The MIT Press

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Author(s): Badi H. Baltagi and Dan Levin
Reviewed work(s):
Source: *The Review of Economics and Statistics,* Vol. 68, No. 1 (Feb., 1986), pp. 148-155
Published by: The MIT Press
Stable URL: http://www.jstor.org/stable/1924938
Accessed: 02/05/2012 11:45

ESTIMATING DYNAMIC DEMAND FOR CIGARETTES USING PANEL DATA: THE EFFECTS OF BOOTLEGGING, TAXATION AND ADVERTISING RECONSIDERED

Badi H. Baltagi and Dan Levin*

Abstract—A dynamic demand for cigarette consumption is estimated using pooled data of 46 states over the period 1963 to 1980. A price elasticity of −0.2 and an insignificant income elasticity is found using pooled estimation techniques. The "bootlegging" effect is modeled explicitly using "neighboring" price. The effect is found to be significant. Two major policy issues are analyzed in light of these new estimates: (1) Cigarette taxation is found to be an effective tool for generating revenues even though there may be spillover effects to neighboring states where bootlegging is significant. (2) The effects of the Fairness Doctrine Act and the advertising ban on cigarette consumption are re-examined. We find mild support for the effectiveness of subsidized anti-smoking messages in reducing cigarette consumption, and no support for the thesis that the ban on advertising helps to increase per capita consumption.

I. Introduction

MEDICAL journals as well as the Surgeon General have published numerous reports warning about the health hazards of smoking.[1] The federal government has also played a major role in attempting to reduce the consumption of cigarettes. Major policy interventions are (i) the imposition of warning labels by the Federal Trade Commission effective January 1965, (ii) the application of the Fairness Doctrine Act to cigarette advertising in June 1967, and (iii) the Congressional ban of broadcast advertising of cigarettes effective January 1971. The banning of pro-smoking messages from television and radio has virtually eliminated anti-smoking messages, since the broadcasting stations are no longer required to adhere to the Fairness Doctrine Act. If these health-scare-oriented messages are more effective than pro-smoking messages, the net effect of the ban might be to increase the consumption of cigarettes and therefore benefit the cigarette industry.[2]

In an effort to assess the net effect of the advertising ban on cigarette consumption, Hamilton (1972) estimated a demand for cigarettes equation incorporating prior estimates of price and income elasticities. He finds that pro-smoking messages are less effective determinants of cigarette consumption than the health-scare anti-smoking messages. Hamilton therefore concludes that the net effect of the advertising ban will be to increase the per capita consumption of cigarettes.

Cigarette taxation may deter cigarette consumption. The effectiveness of this policy instrument depends upon the price elasticity of demand for cigarettes and on whether this elasticity can be accurately predicted over time.[3]

Underlying both policy questions is the proper specification and estimation of the cigarette demand equation. Prior evidence on the magnitudes of price and income elasticities show a wide range of estimates varying from −0.10 to −1.48 for price elasticity and 0.12 to 0.82 for income elasticity. For example, Lyon and Simon (1968), using a quasi-experimental approach, computed arc price elasticities using state sales data before and after a tax change. The median price elasticity found was −0.511 with a 95% confidence interval of −0.346 to −0.713. Maier (1955), on the other hand, arrived at a higher range of price elasticities (−1.08 to −1.48) using a cross-section study of state data. Sackrin (1957) using a cross-section study found an income elasticity of 0.12. Hamilton (1972) using Lyon and Simon's (1968) price elasticity estimate ran cross-section regressions over state data and obtained an income elasticity of 0.73. Faced with this wide range of price and income elasticities, the policy maker arrives at different conclusions using

[1] The latest Surgeon General's report finds that in 1983, 80% to 90% of chronic lung disease in the United States can be directly attributable to cigarette smoking.

[2] See Hamilton (1972) and Doron (1979) for support of this view.

[3] See Laughhunn and Lyon (1971) for support of cigarette taxation as an effective policy tool in reducing cigarette consumption. They estimate a price elasticity of −0.81 and find that this demand for cigarettes is stable over time.

different elasticity estimates. In this study we estimate a dynamic demand for cigarettes based on pooled data of 46 states over the period 1963 to 1980.[4] These panel data allow for regional variation in prices, income and consumption patterns, and cover ten years after the ban on advertising.

Another distinctive feature of this paper is that it tackles the problem of bootlegging in the cigarette industry. Briefly stated, due to the variation in tax rates across states, consumers in state A might be tempted to buy from lower tax state B. This will imply that consumption per capita in state B is over-reported and that in A under-reported. Hence a cross-section study based on state data that does not account for this effect leads to price elasticities that are biased. In this study, the bootlegging effect is modeled explicitly by the use of a neighboring price effect which acts as a substitute price. This effect is found to be statistically significant.[5]

Finally, this paper examines two policy questions in light of the pooled results. The first tests whether there is any support for the hypothesis that the net effect of the advertising ban is to increase rather than decrease the consumption of cigarettes. The second determines to what extent cigarette taxation is an effective tool for generating state revenues.

In section II we outline our demand equation and contrast it with previous specifications. Section III examines the results of the pooling techniques and reports our estimates of price, income and neighboring price effects. Section IV probes the question of the advertising ban and cigarette taxation and their effects on cigarette consumption. Section V gives our summary and conclusion.

II. The Model

Following Hamilton (1972) and McGuinness and Cowling (1975), the cigarette demand equa-tion is modelled as follows:

$$C = f(P, Y, A, H) \tag{1}$$

where C is the per capita consumption of cigarettes by persons of smoking age (14 years and older), P is the real price of cigarettes, Y is the real disposable income per capita, A is the per capita index of advertising,[6] and H is the health dummy variables.

It is also assumed that cigarette consumption is governed by a partial adjustment or habit persistence model,[7] i.e.,

$$\ln C - \ln C_{-1} = \delta(\ln C^* - \ln C_{-1}) + u \tag{2}$$

where C^*, the expected or "desired" level of consumption of cigarettes, is given by

$$\ln C^* = \alpha + \beta_1 \ln P + \beta_2 \ln Y + \beta_3 \ln Pn$$
$$+ \gamma_0 \sum_{i=0}^{\infty} \lambda^i A_{-i}. \tag{3}$$

Note that advertising enters with an infinite geometric lag.[8] Also, a distinctive feature of this specification is the introduction of Pn, which denotes the minimum real price of cigarettes in any neighboring state.[9] This can be justified as follows: At any point in time, cigarette prices vary across states because cigarette tax rates vary. Smokers in a high tax state are tempted to buy from neighboring states with lower tax rates. This smuggling or bootlegging effect can be estimated by the use of Pn which acts as a substitute price.[10]

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[4] Data on advertising was available from the U.S. Federal Trade Commission report from 1963 to 1980. Extending the sample before 1963 requires reconciling two different sources of data. Other data sources are given in the appendix.

[5] The Advisory Commission on Intergovernmental Relations estimates that in 1975 cigarette bootlegging cost the high-tax states $391 million. The Commission also finds that bootlegging is mainly due to wide disparities in tax rates among states, and is responsive to it. The seriousness of the problem was officially recognized by the enactment of the 1978 Federal Contraband Cigarette Act which made the transportation of contraband cigarettes in interstate commerce a federal criminal offense.

[6] Telser (1962) and McGuinness and Cowling (1975) suggest that advertising be measured by the number of "messages" received by consumers. Unfortunately, the absence of such information renders this task impossible. Like Hamilton (1972) and others our study uses an index of per capita advertising expenditures.

[7] For a detailed discussion on the application of the partial adjustment model to cigarette demand, see McGuinness and Cowling (1975).

[8] See Palda (1964) for arguments in support of this hypothesis.

[9] A selector matrix, made up of zeros and ones, is constructed identifying the neighboring states for each state. Each row of this matrix is multiplied by the price variable to pick out the prices of neighboring states. Finally, the minimum of these prices is computed for each state.

[10] This bootlegging specification is a first attempt at dealing with this issue and is not free of problems. For example, (i) it does not account for the fact that in a geographically large state, cross-border shopping may take place in different neighboring states and not just in the minimum-price neighboring state. (ii) It does not explicitly account for bootlegging done over long distances by trucks.

Substituting (3) into (2) and performing some iterative substitutions,[11] the model becomes

$$\ln C_t = \alpha\delta + a\lambda^t + \beta_1\delta \ln P_t + \beta_2\delta \ln Y_t$$
$$+ \beta_3\delta \ln Pn_t + \gamma_0\delta Z_t(\lambda)$$
$$+ (1 - \delta)\ln C_{t-1} + u_t \qquad (4)$$

where $Z_t(\lambda) = A_t + \lambda A_{t-1} + \cdots + \lambda^{t-1}A_1$ and a is a constant involving initial values.

The presence of lagged consumption in the cigarette demand equation can therefore be justified on the basis of the partial adjustment model (equation (2)) or the presence of an infinite geometric lag on advertising (equation (3)).[12] This means that one ought to make careful distinction between δ and λ, the two different sources of dynamic behavior in this demand equation.

For the period 1964–1980, we focus on two major events that may have changed the effect of advertising on cigarette consumption. The first is the Fairness Doctrine Act which subsidized anti-smoking messages from 1968 to 1970. The second is the broadcast ban of cigarette advertisement effective January 1971. The effect of the first policy measure is incorporated in our model by including a dummy variable FD which takes the value of the per capita index of advertising in television and radio for the years 1968–1970, and zero for the remaining years.[13] The effect of the second policy measure is incorporated by allowing separate dummies for each year in which the ban was in effect, i.e., 1971–1980.

In the next section the pooled time-series of cross-section results are presented for the demand equation using an error component model. The Hausman-Taylor (1981) estimation procedure is applied to account for the fact that advertising is invariant across states. Finally, a Zellner-Geisel (1970) estimation procedure is applied to equation (4) to distinguish between lagged effects due to advertising and those due to habit persistence.

III. Results

A. Hausman-Taylor Estimation

Following Balestra and Nerlove (1966), we pool these data using an error component model.[14] Since advertising and the Fairness Doctrine variables are invariant across states, their effects vanish when we apply the Within transformation. In order to estimate these effects and account for the possible correlation between these variables and the time-specific effects, the Hausman-Taylor (1981) efficient estimation procedure is applied. This is an instrumental variables technique which necessarily requires at least as many exogenous state-varying variables as there are endogenous state-invariant variables. Intuitively, the instrumental variables needed come from the between variation, i.e., the state means, of the state-varying exogenous variables. In addition, the within variation of the state-varying variables are used as instruments for the variables themselves. This is an advantage of panel data; instruments are obtained from both the between and within variation of the exogenous state-varying variables. Table 1, panel A, gives the ordinary least squares (OLS), Within, and the Hausman-Taylor results. Except for income and advertising both of which are insignificant, the results indicate little variation between OLS and the efficient estimator.[15] These results indicate a significant lagged coefficient of consumption (0.9), a significant price elasticity (-0.2) and an insignificant income elasticity ranging between -0.002 and 0.004. The neighboring price elasticity coefficient is significant (0.08) and advertising and the Fairness-Doctrine effects are both insignificant. The Hausman (1978) chi-squared statistic is 0.001 indicating that we cannot reject the null hypothesis of no misspecification.[16]

B. Zellner-Geisel Estimation

So far, the dynamic specification considered does not attribute any lagged effect due to advertising.

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[11] See Zellner and Geisel (1970).

[12] Hamilton (1972), for example, does not assume a partial adjustment model. His model is dynamic solely because of the infinite geometric lag on advertising. Also, the moving average error term resulting from the Koyck transformation is ignored. This renders his least-squares estimates inconsistent and inefficient.

[13] The Fairness Doctrine Act tied the number of anti-smoking messages to the number of cigarette commercials. The value of these anti-smoking messages was estimated at $75 million for 1970; see Harris (1979). This is roughly one-third of cigarette advertising expenditures on TV and radio for that year.

[14] For more detailed analysis on estimation and test of hypotheses in an error component model, see Baltagi (1981) and the references cited there.

[15] This may be attributed to the close results of OLS and the Within estimator and the high value of θ obtained (0.888).

[16] For this model, the null hypothesis specifies that the time-specific effects are not correlated with the included exogenous variables, some of which are invariant across states.

TABLE 1.—ESTIMATED COEFFICIENTS OF THE CIGARETTE DEMAND EQUATION

A. Pooled Estimation Results[a]

	$(\ln C_t)_{-1}$	$\ln P_t$	$\ln Y_t$	$\ln Pn_t$	Adv	FD	Constant	S.E.	$\bar{R}^2$
OLS	0.927	−0.225	0.004	0.081	0.038	−0.005	0.114	0.047	0.95
	(97)	(9.4)	(0.3)	(4.5)	(1.2)	(1.1)	(1.4)		
Within	0.931	−0.215	−0.002	0.078	—	—	—	0.046	0.95
	(99)	(9.1)	(0.1)	(4.4)					
Hausman-Taylor[b]	0.930	−0.215	−0.002	0.078	0.063	−0.005	0.070	0.047	0.95
	(98)	(9.1)	(0.1)	(4.4)	(0.2)	(0.1)	(0.1)		

B. The Zellner-Geisel Search Procedure for Different Values of λ

λ	$(\ln C_t)_{-1}$	$\ln P_t$	$\ln Y_t$	$\ln Pn_t$	Adv	FD	Constant	S.E.[c]	$\bar{R}^2$
0.1	0.930	−0.219	−0.004	0.079	0.001	−0.013	0.210	0.047	0.95
	(97.3)	(9.2)	(0.3)	(4.4)	(0.04)	(2.8)	(2.3)		
0.01	0.931	−0.219	−0.004	0.079	0.008	−0.012	0.196	0.047	0.95
	(97.4)	(9.2)	(0.3)	(4.4)	(0.3)	(2.6)	(2.3)		
0.001	0.931	−0.219	−0.004	0.079	0.009	−0.012	0.194	0.047	0.95
	(97.4)	(9.2)	(0.3)	(4.4)	(0.3)	(2.6)	(2.3)		

C. The Zellner-Geisel Search Procedure Truncating the Remainder

λ	$(\ln C_t)_{-1}$	$\ln P_t$	$\ln Y_t$	$\ln Pn_t$	Adv	FD	Constant	S.E.	$\bar{R}^2$
0.43	0.930	−0.215	−0.002	0.078	0.022	−0.014	0.138	0.047	0.95
	(98.0)	(9.0)	(0.1)	(4.4)	(0.6)	(0.6)	(1.1)		

[a] Numbers in parentheses are t-statistics.
[b] The estimates of the variance components used in the Hausman-Taylor procedure are $\hat{\sigma}_\nu^2 = 0.002$, $\hat{\sigma}_\lambda^2 = 0.004$, and $\theta = 0.888$.
[c] As λ varies between 0.999 and 0.001, the standard error of the regression systematically drops from 0.04667 to 0.04659 and $\bar{R}^2$ increases from 0.925 to 0.953.

In fact, the above results find the effect of advertising generally insignificant. In what follows, we consider the specification given in (4) which distinguishes between the dynamics due to advertising and that due to habit persistence. We apply the Zellner-Geisel (1970) estimation procedure to determine the significance of both causes of dynamics and to determine if the price and income elasticities change under this specification.

Table 1, panel B, shows the results of a search procedure for various values of λ. As λ decreases from 0.999 to 0.001 so does the residual sum of squares. However, for small values of λ close to zero, the regression estimates do not change much.[17] The lagged coefficient on consumption $(1 - \delta)$ is 0.93 and significant, the price elasticity is −0.2 and significant. Income elasticity is −0.004 and insignificant, and the neighboring price elasticity is 0.08 and significant. Finally, advertising is insignificant, whereas the Fairness Doctrine effect is −0.01 and significant.

Next, we applied the following two-step estimation procedure which accounts for the error component specification: In the first step, a λ is chosen and the Zellner-Geisel transformation is applied on each variable. In the second step, the Hausman-Taylor efficient estimation method is applied, and the process is repeated for λ between 0.001 and 0.999. Again, this procedure obtained a residual sum of squares which was decreasing in λ. However, ignoring λ^t in equation (4), i.e., truncating the remainder, this procedure converged for λ = 0.43 and the results are given in table 1, panel C.[18] Comparing with the Hausman-Taylor results given in panel A, only the coefficients of advertising and FD are different. However, both of these coefficients are insignificant.

These results show a slow but statistically significant adjustment coefficient in the habit persistence model ($\hat{\delta} = 0.07$). λ, on the other hand, is 0.43 in case we ignore the truncation remainder,

[17] In fact, the only significant change is in the estimate of the coefficient of λ^t. Estimates of the dummy variables and λ^t coefficients are not presented here and are available upon request from the authors.

[18] Dhrymes (1971) showed that ignoring the truncation remainder makes no difference asymptotically. However, Pesaran (1973) and Schmidt (1975) argued for the inclusion of this term, based on empirical as well as small sample Monte Carlo results.

and very small and close to zero in case we do not ignore it. This indicates a fairly quick decay rate for the effect of advertising on consumption of cigarettes.[19]

It is important to emphasize the robustness of the above results. To summarize, we have found a lower price elasticity (-0.2) than Lyon and Simon; an insignificant income elasticity contrary to the large income elasticity of (0.73) found by Hamilton; a neighboring price elasticity of (0.08), indicating a small but significant bootlegging effect on the demand for cigarettes. Finally, we found an insignificant effect of advertising on the consumption of cigarettes. The implications of these results to policy analysis are given in the next section.

At this stage, we pause to explain the difference between our results and those obtained by Hamilton (1972), who used the prior price elasticity of -0.511 to generate an average income elasticity of 0.734 from two cross-section regressions of states, one in 1954 and another in 1965. Similar cross-section regressions performed for each year show a supporting income elasticity to Hamilton's in the range of 0.61 to 0.75 but only over the period 1963–1970. In fact, this income elasticity estimate drops steadily from 0.49 in 1971 to 0.01 in 1979 becoming insignificant from 1972 and on, and even switching sign in 1980.[20] At the least, these results should cast serious doubt over the use of prior constant price and income elasticities for the purpose of estimation and policy calculations over the period of study, 1963–1980.[21]

More important, such cross-section regressions assume a rather simplistic form for cigarette demand. Performing the dynamic cross-section regressions for the years 1964 through 1980, one gets: (i) a lagged coefficient on cigarette consumption, which is 0.9, and is statistically significant for all years; (ii) a price elasticity that varies between -0.02 and -0.33 and is statistically significant in most years; (iii) an income elasticity that is statistically insignificant in 11 out of 17 years and has a negative sign in 5 out of the 6 significant years. This income elasticity never exceeds 0.156 in absolute value.

In summary, static cross-section regressions are biased and should not be relied upon to give unbiased estimates of the income elasticity even if a prior price elasticity is used. Hamilton's high income elasticity of 0.73 is not supported by the dynamic cross-section results nor by our pooled dynamic model. Our results indicate an insignificant income elasticity for cigarette demand.[22]

IV. Policy Analysis

In this section we tackle two important policy implications of our estimates of the demand for cigarettes. The first is the impact of the Fairness Doctrine Act and the ban on broadcast advertising, and the second is the impact of taxation on cigarette demand.

A. The Fairness Doctrine Act and the Advertising Ban on Cigarette Consumption

Previous studies, most notably Hamilton (1972), argued that the health scare and anti-smoking messages were more potent than promotional ads, and that the net effect of the ban is to give a stimulus to cigarette consumption. Given the results in section III, we ask the following questions:

(1) Was the Fairness Doctrine Act effective in reducing the effect of promotional ads (on television and radio) on cigarette consumption?

(2) For 1968–1970, the years when the Fairness Doctrine Act was in effect, does the reduction of one real per capita dollar of broadcast advertising increase cigarette consumption, rather than decrease it?

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[19] The importance of advertising in affecting cigarette demand has mixed reviews in the literature. Many economists argued that cigarette advertising is "the main competitive weapon" by which oligopolists sought to increase their relative shares. See Telser (1962, p. 407). Some studies found cigarette advertising to have an insignificant effect on demand (see Schoenberg (1933) and Schmalensee (1972)), while others found it to be significant (see Hamilton (1972) and McGuinness and Cowling (1975)). More recently, Ashley, Granger and Schmalensee (1980) found that causality runs from consumption to advertising and not vice versa, and that advertising effects on consumption are short-lived.

[20] For space limitations, the results upon which the remainder of this section are based are given in tables 2 and 3 and are available upon request from the authors.

[21] Hamilton (1972) used this prior estimate of the price elasticity in order to circumvent the multicollinearity problem between price and income. Although the multicollinearity problem may be serious in an aggregate time-series regression for the United States, we do not find it to be the case at the state level. For our pooled data, the simple correlation coefficient between price and income never exceeded 0.4 over the entire sample period 1963 to 1980.

[22] Insignificant income elasticities are also supported by Warner (1977) and Lyon and Spruill (1979).

Question 1 can be formulated as testing whether the coefficient of *FD* in the demand equation is non-negative, versus the alternative that it is negative. Table 1 shows that the coefficient of *FD* is negative for both the OLS and the Hausman-Taylor estimators. However, we cannot reject the null hypothesis of non-negativity in both cases. Hence, these results offer support, albeit mild, to the effectiveness of the Fairness Doctrine on the reduction of cigarette consumption.

Question 2 is at the heart of the hypothesis proposed by Hamilton (1972, p. 401) which claims that " ... the net effect of the ban may be to increase consumption, not decrease it." This statement, if true, implies that during the Fairness Doctrine years (1968 to 1970), a dollar decrease in real per capita broadcast advertising may increase consumption rather than decrease it. This can be formulated as testing whether the sum of the coefficients of advertising and *FD* is non-negative versus the alternative that this sum is negative. For the results given in table 1, this sum is positive for both OLS and the Hausman-Taylor results, and we cannot reject the null hypothesis of non-negativity. Hence, in our opinion, this evidence does not provide support to Hamilton's hypothesis.[23]

Hamilton (1972, p. 408) supports his argument by bringing to evidence the fact that

... prior to the Congressional ban the cigarette companies *volunteered* to Congress a private broadcast advertising ban, if in exchange Congress gave the companies' agreement antitrust immunity and all federal agencies dropped their proposals for stronger health warnings. Given that the health scare was a stronger marginal determinant of cigarette demand than was cigarette advertising, the companies' eagerness to assist the government to end the subsidized antismoking advertising was not surprising.

However, using Hamilton's own results and profit maximization that accounts for the cost of advertising, one can explain the above voluntariness of the cigarette companies without necessarily reaching Hamilton's conclusions.[24]

Why then do companies use advertising so extensively beyond the point of profitability? The answer has to do with oligopolistic competition via advertising. We have to distinguish between the effectiveness of advertising to increase total sales, which is low, and its effectiveness to make smokers switch from one brand to the other, which can be high. This argument finds support in Scherer (1980; p. 389), who summarizes previous studies and concludes on the following note: "That repeated rivalrous escalations of cigarette advertising have carried outlays far beyond the short run profit-maximizing point seems indisputable." He also adds that much of the industry's advertising is self-cancelling and unprofitable even in the long run.[25]

B. The Impact of Taxation on Cigarette Demand

A second important policy issue is the extent to which taxation can be used to reduce cigarette consumption and/or to raise revenue. The effectiveness of taxation as a policy tool depends critically on the price elasticity of demand for cigarettes. Before we assess this effect, it is important to distinguish between the two price elasticities estimated from the demand equation. The first is the usual own price elasticity of demand and the second is the neighboring price elasticity effect.

The pooled results reported in table 1 show an own price elasticity of -0.22 and a neighboring price elasticity of 0.08. This means that a tax increase across the board raising real prices in all states by 10% will reduce consumption per capita of cigarettes by only 1.4%. To assess the impact of a tax hike in individual states one ought to be careful in determining whether neighboring states levied a tax or not, and to what extent bootlegging is important for that state. For example, New Hampshire and Massachusetts are neighboring states with the latter being consistently a higher tax state with lower per capita consumption.[26] Own price elasticity in New Hampshire[27] is -0.856 (1.4) and the neighboring price elasticity is 1.316 (2.8). For Massachusetts, own price elasticity is -0.386 (1.6) and the neighboring price elasticity is

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[23] Support for Hamilton's hypothesis is a rejection of H_0, i.e., a negative significant sum of the coefficients of *Adv* and *FD*. However, it is important to add that our results do not decisively refute Hamilton's hypothesis, i.e., the sum of the coefficients obtained is not significantly positive.

[24] Calculations based on our insignificant advertising elasticity are clearly in favor of this view. See also Doron (1979) and Simon (1967) for more detailed calculations in support of this view.

[25] See also Schmalensee (1972) and Doron (1979) and the references cited there.

[26] See Doron (1979, p. 64) who noticed that per capita smoking in New Hampshire was double that in neighboring Massachusetts and argued that this must be due to the existence of bootlegging.

[27] Numbers in parentheses are *t*-statistics.

0.163 (0.5). Using these numbers, let us assess the impact of a tax levied in each of these states.[28] A tax increase in Massachusetts inducing a 10% increase in the real price of cigarettes in that state will (ceteris paribus) decrease reported consumption per capita in that state by 3.9% and increase reported consumption per capita in New Hampshire by 13.2%. Similarly, a tax increase in New Hampshire inducing a 10% increase in the real price of cigarettes in that state will (ceteris paribus) decrease reported per capita consumption in that state by 8.6% and cause an increase in reported per capita consumption in Massachusetts of 1.6%.[29] This example gives an idea of how one can assess the net effect of a tax increase on consumption for a specific state. It is important to calculate the percentage reductions or increases in reported consumption in the adjoining states keeping in mind the varying population size across these states.

What about the tax on cigarettes as a revenue generating tool? Our results indicate a price-inelastic demand for cigarettes with a lower price elasticity than reported in the literature. This implies that there is room for generating revenue at the federal level using tax increases.[30] For state revenues, one ought to refer to the state regressions and worry about the importance of bootlegging in shifting revenues among neighboring states.

V. Summary and Conclusion

In this paper, we have considered a dynamic demand for cigarettes and estimated it using pooled time-series of cross-section data. Our results indicate an insignificant income elasticity, a significant price elasticity much lower than reported in previous literature and a small but significant bootlegging effect across neighboring states. The insignificant income elasticity contradicts higher estimates reported in the literature, implying that states exhibiting growth in their income per capita will not necessarily exhibit more per-capita cigarette con-

sumption. The small but significant own and neighboring price elasticities indicate that cigarette taxation will generate revenues even though there may be spillover effects to neighboring states where bootlegging is significant. However, as an anti-smoking tool, cigarette taxation may not be as effective in reducing cigarette consumption as previously thought. Finally, our findings indicate mild support for the effect of subsidized anti-smoking messages in reducing consumption of cigarettes and no support for the hypothesis that the advertising ban has the effect of increasing consumption rather than reducing it.

APPENDIX

Data Sources

The Tobacco Tax Council reports the annual per capita consumption of cigarettes by state. This is measured in packs of cigarettes per head. It also gives the average retail price per pack. Per capita disposable income data on a state basis are published in various issues of the Survey of Current Business. Population data are obtained from various issues of the Current Population Reports. Price deflators are obtained from the Bureau of Labor Statistics. Advertising expenditures are taken from the United States Federal Trade Commission report to Congress.

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[28] To keep the analysis simple, we assume that Massachusetts is New Hampshire's only neighbor.
[29] That this latter effect is not statistically significant is not surprising given that New Hampshire's real prices (even after the tax hikes) have always been less than those in Massachusetts.
[30] This is in agreement with Lyon and Spruill's (1979) recommendations. However, their study finds a higher price elasticity of −0.45 which varies across different regions in the United States.

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