University of Wisconsin-Madison

Institute for Research on Poverty

Discussion Papers

Robert E. Leu

MODIFYING RISK-TAKING BEHAVIOR THROUGH PUBLIC POLICY: THE CASE OF CIGARETTE SMOKING

DP #629-80

Modifying Risk-Taking Behavior through Public Policy:
The Case of Cigarette Smoking

Robert E. Leu

Institute of Social Sciences, University of Basel, Switzerland, and
Institute for Research on Poverty, University of Wisconsin, Madison

August 1980

The author would like to thank Sheldon Danziger, Arthur Goldberger, Burton Weisbrod, Barbara Wolfe, and especially Jacques van der Gaag for helpful comments. Administrative assistance was provided by the Institute for Research on Poverty. The research was sponsored by the Swiss National Science Foundation and the Swiss Tuberculosis Association.

ABSTRACT

This study analyzes the effectiveness of taxation and anti-smoking publicity in influencing the demand for cigarettes, applying time series analysis to per capita cigarette consumption data in Switzerland between 1954 and 1977. The results suggest that two major publicity campaigns following the publication of the U.S. Surgeon General's Report on Smoking and Health in 1964 caused immediate decreases in cigarette demand by 10 to 13%; more importantly, the two campaigns together appear to have reduced cigarette consumption permanently by 8 to 12%. Publicity also seems to have had important indirect effects, influencing, for example, the price elasticity of cigarette demand. Nominal cigarette price (estimated elasticity values -0.8 to -1.0) turned out to be a better predictor of cigarette demand than real cigarette price (estimated elasticity value -.5). The analysis suggests that publicity accompanying tax induced price increases has had a signal effect on many smokers feeling uncomfortable about their smoking, thereby explaining the reaction of cigarette demand to changes in nominal cigarette price. The study concludes that future anti-smoking publicity campaigns, supplemented by an appropriate tax policy, may well reduce the demand for cigarettes in Switzerland further.

Modifying Risk-Taking Behavior through Public Policy:
The Case of Cigarette Smoking

Recent epidemiological and biomedical research has established smoking as a major risk factor for common disabling or fatal diseases such as lung cancer, ischaemic heart disease, and chronic bronchitis and emphysema.[1] Governments in a number of countries have reacted against smoking by levying special excise taxes on cigarettes, restricting advertising of tobacco products, and initiating or extending anti-smoking campaigns (health education, publicity campaigns, and legal anti-smoking efforts).[2]

The aim of this study is to examine the effectiveness of two instruments that may be used by governments to influence the demand for cigarettes: taxation and anti-smoking publicity. Time series analysis is applied to per capita cigarette consumption data in Switzerland between 1954 and 1977, and a number of hypotheses about how taxation and anti-smoking publicity have influenced cigarette demand are tested, controlling for substitution between cigarette, cigar, and pipe smoking. In particular, I focus on long-ter, effects and on interaction between tax and publicity effects to show that anti-smoking publicity did have a substantial permanent impact, and that there are synergistic effects between publicity and taxation. The results provide an important input for cost effectiveness or cost-benefit studies of future government activities designed to reduce smoking. In addition, an extensive review of the relevant research in other countries, particularly in the United States and the United Kingdom, is presented.

VARIABLES AFFECTING CIGARETTE DEMAND

Per capita cigarette consumption of adults over 15 years of age increased rapidly in Switzerland between 1954 and 1972, interrupted by two substantial decreases in 1964 and 1966 (see Figure 1).[3] In 1966, consumption dropped by more than 20% below the level of the previous year. Since 1972 cigarette consumption has decreased each year except 1977. Per capita pipe tobacco consumption (in grams of tobacco) of adults over 15 years of age has decreased steadily over the whole period, whereas per capita consumption of cigars has remained practically constant.

Treating prices of cigarettes as exogenous, a single equation approach was chosen to estimate the demand for cigarettes. The following variables were included in the demand equation:

$$Q = Q(Y, P, P_C, P_p, Q_C, Q_p, ASP64, ASP66, POP, T) \qquad (1)$$

where Q = per capita cigarette consumption; Y = real disposable income per capita (current or lagged); P = cigarette price (real or nominal); P_C = price of cigars; P_p = price of pipe tobacco; Q_C = per capita cigar consumption; Q_p = per capita pipe tobacco consumption; ASP64 = anti-smoking publicity in 1964 (dummy); ASP66 = anti-smoking publicity in 1966 (dummy); POP = percentage of males in the adult population over 15 years of age; T = time trend.

An income variable was included despite the lack of consistent findings reported by previous studies in the U.S. and the U.K.[4] Compared to these two countries, per capita cigarette consumption in Switzerland was rather low in the early fifties, leaving plenty of room for considerable growth over the next few decades. Hence, I expected income to be a major determinant of cigarette demand between 1954 and 1977.

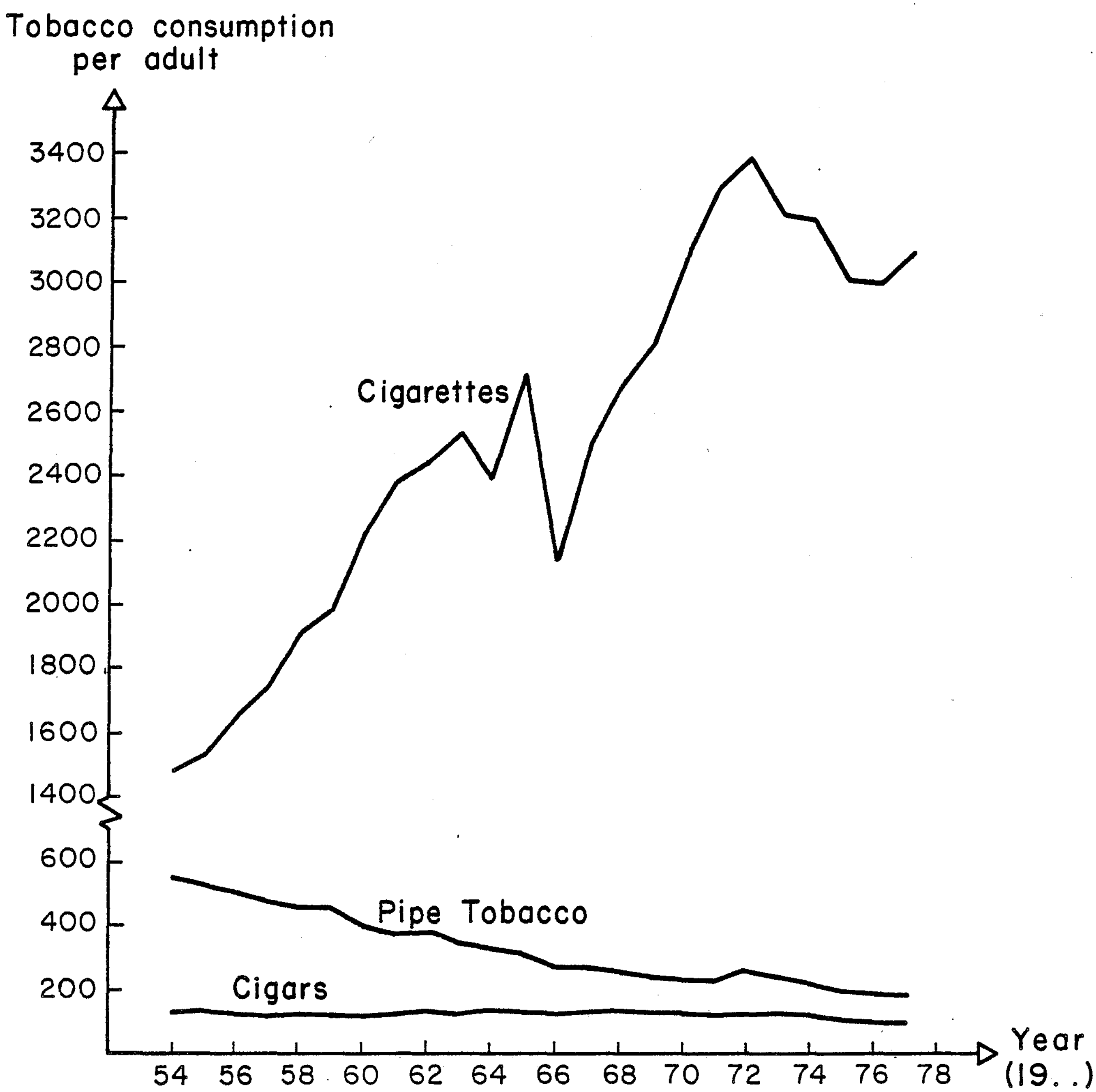

Figure I. Tobacco consumption in Switzerland, 1954-1977

Taxation enters the demand equation through the price variable. The nine changes of the undeflated cigarette price index (yearly base) between 1954 and 1977 appear to have been caused largely by either tax increases or rather uniform increases of the manufacturers' prices, and hence were considered to be exogenous. Indices for both real and nominal cigarette prices were included in the set of explanatory variables. Using the latter was suggested by the observation that the demand for cigarettes seemed to react very sharply to cigarette price increases, even if the price change was less than the increase in the overall price level in the corresponding year.

Anti-smoking publicity is used here to refer to years of extended publicity in the mass media on the health effects of smoking. The publication of the U.S. Surgeon General's Report on Smoking and Health (DHEW, 1964), hereafter referred to as the Terry Report, establishing above all a causal link between cigarette smoking and lung cancer, was the starting point for major sustained publicity campaigns in a number of countries. The report had a considerable effect in Switzerland. First, it led to extensive publicity in 1964 on the health hazards of smoking. Second, it was employed as the main argument to advocate and justify the largest single increase of the tobacco tax in January 1966. The imposition of the higher tax in turn induced another round of publicity in the mass media. Moreover, numerous organizations engaged in a variety of activities designed to encourage people to quit or to reduce smoking. Since there were no data on these latter activities, only the 1964 and the 1966 publicity campaigns could be included in the demand equation.[5]

Little is known about specific behavioral responses to anti-smoking publicity in the mass media.[6] The available evidence indicates that decreases in per capita consumption during and after periods of anti-smoking publicity reflect a decrease in individuals who smoke (U.S. DHEW, 1979, p. A-22). On an aggregate level, there are three main possibilities of how publicity following the Terry Report may have influenced the demand for cigarettes. A first hypothesis is that publicity affected cigarette consumption only in the year of the publicity campaign, with consumption returning a year later to the level that would have prevailed without it. A second hypothesis is that publicity reduced consumption once and for all by a certain amount.[7] Hypothesis three predicts a sudden fall in consumption in the year of the publicity campaign, with the effect tapering off over the next few years.[8] This is supported by survey research reporting a high relapse rate among those giving up smoking.[9] All three hypotheses were tested for both the 1964 and the 1966 publicity events.[10]

Cigar and pipe smoking may both be considered to be close substitutes for cigarette smoking. In order to test for substitution both price and quantity indices for cigars and for pipe tobacco were employed. A population variable was included to account for variations in the sex composition of the adult population. Such changes have been caused mainly by the varying number of mostly male foreign workers. Given the sex specific differences in the amount smoked, per capita consumption was expected to vary with the proportion of males in the adult population. Finally, a trend variable was included to pick up the effect of the increasing smoking among women and youths.[11]

Cigarette advertising expenditures, frequently blamed as a stimulant to cigarette demand, were excluded from the analysis due to lack of data. It is doubtful, however, that this would constitute a misspecification of the demand equation. Economics literature generally has characterized advertising as a competitive weapon firms use in dividing markets, not as a means for expanding industry markets (Hamilton, 1972, p. 104; Simon, 1970, chap. 10). Most econometric studies on cigarette advertising support this position, revealing little consumer sensitivity to advertising.[12] The estimated advertising elasticities were generally small and often insignificant.

Changes in product quality also could not be accounted for due to lack of data. Between 1950 and 1977, the share of filter cigarettes has increased rapidly, reaching 96% in 1977, according to the Swiss Association of Cigarette Manufacturers. At the same time, the average tar and nicotine content has decreased by about 50 percent (Wynder and Hoffman, 1979, pp. 90-95). The implications of omitting changes in product quality are discussed in a later section.[13]

SPECIFICATION OF THE DEMAND EQUATION

Considering the addictive nature of smoking, it seemed unreasonable to expect the effect of changes in some of the explanatory variables, especially in income, to occur immediately or delayed by a fixed time interval of one year. To allow for habit persistence, I used a simple dynamic model[14]

$$Q^*_t = \beta_p + \beta_1 X_t + \varepsilon_{t1} \qquad (2)$$

where Q_t^* denotes the desired level of smoking at time t, X_t represents the set of explanatory variables enumerated in equation (1), and ε_{t1} is a random disturbance. The relationship between the actual and the desired level of smoking was assumed as follows:

$$Q_t - Q_{t-1} = (Q_t^* = Q_{t-1}) + \varepsilon_{t2} \qquad (3)$$

where λ represents the adjustment coefficient ($0 < \lambda \leq 1$), and $_{t2}$ is a random disturbance. Solving for Q^* and substituting into equation (4) yields

$$Q_t = \beta_0\lambda + \beta_1\lambda X_t + (1 - \lambda)\ Q_{t-1} + \xi_t \qquad (4)$$

where $\xi_t = \lambda\varepsilon_{t1} + \varepsilon_{t2}$. Since equation (4) included the lagged dependent variable on the right-hand side, and the sample was small,[15] the assumption that $E(\xi_t \xi_s) = 0$ for all $t \neq s$ could not be tested in the usual way. To allow for the possibility of an autoregressive scheme in ξ_t, a two-stage procedure was used substituting for Q_{t-1}, $\hat{Q}_{t-1}$ predicted by the reduced form of equation (4).[16]

As is usually the case there was little a priori information about the correct functional form of the equation. Cross-country comparison suggested that cigarette consumption might have been approaching its ceiling towards the end of the study period. This has been checked by testing for nonlinearity in both income and trend. The rationale is straightforward in the case of income. Specifying a nonlinear relation between trend and cigarette demand assumed that the relative smoking population or the average cigarette consumption per smoker increased at a diminishing rate from year to year. Since there was no further information available, I also tried out semilog, hyperbolic, and log-linear forms with respect to the nonbinary variables.

The following specifications of the publicity variables were tested according to the hypotheses formulated in the last section: 1) The publicity variable is one in the year of the publicity campaign and zero otherwise; 2) the publicity variable is zero before the publicity campaign and one thereafter; 3) the publicity variables are allowed to interact with the trend variable for a number of years after the two publicity campaigns. The interaction period was varied between two and thirteen years in successive estimates. The coefficient of the interaction variable was restricted such that $0 < \beta_I \leq |\beta_{ASP}| \cdot \frac{1}{I_t}$, where β_I denotes the coefficient of the interaction variable, β_{ASP} is the sum of the coefficients of the two publicity variables, and I_t is the interaction variable.[17] The "mixed estimation" method suggested by Theil and Goldberger (1961, pp. 65-78) was used to estimate this version of the demand equation.

It is well known that fitting a model to time series data may produce spuriously good fits because of the autoregresssive nature of the data.[18] In order to check for this possibility, I estimated a second model, focusing on changes rather than on levels of cigarette smoking over time. For simplicity, I chose a static approach, using the reduced form of equation (4) specified in first differences.[19] The latter then reads

$$Q_t - Q_{t-1} = \beta_1 (X_t - X_{t-1}) + (\varepsilon_t - \varepsilon_{t-1}).$$

The method of ordinary least squares was used to estimate alternative specifications of equation (5). Two-step Cochrane-Orcutt estimation was applied to all equations presented in the results, assuming a first-order autocorrelation scheme, whenever the calculated value of the Durbin-Watson statistic fell in the inconclusive or rejection region at the 5% level.

In these cases, the value of   is displayed along with the reestimated other parameter estimates.

RESULTS

No indication was found that a linear specification of the demand equation was not adequate for the period between 1954 and 1977 (F-test). Since the estimation results remained basically the same regardless of the functional form used, I will only present the results of the linear equations (see Tables 1 and 2). Equation (6) is the partial adjustment model described by equation (4). Equations (7) to (10) are variants of the reduced form of equation (4), with equation (7) to (9) specified in first differences.

The results suggest that cigarette consumption in Switzerland between 1954 and 1977 was mainly determined by disposable income, nominal cigarette prices, the two anti-smoking publicity campaigns, and the trend variable presumably capturing the effects of both the changing smoking habits among women and youths and of some substitution of cigarettes for pipe tobacco. All five variables were highly significant ($p < 0.005$) and showed remarkably stable parameter values in a large number of regression equations performed. That this also held in the case of first differences strongly reconfirmed the results. The estimates also turned out to be surprisingly insensitive to changes in sample size, different specifications of the dependent variable, and variations in the number of variables included on the right-hand side.

Because the sample was small, I dropped some of the variables listed in equation (1). Real cigarette price was never significant ($p = 0.05$)

Table 1

Linear Cigarette Demand Functions for Switzerland, 1954-1977[a]

	(6)	(7)
Income (current)	.25 (5.47)[b] [.79][c]	--
Income (lagged-1)	--	.23 (3.44) [.72]
Cigarette Consumption (lagged-1)	.04 (.32)**	--
Trend	82.90 (6.53)	76.11 (3.71)
Cigarette Price (nominal)	-20.54 (-8.91) [-.79]	-24.74 (-6.29) [-.95]
ASP64S[d] (shift)	-308.90 (-4.80) [-.12]	--
ASP64[e]	--	-242.39 (-4.82) [-.10]
ASP66[f]	-255.05 (-3.46) [-.10]	-292.64 (-4.86) [-.12]
Intercept	1568.21 (5.47)	--
$\bar{R}^2$	.99	.86
D.W.[g]	--	1.97
h	--	--

Table 1--Continued

	(6)	(7)
"H"[i]	.00	23.3
(v)	(15)	(10)**
F[j]	366.20	40.1
(v_1, v_2)	(6,16)	(5,18)

All coefficients are significant at p = 0.005 unless otherwise indicated. Not applied in table. **Not significant at p = 0.05. --Variable not included or coefficient not calculated.

[a]Annual per capita cigarette consumption.

[b]t-values in parentheses, except as indicated in the last and the second-to-last row.

[c]Elasticity values calculated at the means of the variables in brackets for income and price variables; percentage change calculated at the mean of the dependent variable in brackets for the dummy variables.

[d]ASP64S: zero before 1964, one thereafter.

[e]ASP64: one in 1964, zero otherwise (before transformation to first differences).

[f](ASP66: one in 1966, zero otherwise (before transformation to first differences).

[g]D. W.: Durbin-Watson statistic.

[h]ρ: first-order autocorrelation coefficient.

[i]"H": Haitovsky's heuristic measure of multicollinearity. v, v_1, v_2: degrees of freedom.

[j]F: F-statistic.

when the original data were used. This rather surprising result will be discussed below. Variations in the sex composition of the adult population also did not seem to influence cigarette consumption appreciably. The coefficient was never significant ($p = 0.05$) when first differences were used. The price for cigars, the price for pipe tobacco, and per capita cigar consumption were never significant at the 10% level, indicating zero cross-price elasticities and the absence of substitution between cigarettes and cigars. Including per capita pipe consumption suggested that there was some substitution of cigarettes for pipe tobacco. The coefficient, also small, was highly significant ($p < 0.005$) when trend was omitted. Due to the almost perfect correlation between the two variables (compare with Appendix table), it failed to be significant when the latter was included. Hence, it appears that the coefficient of the trend variable includes the substitution effect of cigarettes for pipe tobacco.

The two-step estimates presented in equation (6) indicate that there was hardly any difference between short-and long-run effects of variations in the independent variables.[20] Although I did not expect this result with respect to income changes, it seemed plausible with respect to price variations and the publicity campaigns. Equation (6) was used to forecast 1978 and 1979 cigarette consumption. Observed consumption fell well within the 95% confidence interval. This is remarkable, since there was another substantial increase of the tobacco tax in 1978, and another publicity campaign in 1979, caused by a public vote on a complete advertising ban for tobacco products.

Transforming the data to first differences seems to have reduced multicollinearity substantially.[21] Haitovsky's heuristic measure (1969)

"H" of multicollinearity was highly significant ($p < .005$) in equation (6) and (10), indicating extensive multicollinearity, but was not significant at the 5% level in equations (7) and (8) specified in first differences.

The Impact of Income, Price, and Anti-smoking Publicity

Income. The estimated parameter values suggest an income elasticity between 0.7 and 0.9. This is consistent with the results of Behnke (1977) for West Germany, reflecting the typical experience of continental European countries with respect to cigarette consumption after World War II. No evidence was found that the assumption of a constant marginal propensity to smoke was too restrictive (t-test).

Cigarette prices. Nominal cigarette price was highly significant ($p < 0.005$) in almost all of the regression equations performed, suggesting a price elasticity between -0.8 and -1.0. By contrast, real cigarette price was never significant ($p = 0.05$) in the equations using the untransformed data when income or trend was controlled for. Since multicollinearity was high among these three variables (compare with Appendix), I suspected that this might have caused the unexpected result. Real cigarette price indeed turned out to be significant at the 5% level when the method of first differences was applied. Equation (8) (see Table 2) suggests a mean price elasticity of -0.5. However, when cigarette demand was regressed on both nominal and real cigarette price, the latter turned up with the "wrong" sign. Hence, I concluded that between 1954 and 1977 nominal cigarette price was a better predictor of cigarette demand than real cigarette price.

Table 2

Real Cigarette Price, Publicity, and the Demand for Cigarettes, 1954-1977[a]

	(8)	(9)	(10)
Income (current)	.29 (4.04) [.92]	.29 (4.20) [.94]	--
Income (lagged-1)	--	--	.23 (4.77) [.71]
Trend	--	--	101.53 (8.80)
Cigarette Price (nominal)	--	--	-25.91 (-11.12) [-.99]
Cigarette Price (real)	-14.26 (2.10)* [-.53]	-16.46 (-2.71)* [-.61]	--
ASP64S (shift)	--	--	-337.14 (-4.85) [-.14]
ASP64	-246.17 (-3.70) [-.10]	-248.68 (-4.69) [-.10]	--
ASP66S[b]	--	--	271.88 (-2.67)* [-.11]
ASP66	-336.52 (-3.96) [-.13]	-305.68 (-4.29) [-.12]	--
Signal Effect[c]	--	-185.64 (-2.88) [-.07]	--

Table 2--Continued

	(8)	(9)	(10)
Interaction Effect	--	--	1.08 (2.97) [.16]
$\bar{R}^2$	.76	.85	.99
D.W.	2.02	1.90	2.12
	--	.20	--
"H" (v)	17.6 (6)**	12.8 (10)*	.00 (15)
F (v_1,v_2)	27.1 (4,19)	33.6 (5,17)	483.28 (6,16)

[a]Symbols and abbreviations as indicated below Table 1. *Significant at p = 0.05.

[b]ASP66S: one between 1966 and 1972, zero otherwise.

[c]Signal effect: one in 1966, 1973, and 1974, zero otherwise.

[d]Interaction effect: ASP66S$\cdot T^2$, where T = time trend.

The familiar explanation would be that the smokers have revealed a considerable degree of money (tax) illusion. It seems extremely unlikely, however, that money illusion should have accounted entirely for the price sensitivity of demand, given the addictive nature of smoking. No evidence for money illusion was found when analyzing the demand for alcoholic beverages in Switzerland (Leu and Lutz, 1977, pp. 542-559). Yet smoking and drinking are close correlates,[22] and there is no reason why money illusion should have prevailed in one case, but not in the other. Factors other than money illusion are clearly implied as also having influenced smokers' reaction to changes in the cigarette price.

There is substantial evidence in various countries that between 40 and 90% of all smokers would prefer not to smoke, yet are unable to quit.[23] In Aberlin and Wuthrich's representative study (1976) for Switzerland, about one-third of the smokers interviewed had seriously tried to stop smoking in the twelve months prior to the investigation. Given this attitude, cigarette price increases may have offered an occasion for many to stop smoking or at least to try to do so: that is, we may think of price increases as having had a "signal" effect on many smokers feeling uncomfortable about their smoking.

The impact of nominal cigarette price on cigarette demand may thus be understood as a composite of a "real price" effect and a signal effect. Having estimated the real price effect in equation (8), I subsequently sought to pick up the signal effect by a separate variable. In equation (9) I included a signal dummy variable, specified to be one in all years with a tobacco tax increase and zero otherwise. The coefficient turned out to be highly significant ($p < 0.005$). When the signal variable was designed to include all price increases, it failed to be significant ($p = 0.05$). The result thus seems to imply that a signal effect was mainly present when the price rise was due to a tobacco tax increase. A tentative interpretation would be that tax induced price rises usually cause more publicity than autonomous increases of the manufacturers' prices, thereby pointing to publicity as a key determinant of the smokers' reaction to cigarette price variations.

Anti-smoking publicity. Tables 1 and 2 imply that both publicity events caused immediate decreases in cigarette demand of between 10 and 13%. On average, the two events appear to have decreased cigarette consumption by about 11.5%, at least temporarily. The long-term effects of publicity are harder to assess. Equations (6) and (10) suggest that 1964 publicity (ASP64S) shifted cigarette consumption to a lower level for the remaining years of the study period than would have prevailed otherwise. With respect to 1966 publicity (ASP66), the assumption that the effect of publicity was restricted to that year turned out to be more adequate than the shift hypothesis, as long as interaction was not allowed for (equation (6)). However, allowing for interaction implied that the shift variable was the adequate specification for both publicity campaigns.

In order to test the hypothesis that publicity has had a permanent impact, we selected the equation producing the highest coefficient on the interaction variable. In equation (10) interaction was allowed for between 1966 and 1972, and the interaction variable was specified in quadratic form. ($I_t = ASP66S \cdot T_t^2$, where I = interaction variable and T = trend.) The coefficient implies that even under these unfavorable assumptions only 64% of the effect of the two events together tapered off over time. Allowing interaction for both variables until the end of the study period (I_t = ASP64S$\cdot T_t$) suggested that about half of the publicity effect had faded over time. Hence, it appears that the two publicity campaigns permanently reduced cigarette demand by 8 to 12%. This is consistent with evidence from two U.S. national survey studies, reporting that between 7 and 13% of the smokers reacting to the Terry Report achieved long-term success (Horn, 1968; Swinehart and Kirscht, 1966).

DISCUSSION

Smokers in Switzerland seem to have reacted more strongly to the scientific evidence linking smoking to disease than smokers in other countries. As indicated, both publicity campaigns following the publication of the Terry Report led to immediate drops in per capita cigarette consumption of 10 to 13%. By comparison, the Terry Report was credited with having caused a decrease of cigarette demand in the U.S. of 5 to 7% (Hamilton, 1972, p. 406; Warner, 1977, p. 648). British researchers have estimated that the first two reports of the Royal College of Physicians, published in 1962 and 1971, temporarily decreased cigarette consumption by roughly 5% each (Atkinson and Skegg, 1973, p. 273; Townsend and Atkinson, 1977). More important for policy purposes, however, is the finding that publicity in Switzerland has had a permanent impact, shifting cigarette consumption to a lower level than would have prevailed otherwise. As indicated, it appears that publicity has permanently reduced cigarette demand by 8 to 12%. However, this is likely to be a conservative estimate of the true impact of publicity, since the analysis neglects important indirect effects.

First, anti-smoking publicity, together with heavy commercial promotion campaigns, has stimulated an overwhelming majority of smokers to switch to filter cigarettes (U.S. DHEW, 1969, 1973, 1976; Royal College of Physicians, 1971), has contributed to the substantial lowering of the average tar and nicotine content per cigarette,[24] and has induced smokers to smoke less of each cigarette (U.S. DHEW). These changes in product quality and in smoking behavior are important with respect to the health consequences of smoking. Recent studies consistently show a lower risk for individuals who smoke light cigarettes compared to those smoking high tar and nicotine cigarettes.[25] Focusing exclusively on per capita consumption, my analysis does not take into account the potentially beneficial health effects of these changes. Indeed, neglecting changes in product quality and in smoking behavior may have upwardly biased the coefficients of the interaction term in the demand equation. It has been argued that smokers switching to lighter cigarettes or reducing the number of puffs per cigarette might in turn increase the number of cigarettes smoked to maintain their level of nicotine intake.[26] Inasmuch as this was the case, my results underestimate the permanent impact of publicity (e.g., overestimating the relapse rate among those who reacted to publicity).

Second, publicity has stimulated the militancy of nonsmokers and has changed attitudes about the "rights of nonsmokers" (Leventhal and Cleary, forthcoming). This is reflected by the founding of nonsmoker associations, pressing for nonsmoking sections in restaurants, nonsmoking areas on the job, smoking restrictions in public buildings, etc., and for legislative anti-smoking efforts. All these factors may have intensified the pressures on smokers to quit or to reduce smoking (Eisinger, 1971). It has been suggested that the recent increases in success rates in the U.S. may be due to such changes in the social environment multiplying the effectiveness of previously unsuccessful programs and procedures (Leventhal and Cleary).

Third, we have only been able to estimate the effect of two isolated publicity campaigns. Yet there is evidence that the cumulative effect of continued anti-smoking efforts is more dramatic than the transient reductions in annual consumption following prominent anti-smoking activities. The National Clearinghouse for Smoking Research has reported findings from a pair of U.S. national studies on the impact of the Terry Report that found 20 months after the publication of the report, 52.9% of a representative sample of smokers had considered quitting, 34.4% had tried, 15.5% had achieved short-term success, and 7.1% had achieved long-term success. More recent data suggest short and long-term success rates roughly double those reported earlier (Horn, 1968; Swinehart and Kirscht, 1966).

Fourth, some tax increases seem to have been prompted directly or indirectly by anti-smoking publicity. As noted, the huge increase of the cigarette tax in January 1966 appears to be the most prominent example. Higher cigarette taxes as a result of the Terry Report and the publicity accompanying it were imposed in a number of countries. In the U.S., for example, there were 23 state and local tax increases in 1965 compared with no more than a dozen in any of the preceding years (Kellner, 1973). Whatever the true reasons for these tax increases, it appears that some portion of increased taxation, and hence of tax induced reductions in consumption, should also be considered an effect of anti-smoking publicity.[27]

The long-term impact of anti-smoking publicity has been assessed in two other studies. Warner (1977), projecting precampaign future cigarette demand and comparing these predictions with realized consumption, concluded that "in the absence of any campaign, per capita consumption in the U.S. likely would have exceeded its actual 1975 value by 20 to 30 percent" (p. 645).[28] This rather substantial impact was attributed to the cumulative effect of persistent publicity, supported by other public policies. Atkinson and Skegg (1973) in their study for the U.K., on the other hand, concluded that "publicity had the effect of a sudden fall in consumption, with consumption gradually returning to its previous (expected) level" (p. 278). This result was derived by fitting a "return trend" to the data, designed to pick up the relapse rate among those smokers who had reacted to publicity. The conclusion derived by Atkinson and Skegg is at variance with both Warner's results for the U.S. and the results presented here for Switzerland.

None of the three studies can provide a conclusive answer to the question of how publicity following scientific reports has affected cigarette consumption in the long run because they all refer to average per capita cigarette consumption rather than to patterns of individual smoking behavior. The problem with using aggregate annual consumption data is that we can never be really sure whether we are measuring the effects of publicity over time or something else. For example, we do not know with certainty whether the return trend emphasized by Atkinson and Skegg indeed reflects the fading impact of publicity, or, at least in part, the influence of other factors which have been omitted or have not been specified adequately in the demand equation. Similarly, in the case of Warner's study, we do not really know what the ceiling rate of smoking would have been in the absence of any anti-smoking campaign.

The predictive power of the equations here with respect to publicity is rather limited. Considering the attitudes of many smokers about their smoking, I feel confident in predicting that another publicity campaign would again influence consumption substantially. This has already been confirmed in 1979 with consumption dropping in response to publicity accompanying a public vote about an advertising ban for tobacco products. A well-defined campaign, using elaborate advertising techniques and relying mainly on radio and television, might have an even larger effect.

One can only speculate about the effects of a continued anti-smoking campaign. Most probably its marginal effectiveness would diminish over time as the early success reduced the smoking population to more hard-core smokers. But there is evidence that a continued campaign can have a continuing suppressing influence on cigarette demand. The best known example is the health scares under the fairness doctrine in the U.S. between 1968 and 1970 that caused consumption to drop over all three years. It has been demonstrated that the health scares depressed consumption considerably more than advertising boosted it (Hamilton, 1972). When the campaign was stopped, consumption started to rise again. Additional evidence, indicating that continued anti-smoking efforts can have both cumulative effects and a number of indirect effects, has been presented above.

Numerous studies in the U.S.[29] and the U.K.[30] have consistently found that in the post World War II period changes in real cigarette price have influenced cigarette demand. Averaging the elasticity values reported by the various studies for each country, averaged price elasticity for both turned out to be between -0.4 and -0.5. This is consistent with the real price elasticity of cigarette demand of -0.5 found in this study.

POLICY IMPLICATIONS

The analysis suggests that future anti-smoking publicity campaigns may well reduce the demand for cigarettes in Switzerland. Since there appear to be synergistic effects between anti-smoking publicity and cigarette tax changes, taxation may be used to supplement publicity efforts. The recommendations of the study for tax policy depend on the goal(s) policymakers pursue with cigarette taxation. A tax on cigarettes can be used to achieve one of three goals: to raise revenues, to "price out" tobacco, or to correct for externalities. The three goals are mutually exclusive, and hence, except by coincidence, the optimal tax rate will be different in each case (Leu and Lutz, 1977). If the goal of taxing cigarettes is to maximize tax revenues, then the actual tax rate is close to the optimal rate, given the estimated price elasticity of -0.8 to -1.0. If the goal of cigarette taxation is to reduce smoking, then the tax rate should be higher than the present rate. This study implies that in the short run, that is, as long as the smokers react so strongly to tax increases for reasons other than the change in real cigarette price, taxation represents a powerful tool to influence demand. In the long run, however, the potential of taxation to reduce smoking seems to be rather limited, given the price elasticity with respect to real cigarette price of -0.5. Upper limits for the tax rate are given by the tax policies in the neighboring countries, since price differentials inevitably encourage smuggling. Finally, if the goal of cigarette taxation is to correct for externalities, then the actual tax rate is too high rather than too low (Leu, forthcoming). The present study implies that lowering the tax rate would increase cigarette demand and decrease cigarette tax revenues.

One problem with levying a special excise tax on cigarettes is that the latter is highly restrictive. In some countries, cigarette smoking has become closely related to socioeconomic class, both in terms of numbers of smokers and the amount smoked. This means that tax increases will fall much more heavily on lower income groups in both relative and absolute terms. There is evidence that anti-smoking efforts contribute to a more skewed distribution of cigarette smoking by income class. Combining anti-smoking publicity campaigns and a tax policy aimed at reducing smoking may thus produce substantial undesired distributional effects.

Appendix

Patterns of Multicollinearity among Independent Variables, 1954–1977[a]

	Income (current)	Income (lagged-1)	Cigarette Consumption (lagged-1)	Trend	Price (real)	Price (nominal)	ASP64S[b]	ASP66[c]	Pipe	Cigars	Population
Income (current)	.99										
Income (lagged-1)	.67**	.99									
Cigarette Consumption (lagged-1)	.05	.58*	.98								
Trend	.37	-.24	.31	.99							
Price (real)	.14	-.19	.11	-.61*	.93						
Price (nominal)	-.52*	.71**	-.55*	.76**	.53*	.98					
ASP64	.07	.06	-.17	-.16	-.48*	.09	.88				
ASP66	-.05	-.32	.71**	-.38	.10	.43	.30	.52			
Pipe	.16	-.20	.37	-.89**	-.63*	.66**	-.37	-.42	.99		
Cigars	-.06	.44*	-.41	.16	.50*	-.52*	.52*	.11	.31	.73	
Population	-.16	-.32	.68**	-.24	-.33	.30	-.34	-.44	-.50*	.57*	.73

*Significant at $p = .05$; **significant at $p = .005$.

[a] The diagonal sets out R^2 for the independent variables, each in turn regressed on all other independent variables included in the table. Partial correlation coefficients of each pair of variables, controlling for the influence of all other variables included in the table, are shown off the diagonal.

[b] ASP64S: zero before 1964, one thereafter.

[c] ASP66: one in 1966, zero otherwise.

Notes

[1]Summaries of the evidence linking smoking to disease are provided by the U.S. Department of Health, Education and Welfare (1964, 1973b, & 1979), the Royal College of Physicians (1962, 1971, 1977) and the World Health Organization (Fletcher and Horn, 1970, 1975).

[2]Three main arguments have been advocated to justify government intervention. First, smoking can be interpreted as a merit bad." Learning to smoke usually occurs in childhood or adolescence; if a person does not smoke at the age of twenty, he/she is unlikely to take it up (Royal College of Physicians, 1977, p. 104). The problem is that many smokers would like to cease smoking later in life, but cannot because they have become dependent on it (pp. 98-99). Second, there is evidence that smokers are not always accurately informed about the health hazards of smoking. Although smokers nowadays are generally aware that smoking may be dangerous, many of them consider that they themselves are not very much at risk (p. 106). Third, there is evidence that smoking causes both monetary and non-monetary external costs to nonsmokers (see Atkinson and Townsend, 1977; Leu, forthcoming).

[3]Tourists, foreign workers, and foreign commuters, weighted by the number of days they spent in Switzerland, are included in the population base. Cigarette consumption was computed drawing mainly on annual sales statistics of the domestic producers, adding imports and subtracting exports of tourists, foreign workers, and foreign commuters. For data sources and the procedure employed to compute cigarette consumption, see Leu (1979).

[4]Compare Lyon and Spruill (1976); Miller (1974); Peto (1974); Schmalensee (1972).

[5]To date, only prominent events could be considered in demand studies: scientific reports on the health effects of smoking (see, for example, Russel, 1973; Atkinson and Skegg, 1973; Peto, 1974; Warner, 1977) regulations on cigarette advertising (see, for example, McGuiness and Cowling, 1975, and Johnston, 1975, for a critical review), and special anti-smoking campaigns (see especially Hamilton, 1972).

[6]Compare the literature summarized in U.S. DHEW (1979, pp. 21-23).

[7]Schmalensee (1972, p. 154) argues that the effect of the report did not fade because of the remainders in the media. See also McGuiness and Cowling (1980, p. 128).

[8]Compare Atkinson and Skegg (1973, p. 273).

[9]See, for example, Lynch (1963); Swinehart and Kirscht (1966); Horn (1968); Hunt and Matazarro (1971).

[10]Sumner (1971) has argued that the effect of the report was mainly to discourage young people from taking up smoking, resulting in a vintage effect increasing over time. But this hypothesis is inconsistent with the evidence about the increasing smoking among youths (see, for example, Battegay et al., 1975). Atkinson (1974) has suggested that, theoretically, publicity might even increase smoking among youths.

[11]For empirical evidence on smoking habits in Switzerland, see Abelin and Wuthrich (1976); Battegay et al. (1975); Konso (1972).

[12]See, for example, Schoenberg (1933); Tennant (1950); Schmalensee (1972). Bass (1969) reported significant elasticities for the U.S. However, as Schmalensee noted, his simultaneous equation system was not identified. McGuiness and Cowling (1975) found a significant impact of cigarette advertising in the U.K., but the elasticity values, properly interpreted (see Johnson, 1975), were rather small. Finally, Behnke (1977) came up with a significant elasticity estimate of .14 for West Germany; however, the study only covered eleven observations.

[13]It should be noted that product quality is an endogenous rather than exogenous variable.

[14]The partial adjustment model was initially suggested by Nerlove (1956).

[15]The tests suggested by Durbin (1970, pp. 410-421) are not valid for the small-sample case.

[16]The consistency of this instrumental variable or two-stage approach does not depend on particular assumptions about the structure of the disturbances. See, for example, Griliches (1967, pp. 40-). It should be noted, however, that two-step procedures are in general asymptomatically less efficient in this type of model than maximum likelihood procedures. See, for example, Sims (1974, p. 300).

[17]It was assumed that all values of β_I within the interval were equally likely. β_{ASP} was calculated as the sum of the coefficients for the two publicity variables in equation (7). Unconstrained estimation produced essentially the same results; the restriction was not binding.

[18]See, for example, Granger and Newbold (1974).

[19]Using the method of first differences has the disadvantage of introducing autoregression in the disturbances that are otherwise independent. See, for example, Kmenta (1971, pp. 390).

[20]This is consistent with the results of McGuiness and Cowling (1975) for the U.K.

[21]Multicollinearity was gauged following the techniques suggested by Farrar and Glauber (1967), with Haitovsky's heuristic modification (1969). The Appendix shows that multicollinearity among the untransformed independent variables was extensive. The diagonal of the table sets, the R^2 for the independent variables, each in turn regressed on all other independent variables. The auxiliary regressions indicate that the income and price variables, lagged cigarette consumption, the time trend, and the consumption of pipe tobacco were extremely collinear. The bulk of the off-diagonal partial correlation coefficients suggest that the income and price variables formed the heart of the problem. Sixteen of the twenty-one partials significant at the 5% level involved one or both of these variables, and twelve of them involved price variables. This was unfortunate insofar as cigarette price was one of the variables focused on in this paper.

[22]See, for example, Friedman et al. (1971). A summary of the empirical evidence is provided by the Third Report of the Royal College of Physicians (1977, p. 99). Evidence for Switzerland is provided by Battegay et al. (1975).

[23]See, for example, McKennel and Thomas (1967); Horn (1968).

[24] Compare Wynder (1979).

[25] See, for example, Hammond et al. (1977, p. 111). It has also been argued that the trend to light cigarettes might make it easier for more recently recruited smokers to quit (see Leventhal and Cleary, forthcoming). However, it is not known whether smokers of light cigarettes are more likely to quit, or to succeed in quitting (see Harris, forthcoming).

[26] The available studies neither clearly exclude nor clearly prove that smokers increase the amount smoked when switching to lighter cigarettes. It has been posited that different explanations may apply to different age and sex groups (see U.S. DHEW, 1979. p. A-17).

[27] Compare Warner (1977, p. 648).

[28] Warner used ordinary least squares to estimate demand equations including the lagged dependent variable on the right-hand side. Assuming a habit persistence model, the consistency of his results rests on the assumption that there was no autoregression in the disturbances.

[29] See Sackrin (1962); Lyon and Simon (1968); Houthakker and Taylor (1970); Langhunn and Lyon (1971); Miller (1970, 1974, 1975); Spruill, (1976).

[30] See Stone (1945); Sumner (1971); Russel (1973); Atkinson and Skegg (1973); Peto (1974).

References

Abelin, Th. and Wüthrich, P. 1976. Repraesentativerhebung über die Rauchgewohnheiten in der deutsch-französich-und romanisch-sprachigen Schweiz 1975. *Sozial-und Praeventivmedizin*, *21*, 17.

Atkinson, A. B. 1974. Smoking and the economics of government intervention. In Perlman, M. (Ed.), *The economics of health and medical care*. New York: John Wiley & Sons, pp. 428-441.

Atkinson, A. B. and Skegg, J. L. 1973. Anti-smoking publicity and the demand for tobacco in the U.K. *The Manchester School of Economic and Social Studies*, *41*, 265.

Atkinson, A. B. and Townsend, J. L. 1977. Economic aspects of reduced smoking. *The Lancet*, *3*, September, p. 492.

Bass, F. M. 1969. A simultaneous equation regression study of advertising and sales of cigarettes. *Journal of Marketing Research*, 6, 291-300.

Battegay, R., Mühlemann, R., Hell, D., Zehnder, R., Hoch, P., and Dillinger, A. 1975. Alkohol, tabak und drogen im leben des jungen mannes. Untersuchung an 4082 Schweizer Rekruten betreffend Suchmittelkonsum im Zivilleben und während der Rekrutenschule. Basel/München/Paris/London/New York/Sydney: S. Karger.

Behnke, E. A. 1977. *Werbung und zigarettenkonsum*. Meisenheim am Glan: Anton Hain.

Durbin, T. 1970. Testing for serial correlation in least-squares regression when some of the regressors are lagged dependent variables. *Econometrica*, *38*, 410-421.

Eisinger, R. A. 1971. Psychological predictors of smoking recidivism. *Journal of Health and Social Behavior*, *12*, 355-362.

Farrar, D. E. and Glauber, R. R. 1967. Multicollinearity in regression analysis: The problem revisited. Review of Economics and Statistics, 49, 92-107.

Fletcher, C. M. and Horn, D. 1970. Smoking and health. Reprinted from WHO Chronicle, 24, 8, 345-370.

Granger, C. W. J. and Newbold, P. 1974. Spurious regressions in econometrics. Journal of Econometrics, 2, 111-120.

Grilliches, Z. 1967. Distributed lags: A survey. Econometrica, 35, 16-48.

Haitovsky, Y. 1969. Multicollinearity in regression analysis: Comment. Review of Economics and Statistics, 51, 486-489.

Hamilton, J. L. 1972. The demand for cigarettes: Advertising, the health scare, and the cigarette advertising ban. Review of Economics and Statistics, 54, 401-410.

Hammond, E. C., Garfinkel, L., Seidmann, H., and Lew, E. A. 1977. Some recent findings concerning cigarette smoking. Reprinted from Origins of human cancer. New York: Cold Spring Harbor Laboratory.

Harris, J. E. Forthcoming. Cigarette smoking among women and men in the United States, 1900-1979. In the 1980 Surgeon General's Report on Smoking and Health. The health consequences of smoking for women. U.S. Department of Health, Education and Welfare, Office of the Surgeon General, Office of Smoking and Health.

Horn, D. 1968. See p. 12.

Horn, D. 1968. The health consequences of smoking. In Borgotta, E. F. and Evans, R. R. (Eds.), Smoking, health and behavior. Chicago: Aldine.

Houthakker, H. S. and Taylor, L. D. 1970. Consumer demand in the United States: Analyses and projections. Cambridge, Masschusetts: Harvard University Press.

Hunt, W. A. and Matazarro, J. D. 1971. Relapse rates in addiction programs. Journal of Clinical Psychology, 27, 4, 163-184.

Johnson, J. 1980. Advertising and the aggregate demand for cigarettes: A comment. European Economic Review, 14, 117-125.

Kellner, I. L. 1973. The American cigarette industry: A re-examination. Unpublished Doctoral Dissertation, New School for Social Research, Michigan.

Kmenta, J. 1971. Elements of econometrics. London/New York: Macmillan Publishing Co.

Konso, A. G. 1972. Familie schweizer unter der lupe: Zigaretten--rauchtr. Konsonanz, quartalschefte fūr markt-und sozialanalyse, Basel. Heft, 35, 14-17.

Langhunn, D. J. and Lyon, H. L. 1971. The feasibility of tax induced price increases as a deterrent to cigarette consumption. Journal of Business Administration, 3, 27-35.

Leu, R. E. 1979. Der verbrauch von tabakwaren in der Schweiz 1950-1978. Sozial-und Praeventivmedizin, 24, 321-323.

Leu, R. E. Forthcoming. Rauchen und gesundheit: Eine volkswirtschaftliche analyse. Zurich: Schulthess Polygraphischer Verlag.

Leu, R. E. and Lutz, P. 1977. Oekonomische aspekte des alkoholkonsums in der Schweiz. Zurich: Schulthess Polygraphischer Verlag.

Leventhal, H. and Cleary, P. D. Forthcoming. The smoking problem: Research and theory in behavioral risk modification. Psychological Bulletin.

Lynch, G. W. 1963. Smoking habits of university staff. British Medical Journal, 30,

Lyon, H. L. and Simon, G. L. 1968. Price elasticity of the demand for cigarettes in the United States. American Journal of Agricultural Economics, 50, 881-893.

Lyon, H. L. and Spruill, M. L. 1976. A temporal cross-section analysis of cigarette price elasticity in the United States. Working paper, University of Kentucky: Lexington.

McGuiness, T. and Cowling, K. 1975. Advertising and the aggregate demand for cigarettes. European Economic Review, 6, 311-328.

McGuiness, T. and Cowling, K. 1980. Advertising and the aggregate demand for cigarettes: A Reply. European Economic Review, 14, 117-125.

McKennel, A. C. and Thomas, R. K. 1967. Adults and adolescents' smoking habits and attitudes. Government Social Survey. London: HMSO.

Miller, R. H. 1970. The demand for cigarettes in the United States. U.S. Department of Agriculture, Economic Research Service.

Miller, R. H. 1974. Factors affecting cigarette consumption. U.S. Department of Agriculture, Economic Research Service.

Miller, R. H. 1975. Pricing out tobacco: Price as a factor in cigarette consumption. U.S. Department of Agriculture, Economic Research Service.

Nerlove, M. 1956. Estimates of the elasticities of supply of selected agricultural commodities. Journal of Farm Economics, 38, 2,

Peto, J. 1974. Price and consumption of cigarettes: A case for intervention? British Journal of Preventive and Social Medicine, 28, 241.

Royal College of Physicians. 1962. Smoking and health. London: Pitman Medical.

Royal College of Physicians. 1971. Smoking and health now. London: Pitman Medical.

Royal College of Physicians. 1977. Smoking or health. London: Pitman Medical.

Russell, M. A. H. 1973. Changes in cigarette price and consumption by men in Britain, 1946-71: A preliminary analysis. British Journal of Social and Preventive Medicine, 27, 1.

Sackrin, S. M. 1962. Factors affecting the demand for cigarettes. Agricultural Economics Research, 14, 81-88.

Schmalensee, R. L. 1973. On the economics of advertising. Amsterdam: North Holland Publishing Co.

Schoenberg, E. H. 1933. The demand curve for cigarettes. Journal of Business, 6, 15-35.

Simon, J. L. 1970. Issues in the economics of advertising. Chicago: University of Illinois Press.

Sims, A. 1974. Distributed lags. In Intrilligator, M. F. and Kendrick, D. A. (eds.), Frontiers of quantitative economics: Volume II. Amsterdam: North-Holland.

Solow, R. M. 1967. The new industrial state or son of affluence. The Public Interest, 9, 105.

Stone, R. 1965. The analysis of market demand. Review of Economics and Statistics, 108,

Sumner, M. T. 1971. The demand for tobacco in the U.K. Manchester School of Economic and Social Studies, 39, 23.

Swinehart, J. W. and Kirscht, J. P. 1966. Smoking: A panel study of beliefs and behavior following the PHS Report. Psychological Reports, 18, 519-528.

Tennant, R. B. 1950. The American cigarette industry. New Haven: Yale University Press.

Townsend and Atkinson. 1977.

U.S. Department of Health, Education and Welfare, Public Health Service. 1964. Smoking and health, report of the Advisory Committee to the Surgeon General of the Public Health Service. Washington, D.C.: U.S. Government Printing Office.

U.S. Department of Health, Education and Welfare, Public Health Service. 1969. Use of tobacco: Practices, attitudes, knowledge, and beliefs, United States-Fall 1964 and Spring 1966. Washington, D.C.: U.S. Government Printing Office.

U.S. Department of Health, Education and Welfare, Public Health Service. 1973a. Adult use of tobacco-1970. Atlanta: Center for Disease Control.

U.S. Department of Health, Education and Welfare, Public Health Service. 1973b. The health consequences of smoking. Washington, D.C.: U.S. Government Printing Office.

U.S. Department of Health, Education and Welfare, Public Health Service. 1976. Adult use of tobacco-1975. Atlanta: Center for Disease Control.

U.S. Department of Health, Education and Welfare, Public Health Service. 1979. Smoking and health: A report of the Surgeon General. Washington, D.C.: U.S. Government Printing Office.

Warner, K. E. 1977. The effects of the anti-smoking campaign on cigarette consumption. American Journal of Public Health, 67, 645.

World Health Organization. 1975. Smoking and its effects on health: Report of a WHO Expert Committee. Technical Report Series No. 568, Geneva.

Wynder, E. L. and Hoffmann, D. 1979. Smoking and health: Pathogenic and preventive considerations. Bulletin der Schweizerischen Akademie der medizinischen Wissenschaften, 35, 83-98.