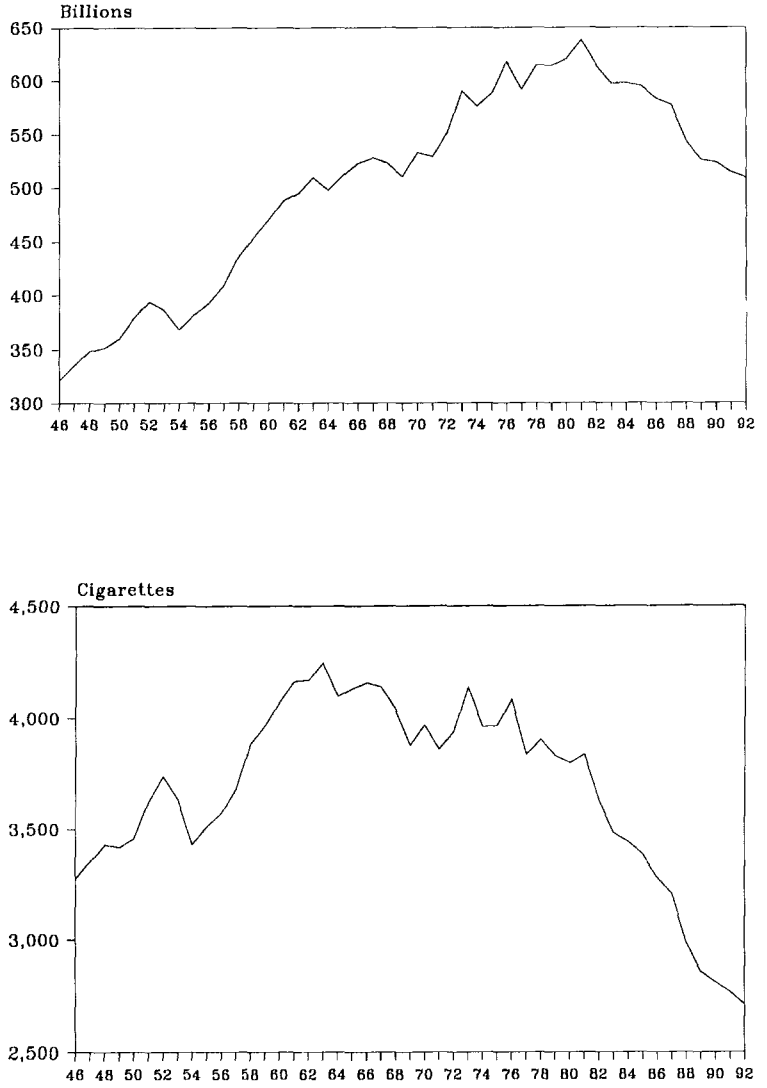
The *Tobacco Situation* (USDA) reports published throughout the period attributed declining cigarette sales to this publicity. Throughout the late 1950s occasional notes in these reports claimed that the health scare had some lingering effects, but that it had essentially run its course. In one among a series of annual reports on cigarette smoking, Wooten (1958) noted that statistical evidence presented after 1954 had actually refuted the initial claims of the impacts of smoking on health. It is perhaps ironic to note that 1958 was the year when the Hammond and Horn piece was actually published.

The next major health shock came in 1964 when the United States Public Health Service issued the report of the Advisory Committee to the Surgeon General. This report concluded that cigarette smoking caused lung and larynx cancer in men and chronic bronchitis in both men and women. The following year, the Congress passed a law requiring labeling on all cigarette packages sold in the United States. The labeling came into effect in 1966 with the warning:

"Caution: Cigarette smoking may be hazardous to your health."

This warning was followed by three years of intense anti-cigarette advertising on television and radio (1968-1970). These ads were required by the Federal Communication Commission's Fairness Act in order to offset advertising by cigarette manufacturers. When the Congress banned TV and radio advertising of cigarettes, effective January, 1971, the period of intense anti-smoking commercials also ended. Hamilton's study used geometric lags in order to measure the net effect of the change on cigarette consumption, finding that the advertising effect was so insignificant that the

Figure 1: Total and Per Capita (Adult) U.S. Consumption of Cigarettes (1946-1992)



net effect of the advertising ban was actually an increase in smoking. The January, 1971 penod ushered in a new era in the smoking health controversy, not only due to the advertising ban, but also with stronger warnings on cigarette packages, replacing *may* be hazardous to *is* hazardous. During the post 1971 era, numerous studies emerged linking cigarette smoking with a host of health problems including strokes, especially in women who take birth control pills, emphysema, heart disease, low fetal weight, and so on.

Theoretical Framework

Within the context of household production theory, (Becker, 1965; Muellbauer, 1974) we may conceptualize an individual as maximizing a utility function:

$$U(Z) \tag{1}$$

with the usual convexity and continuity properties, where Z is a vector of commodities or activities

produced by the individual. The production function, again with the usual properties, is expressed:

$$f(Z;\ x\ (A)\,|k,\Theta) = 0 \qquad (2)$$

where x is a vector of market purchased inputs with various characteristics (A) which may or may not be priced hedonically (Lancaster, 1965; Rosen, 1974), k is a vector of characteristics associated with the individual, and Θ is a vector of information associated with the production function (e.g. product quality information, Kihlstrom, 1974). Given the budget constraint $I = px$, where p is the vector of parametric prices associated with x, the individual minimizes the cost of producing Z, and obtains shadow prices (π) such that a cost function emerges of the form:

$$C = \pi Z \qquad (3)$$

The model may be cast in an intertemporal framework where (1) represents the present discounted value of the sum of all future utilities:

$$U=\sum_{t=0}^{T} U_t \qquad (4)$$

where U_t is the utility attained in period t, discounted to the present, and T is the time horizon (life expectancy) of the individual. Allow Z to be partitioned into two explicit commodity groups, pleasure generating, and health stock, denoted Z_p and Z_H respectively. Consumption of a hazardous good, cigarettes in this case (X_c), has properties associated with the intertemporal form of the production function expressed in (2) such that:

$$\frac{\partial Z_{H(t+\alpha)}}{\partial X_{ct}} < 0 \qquad \text{and} \qquad \frac{\partial Z_{Pt}}{\partial X_{ct}} > 0$$

Consumption in any time period t increases immediate pleasure, or gratification, but reduces the health stock in some future period, $t+\alpha$, where α is the "incubation period." Thus the opportunity cost of consumption of X_c is the market price paid plus the loss of future health stock owing to its consumption. This may alternatively be viewed as raising the shadow price of health stock in the future (π_H).

In the absence of "health scare" information (θ), the individual only gauges the health effects of smoking by periodically observing her/his health stock and adjusting consumption accordingly.

Cigarettes have been indicted in two distinct regards which have important implications for modeling demand over time. First is the onset of fatal heart attacks, strokes and lung cancer, which bring a premature end to the utility stream, by reducing T. Second is the development of chronic diseases such as emphysema and bronchitis, which reduce future health stock Z_H over long periods of time.

Ippolito (1979) worked through the comparative statics of an intertemporal hazardous goods model in order to determine the effects of exogenously produced health scare information upon consumption paths. Her model was developed only for the first case, explicitly ignoring "early warning signs." The results obtained in her model indicated that smoking should rise in older age groups once life expectancy becomes shorter than the incubation period, α.

Empirical evidence over the years has supported the claim both epidemiologically and in terms of observed consumption paths that early warning signs do in fact appear, and impact upon consumption over the life cycle. Diminution of the health stock, whether it occurs simply as a result of the aging process in general, or whether it is accelerated by the cumulative effects of smoking over time, may be expected to diminish the marginal utility of smoking. Cross sectional studies by Sackrin (1957), Lewit and Coate (1981) and the U.S. Centers for Disease Control (1989) have shown that consumption over the life cycle is shaped in an inverted U. Sackrin found that the peak smoking age group is the 35-44 age cohort. One line of reasoning for increased smoking leading up to these years is habit formation, which has been a primary rationale for including lagged consumption as an independent variable in demand studies using time series data (Houthakker and Taylor, 1970), with the expectation that $\partial X_{c(t+1)}/\partial X_{ct} > 0$. Once past the 35-44 year cohort, individuals cut back on smoking as

their health stock diminishes. People who smoked more in their early years should be expected to cut back at a greater rate, if in fact smoking reduces the health stock over time, in turn further reducing the marginal utility of smoking. Thus, at the theoretical level, the effect of lagged consumption is ambiguous, while empirically the effect has been found to be strictly positive (Houthakker and Taylor, 1970; Hamilton; Warner). Use of an age cohort variable to capture this life cycle phenomenon leads to no such ambiguity; the expectation being that higher (lower) proportions of adults in the 35-44 year cohort will lead to higher (lower) per capita consumption. Moreover, use of the age cohort variable becomes very important empirically if the age distribution of the adult population changes substantially over the observation period, as it has in the post World War II era.

Two primary changes have taken place regarding the characteristics (the A vector associated with X_c) of cigarettes in the post World War II era: the advent of the filter tip, and the low tar and nicotine innovation. Prior to 1954, less than 3 percent of all cigarettes sold in the U.S. had filters. Immediately after the 1954 health scare, the filter tip market share expanded rapidly, taking over 50 percent of the market by 1960. In 1989, 97 percent of cigarettes sold in the U.S. had filters. The low tar and nicotine share was less than 10 percent in 1971, but increased to over 60 percent by 1984. It has since slipped slightly but still constitutes over 50 percent of the market. (See Figure 2).

Model Specification and Results

Aggregate annual U.S. data were collected for the post World War II era. (1946-92). The first specification to be estimated was the form:

$$X_c = \beta_0 + \beta_1 \, Price + \beta_2 \, Income + \beta_3 \, Age + \beta_4 \, Filt + \beta_5 \, LTN + \beta_6 \, \theta_1 + \beta_7 \theta_2 + \beta_8 \, \theta_3 + U \qquad (5)$$

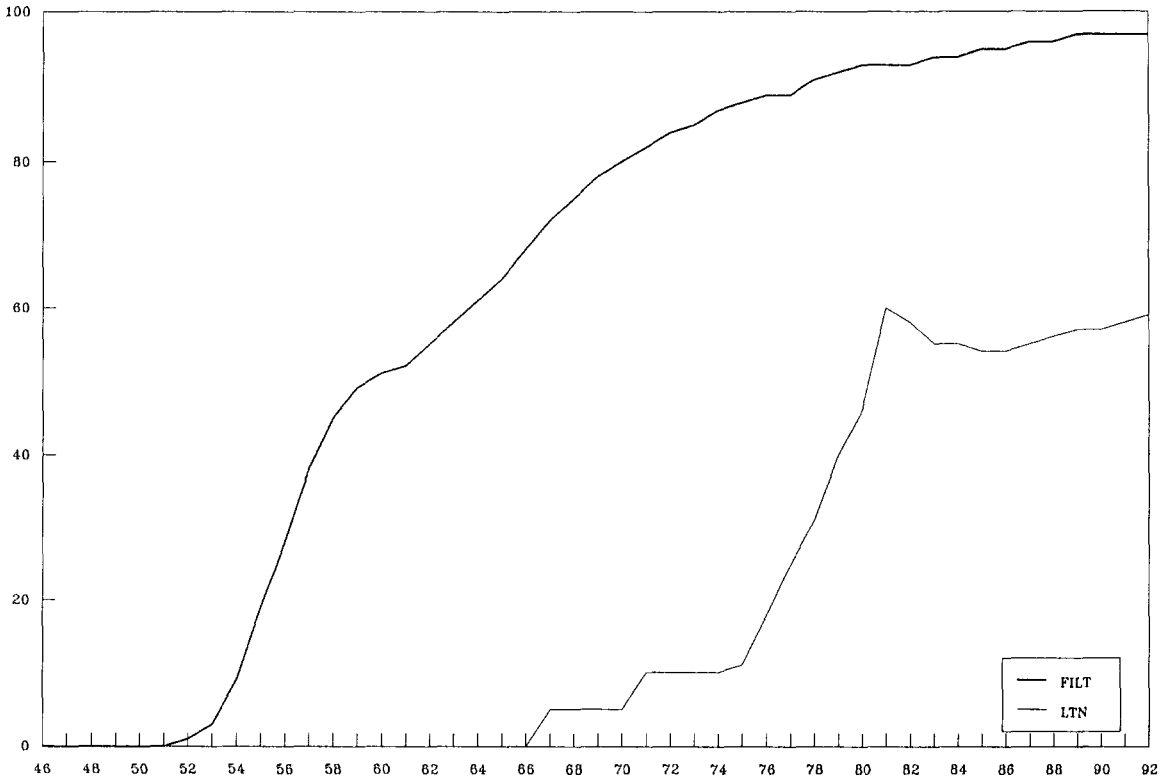
The dependent variable, X_c, was measured as annual national cigarette sales per capita (age 18 and over). *Price* was measured as the weighted average retail price of cigarettes, deflated by the Bureau of Labor Statistics (BLS) consumer price index (CPI, base 1982-84). *Income* was measured as aggregate per capita U.S. personal consumption expenditures, again deflated by the BLS CPI. *Age* was specified as the proportion of the adult population in the peak smoking age group (35-44). *Filt* and *LTN* were computed as the proportion of cigarettes sold with filter-tip and low tar and nicotine respectively.

The health scare variables were specified as time related variables. The first (θ_1) was assigned values of 1 for 1954 and 1955, when the results of the Hammond and Horn study were released and highly publicized. The variable was then allowed to decay geometrically in a manner similar to Hamilton's specification. In this case the decay rate was assigned the form $\theta_t = \lambda^t$ with $t = 1$ in 1956, 2 in 1957, etc. A factor of 0.7 was used as a measure of partial adjustment to equilibrium following the evidence produced in previous studies (Houthakker and Taylor, Hamilton, Mann). The variable was truncated at a value of 0.06 in 1963, just prior to the release of the 1964 surgeon general's report. This report ushered in a new era in the smoking health controversy, and was followed by increasing efforts on the part of government to reduce smoking, including the labeling and anti-smoking television and radio ads. The value of θ_2 was set at 1 in 1964, and allowed to increase linearly until 1970. For the 1971 event, which began the third era with the harsher warnings, banning of cigarette advertising, etc., the variable θ_3 was assigned a value of 1 in 1971, and allowed to increase linearly until the end of the observation period. The θ_2 variable was allowed to decay beginning in 1971 in the same manner as θ_1, before, and was truncated when it fell below 0.1 in 1981.

As revealed in Table 1, the values of all the parameter estimates for (5), estimated as model 1, were of the expected sign and statistically significantly different from zero at the 99 percent level of confidence, with the exception of the *LTN* market share. The *LTN* variable was then dropped from the equation, which was re-estimated as model 2. Model 3 was estimated using lagged consumption as an independent variable.

Note that the inclusion of the lagged endogenous variable reduces the absolute values of

Figure 2: Filter Tip & Low Tar-Nicotene Market Share



all the parameter estimates. The parameters in model three may be interpreted as short run effects, with long run impacts calculated by dividing by one minus the lagged consumption parameter of 0.24 (Intriligator, 1978; Phlips,1983). While the lagged consumption parameter is statistically different from zero at the 95 percent level of confidence, it should be noted that the problem of serial correlation, which plagued previous studies, was effectively removed from this demand model without necessitation of the lagged consumption variable. Moreover, the results are robust in the sense that the long run price and income elasticities, obtained from model three, calculated at the sample means, are similar to those obtained from model two, which excluded lagged consumption. (See Table 2). The magnitudes of the elasticity estimates range from -0.38 to -0.62, and the -0.50 estimate from model three is very near the midpoint of elasticities estimated in previous studies. The income elasticity estimates are slightly lower in absolute value than the price elasticities, and are also low relative to previous studies. This is perhaps an indication that the income elasticity of demand for cigarettes has declined slightly in recent years. All of the price and income elasticity estimates are in the inelastic range, which corroborates most of the evidence produced from the cigarette demand literature, and should be expected, since no close substitutes for cigarettes exist.

The results indicate that the development of the filter tip and its acceptance by the public have had a substantial impact upon cigarette consumption over the past four decades. Although the *LTN* innovation has been successful in gaining market share, the evidence here indicates that it has not mitigated the effects of the health scare, or stimulated consumption in any way.

The parameters on the health trend variables imply that the 1954 scare had the largest single year impact upon consumption (between 243 and 308 cigarettes per capita, a 6 to 8 percent

Table 1. OLS Regression Results. U.S. Cigarette Demand, 1946-1992

MODEL	1	2	3
Variable			
Price	-25.94***	-22.05***	-15.68***
	(6.36)	(4.47)	(5.28)
Income	0.20***	0.21***	0.15**
	(0.07)	(0.07)	(0.07)
Age	63.09***	61.86***	44.59**
	(17.05)	(16.90)	(18.27)
Filter	10.22***	9.61***	7.63***
	(1.63)	(1.46)	(1.70)
LTN	-3.94	---	---
	(4.58)		
1954 *Health*	-307.94***	-308.82***	-243.15***
	(57.55)	(57.40)	(63.48)
1964 *Health*	-41.23**	-54.31***	-46.84***
	(20.11)	(13.41)	(13.34)
1971 *Health*	-95.35***	-112.91***	-86.57***
	(23.20)	(11.14)	(16.64)
Lagged Cons	---	---	0.24**
			(0.12)
R^2	.96	.95	.96
F	92.82***	106.72***	102.34***
d.w.	1.64	1.63	---
ρ	0.17	0.17	---
	(0.14)	(0.14)	

Numbers in parentheses are standard errors
*** Statistically significant at 99 percent level
** 95 percent level
* 90 percent level

Table 2. Price and Income Elasticity Estimates

	Model 1	Model 2	Model 3	
			SR	LR
Price	-.62	-.53	-.38	-.50
Income	.41	.43	.31	.39

decline). The coefficient on the 1971 health scare shows that, ceteris paribus, annual per capita consumption is currently declining at a rate of between 86 and 113 cigarettes per year, or 3 to 4 percent of 1992 consumption.

The age cohort parameter indicates that the proportion of the adult population in the peak smoking age group (35-44) is an important factor to be considered in time series estimation. As the baby boomers continue to swell the ranks of this cohort over the next few years, per capita consumption will be boosted slightly, ceteris paribus. Apart from income, this is in fact perhaps the only currently identifiable trend which can be expected to have a positive impact upon consumption in the near future. It should be noted, however, that the leading edge of baby boomers has already begun to move beyond this age group.

Conclusions and Suggestions for Further Research

The results of this estimation suggest that all three of the models chosen have high degrees of reliability and statistical significance. Price, income, age distribution, the filter tip, time related health effects, and lagged consumption all seem to play important roles in determining annual per capita smoking in the U.S.

This paper demonstrates several important points which may be useful. First, consumers respond in substantial ways to the release of health related information regarding the products they consume. Both short run and long run responses have been demonstrated in this analysis. This has potentially enormous applications to consumption of a wide variety of products which may have problems involving safety, ranging from illicit drugs to food which carries the risk of contamination. While extrapolation from trends always should be undertaken with caution, it does appear that the U.S. may in fact be headed in the direction of a smokeless society. However, it will be well into the 21st century before this will occur.

Second, although cigarette demand is inelastic, price is an important variable in determining consumption. The large price increases that persisted throughout the 1980s, resulting from a combination of manufacturer price hikes as well as increased excise taxes played a great role in assisting health concerns in accelerating the downward trend in consumption. The recent price reductions announced by manufacturers will undoubtedly help to cause a levelling off of consumption in the near future. Government decisions to raise excise taxes however, will almost certainly lead to a renewal of this phenomenon, especially given the current fiscal climate and degree of hostility toward smoking and smokers.

More research is needed to monitor changes in the phenomenon of smoking in the U.S., since many interesting questions remain. One set of questions involves the potential interaction among the variables identified and measured in this study (e.g. does the presentation of health evidence change elasticities?). Second, the extent to which smoking is related to other behaviors such as alcohol or coffee, and non cigarette forms of tobacco consumption could be measured by a system of equations which endogenizes variables other than cigarettes.

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