Advertising and the Demand for Cigarettes

By

Richard Saba

Auburn University

November 1989

Draft

Please do not quote without permission

Advertising and the Demand for Cigarettes

Does advertising by cigarette firms increase the aggregate demand for cigarettes? If advertising does increase the aggregate demand for cigarettes, then a public policy banning cigarette advertising might be efficient given the intent to reduce any increase in the number of smokers. But if advertising only affects brand choice then a public police banning cigarette advertising would be a waste of society's resources. Although the question is often raised and has received a great deal of attention in both the academic and trade literature it remans unresolved. One reason for the lack of agreement is that the topic can become emotionally charged as is the case with many anti-smoking zealots. In their crusade to demonstrate ill intent by the cigarette companies, sound statistical and econometric practices take a back seat to "the obvious" as seen by these advocates. There are others however, who look at the question objectively and reach conclusions contrary to those of earlier writers (see Schmalensee (1972). Our intent in this paper is two fold. First, we will critique a representative set of academic studies which examine the effect of advertising by cigarette companies on the aggregate demand for cigarettes. Second we will suggest an empirical model which would overcome the criticisms of these and other previous works.

There are three papers of particular interest which we will discuss. All three claim, contrary to the findings of Baltagi and Levin (1986), Hamilton (1972), and Schmalensee (1972), that ad-

vertising by cigarette companies induces increases in the aggregate demand for cigarettes and not just simple shift in market share among firms. All three papers claim to have addressed some of the flaws found in previous studies.

The most ambitious of the three is the study by Roberts and Samuelson, "An Empirical Analysis of Dynamic, Nonprice Competition in an Oligopolistic Industry"'(1988). They find previous studies lacking since they were all based on static models. They argue that "static models cannot always capture elements of strategic behavior that arise when firms engage in repeated market interactions (and) (s)econd, that in oligopolistic industries non price tools, such as advertising, product quality, or R&D, often provide the major source of inter firm rivalry. These tools frequently have long-lived effects that cannot be adequately captured in a static framework". Also this study attempts to incorporate marginal cost information in estimating the parameters of the cigarette market in an effort to address the simultaneity problem indigenous to other studies. The paper however suffers from several fundamental problems. First the link between their theoretical model and the empirical model which they end up estimating is tenuous in a number of places. Their empirical model treats output prices as endogenous. But, in the theoretical model firms are only allowed to choose advertising expenditures while optimal output prices are not part of the firm's choice set[1]. Second, they ignore cross-market effects in their analysis. They

assume, for example, that an increase in advertising in the present period for one brand of cigarette will not affect a competitors advertising strategy in the next period. However, these cross effects may be vary important if any size effects of advertising in one market derive from reductions in size for thè other market. Third, advertising cost are not considered a cost of production and are ignored in the determination of marginal cost of output. Failure to account for advertising cost introduces simultaneity and omitted variables bias in estimates of their advertising coefficients. Fourth, they estimated their demand system using nonlinear three-stage least-squares. The statistical properties of estimators derived from this procedure are dependent upon large sample sizes. Curiously sample size and degrees of freedom are never reported in any of their results. An other problem with the methodology is that no interaction terms were used in the analysis. Only dummies for the firms were used. But this can lead to seriously biased estimates of the slope coefficients if the true slope parameters differ among firms.

Although the technical problems mentioned above are of concern we find two more disturbing difficulties with the paper. First, we find no convincing evidence that advertising increases the <u>total demand</u> for cigarettes and second that the model as set up by the authors is incapable of differentiating among opposing theories. That is, the results are observationally equivalent to one which implies a significant market share effect and no market size effects of advertising.

Roberts and Samuelson base their conclusions concerning the effect of advertising on market demand from their interpretation of the estimated demand coefficients and joint hypothesis test given in Tables 2 and 3 of their paper(See pages 211 and 212). They estimated a demand for both low and high tar cigarettes for each firm as a function of cost and advertising indices by the firm and its rivals. The coefficients on market shares for both the low and high tar demand estimates are statistically in-

significant. However, the supposed market-size effects of own market coefficients are is positive and significant at the 5% level for the low-tar market and negative and insignificant for the high-tar market. Roberts and Samuelson interpret these results as indicative of increased aggregate demand resulting from advertising. This interpretation is suspect since Roberts and Samuelson ignore the cross-market effects and the significant joint effect of high-tar advertising on the low-tar market. Since no evidence on the actual magnitude of these effects was presented it is inappropriate to draw such conclusions. If, for example, firms divide their advertising dollars equally between high-tar and low-tar advertising the total effect on market demand could be zero if the opposing effects cancel each other out.

The last comment to make concerning the Roberts and Samuelson article is that the empirical test are incapable of distinguishing between the model posited by the authors and a simple model which implies that increased sales result in increased advertising ex-

penditures. This equivalence derives from the fact that their size coefficients relate to a share variable and their share coefficients relate to a size variable. Their are many examples in the advertising literature which indicate the direct relation between market demand and the determination of the size of the advertising budget. The results reported by Roberts and Samuelson would support this theory as well as the theory they proposed.

A second paper, by Chetwnyd, et. al. also claims to have found evidence contrary to the general view that advertising expenditures do not effect aggregate demand but only market shares. Their paper, "The Impact of Cigarette Advertising on Aggregate Demand for Cigarettes in New Zealand," suffers from several problems both conceptual and empirical.

The authors attempt to estimate a demand equation for cigarette consumption with out taking into account cost. They use a "habit model" which posits cigarette consumption as a function of expenditures on print media advertising, average price of a pack of cigarettes and average income in the time period. However, any relation that might be picked up between cigarette consumption and advertising expenditures in this formulation of the model could be considered spurious at best. The observations are on equilibrium outputs and prices which are the result of the interaction between marginal cost and marginal revenue. Only if one could demonstrate that cost were constant over the time period under consideration and that advertising cost had no effect on

marginal cost would results of the empirical model have any legitimate claim as an estimate of true demand.

Ignoring the problems mentioned above there are fundamental problems with the methodology. The authors claim to be testing two distinct models, the "habit" and "carry over" models. But as Ekelund and Jackson state (1989), the "carry over" model is a special case of the habit model, one which allows for the longest possible "carry over". Since the two models are interrelated their test is a joint test of both models and incapable of differentiating between the two.

The third paper we consider is by Seldon and Doroodian titled " A Simultaneous Model of Cigarette Advertising: Effects on Demand and Industry Response to Public Policy," (1989). The intent of the study is to examine the response of aggregate cigarette demand to advertising and the reaction of consumers and industry to government health warnings and media policy. The authors derive the optimal amount of advertising from a continuous time profit maximization model. The optimal amount of advertising is included as an argument in their derived demand equation. They then use three stage non-linear least squares to simultaneously estimate the demand and advertising equations. Unlike many other studies the theoretical model does consider marginal cost. However, they assume away any supply side effects with their assumption of constant cost. This not only assume no change in the cost structure on the industry over the thirty year period but also implies that

cost are independent of advertising expenditures. This assumption implies constant long-run marginal cost. Therefore, any observed changes in the level of consumption necessarily must obtain from a shift in demand and not a change in quantity demanded. An other important factor assumed away is the effect of one firm's level of advertising on the advertising decisions of other firms. In the model the authors take the advertising decision of rival firms as given. This simply eliminates from possible consideration the argument that advertising in an ologopolistic setting is simply a tool used to protect a firm's market share from raiding by rival firms: the vary argument the paper is supposed to be testing.

Even if the serious flaws in the theoretical formulation of the model are ignored, the validity of their empirical results are highly suspect. As in the Roberts and Samuelson paper, the three stage non-linear least squares technique was used. Since this procedure has only asymptotic justification, it requires sample sizes several times larger than that required of ordinary OLS models to obtain similar confidence in the precision of the estimates. The models estimated by the authors have at most 17 degrees of freedom and as little as 10. Any serious applied economist should question the significance levels the authors attribute to the coefficients in the various models.

The problems we find with both the theoretical and empirical models are not unique to the three papers discussed above. Indeed the same criticisms could be leveled at much of the empirical work

in the area regardless of which view they tend to support. The binding constraint dictating the form of both the theoretical and empirical models has been the availability of data. Although undesirable, this is a condition faced by most empiricists. At this point we would like to propose a model which we believe circumvents many of the problems relating to data available.

A Proposed Model

Our objective is to accurately measure the effect of advertising on aggregate demand for cigarettes. As discussed above there are a multitude of problems confronting the researcher. How do we account for the market setting and individual firm responses to the actions of other firms in the industry. Which of the oligopoly models do we use? How do we account for market shares and brand differentiation? We believe that the present research has gone in the wrong direction. While highly insightful and clever they only introduce greater and greater measurement problems. The model develop below will avoid many of the problems inherent in the estimation of market systems.

We assume the market to be characterized by a Cournot Equilibrium. Each firm in the market has an expectation about the output choices of the other firms in the industry. The total output for the industry is $Y = y1 + y2 + \ldots + yn$. Let $s_i = y_i/Y$ be firm i's share of the total market output. The the equilibrium output of each firm can be described by

$$(1)\quad p(Y)[\,1 - 1/(\dot{Y}(Y)/s_i)\,] = MC(Y_i).$$

Where $\ddot{Y}(Y)$ is the elasticity of market demand and $(\ddot{Y}(Y)/s_i)$ the elasticity of demand facing the individual firm. As we can see this is simply the monopoly solution except for the market share term. If it were possible to assume no change in market demand and we had observations on different levels of marginal cost we could estimate the market demand curve. The assumption of no change in market demand would be acceptable if we could limit the time period under consideration. It would seem reasonable to assume that market demand would be relatively stable over a year. Unfortunately there are only about seven firms in the industry and vary little if any difference in production cost for tobacco products among firms. So trying to estimate a market demand from the output decisions of individual firms would be futile. However, there is a way around this problem. Since cost conditions among firms are essentially identical, we will treat the aggregate output of all firms like the output of a single monopolist. Each state's demand for cigarettes may be considered a proportion of the total market demand for this aggregate firm. Although production cost is identical across states, marginal tax cost differs. Since we assume that the demand for cigarettes in one states is representative of the total market demand we have from between forty-five to fifty-one observation on the total market demand in any given year[2]. We can now estimate the market demand for cigarettes for each year (1950 - 1988) using the following empirical model

(2) $q_{it}/s_{it} = b_0 + b_1P + b_2I_{it} + b3POP_{it} + b_4T + b_5Dummy$

Where

q_{it}/s_{it} = Total consumption for state i in year t divided by the states share of market demand.

P = Price of a pack of cigarettes

I_{it} = income per capita

POP_{it} = smoking age population

T = tax rate in state i for year t

Dummy = dummy variables accounting for major health announcements and advertising ban effects.

Estimates of equation (2) will give us estimates of the market demand for cigarettes for each year from 1950 through 1988. Using these estimated market demand equations we can generate the quantity demanded in each of the 38 years for an average weighted price. Any differences in these quantities among years represents shifts in the aggregate demand for cigarettes. We can now regress these quantities, Q_t , against national measures of income per capita, smoking age population, total advertising expenditures, and the dummy variables for health announcements and advertising ban effects. The resulting estimated coefficients will measure the effect of the three parameters on the aggregate demand for cigarettes. These measures will be free of the simultaneity and cross effect problems of earlier studies.

We will also estimate a model similar to the one described but with a redefined demand. It might be more meaningful to

measure the demand for nicotine adjusted cigarettes than simply the demand for cigarettes. In this formulation of the model a cigarette with .1 grams nicotine would be equivalent to 2 cigarettes that contained only .05 grams each. Data on average nicotine content of cigarettes by year are available or calculable from published government studies.

It is our belief that the model described will result in more reliable estimates of the true effect of advertising expenditures on aggregate demand than previous papers.

References

1. Baltagi, Badi H. and Dan Levin, "Estimating Dynamic Demand For Cigarettes Using Panel Data: The Effects of Bootlegging, Taxation and Advertising Reconsidered," Review of Economics and Statistics, (1986), 148-155.

2. Chetwynd, J. , Coope, P. Bodie, R. J. and E. Wells, "Impact of Cigarette Advertising on Aggregate Demand for Cigarettes in New Jealand", British Journal of Addiction, 83, pp.409-414.

3. Ekelund, Robert B. and John Jackson, "Some Caveats on 'The Impact of Cigarette Advertising on Aggregate Demand for Cigarettes in New Zealand", British Journal of Addiction, forthcoming.

4. Hamilton, James L. "The Demand for Cigarettes: Advertising, the Health Scare, and the Cigarette Advertising Ban," Review of Economics and Statistics, 54 (Nov. 1972), 401-411.

5. Roberts, Mark J., and Samuelson, Larry. "An Empirical Analysis of Dynamic, Nonprice Competition in an Oligopolistic Industry, Rand Journal of Economics, 19 (Summer 1988) 200-220.

6. Schmalensee, Richard L., On the Economics of Advertising, (Amsterdam: North-Holland Publishing company, 1972).

7. Seldon, Barry J. and Khosrow Doroodian, "A Simultaneous Model of Cigarette Advertising: Effects on Demand and Industry Response to Public Policy,"Review of Economics and Statistics(1989), forthcoming.

Footnotes

1 See footnote 7 page 203.
2 We do not have data for all states in the early years. The Distric of Columbia is also included in the sample accounting for the fifty-first observation.