Advertising, Price, and Welfare: Evidence From the U.S. Brewing Industry*

CAROL HORTON TREMBLAY
VICTOR J. TREMBLAY
Oregon State University
Corvallis, Oregon

I. Introduction

The welfare effect of advertising has been a subject of controversy among economists for some time. One obvious concern is simply the cost of advertising. In 1990, for example, Americans spent $130.1 billion on advertising. To put this figure into perspective, this amounted to $523 per capita, 2.35 percent of gross national product, and roughly 80 percent of the national deficit.¹

Much of the early debate regarding the social desirability of advertising stems from different preconceptions regarding its purpose [13; 14; 8; 49]. For example, according to the Kaldor [29] hypothesis advertising is primarily persuasive or deceptive in nature. It changes consumer preferences, creates brand loyalty, and persuades consumers to favor commodities that they did not previously desire. An opinion survey by Bauer and Greyser [5] indicates that consumers believe that much of advertising is persuasive, and Greyser and Reece [27, 158] find that 85 percent of the over 2,700 Harvard Business Review subscribers surveyed believe that advertising “persuades people to buy things they do not need.” If advertising is purely deceptive, then it can be classified as a “bad” and reduces welfare.

Alternatively, Stigler [52], Telser [54], and Nelson [37] argue that advertising can benefit society by providing useful information to consumers. In this case, advertising leads consumers to products that have more preferred characteristics, are sold at more convenient locations, and are sold at lower prices. Thus, advertising is a “good” and enhances social welfare.

More recent theoretical work has not resolved the issue of how advertising affects social welfare. For imperfectly competitive markets, Dixit and Norman [16; 17; 18] show that advertising is socially excessive. However, Fisher and McGowan [23] and Shapiro [47] show that the Dixit-Norman result need not hold if advertising attracts new customers or does not change tastes. For perfectly competitive markets, Hochman and Luski [28] demonstrate that the market will supply the socially optimal level of advertising. Yet, according to Stegeman [50], this result is not robust

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¹. The advertising figures come from Direct Marketing [69, 10], the population figures from the U.S. Bureau of the Census, Census of Population, the GNP figures from the Survey of Current Business, and the national deficit figures from the Economic Report of the President, 1991.
to different assumptions about consumer search costs and the number of advertising media used by firms.

Becker and Murphy [6] claim that previous research understates the social benefits of advertising by ignoring the utility derived from television and radio programs funded by advertisers. They develop a general framework to analyze the welfare effects of advertising which has three distinguishing features. First, it encompasses many alternative models by allowing advertising to be either a good or a bad. Second, it accounts for the benefits of free television and radio programming that are paid for by advertising. Third, it provides an empirical test of the hypothesis that the market level of advertising is socially optimal. Determining the impact of advertising on the equilibrium output price is a key element in this hypothesis test.

We analyze the advertising-price relationship by modifying the new empirical industrial organization technique. This technique provides a method for estimating a firm's price equation in an imperfectly competitive setting. By incorporating advertising into this price equation, the effect of advertising on the equilibrium price can be readily estimated.

The model is applied to firm data for the U.S. brewing industry from 1950 through 1988. The brewing industry is an ideal candidate for such an investigation because the market is imperfectly competitive and advertising has played an important role in the development of the industry [26; 36; 43; 53]. More importantly a number of consumer groups favor restrictions on beer advertising because they believe that such advertising promotes alcohol abuse [72]. In Central Hudson and Gas Corporation v. Public Service Commission (447 U.S. 557, 1980), the U.S. Supreme Court ruled that commercial speech can be restricted if there is a substantial social gain from the restriction. Thus, the primary purpose of this study is to determine whether restrictions on beer advertising would enhance social welfare. The model also enables a test for the presence of market power and an analysis of the main sources of market power, including advertising.

In the sections that follow, the Becker and Murphy model is extended to incorporate the external costs of beer advertising. Then the new empirical industrial organization framework is described and implemented to determine the effect of advertising on the price of beer. In conjunction with information from other sources, these results support the hypothesis that beer advertising is excessive from society's point of view.

II. Advertising and Welfare

Unlike previous work, Becker and Murphy's welfare function incorporates the utility derived from radio and television programming and allows advertisements to generate positive or negative utility. They consider a monopoly setting in which advertising \((A)\) affects social welfare \((S)\), measured by the sum of consumer and producer surplus. \(S\) is assumed to be strictly concave\(^2\) and twice continuously differentiable in advertising.

\[
S = V(A, p, T) + \pi(A, p, T),
\]

where \(V\) is the money value of consumer utility, \(\pi\) is the producer surplus or profit from the production of advertising and output \((q)\), \(p\) is the price of output, and \(T\) is the revenue accruing to the firm from the sale of advertising to consumers.

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2. This is a standard welfare assumption [30, 191], which results if incremental increases in advertising expenditures lead to increasing and then decreasing returns.
In the Becker and Murphy framework, advertising can be viewed as either a good ($\partial V/\partial A > 0$) or a bad ($\partial V/\partial A < 0$) in the eyes of the consumer. If advertising is a good, it is sold to consumers at a positive price, and revenue is transferred from consumers to the producer ($T > 0$). This might occur for some advertising found in printed material, for example. Alternatively, if advertising is a bad, people will consume it only if adequately compensated. This occurs with radio and television advertising. The producer bribes consumers with programming in exchange for being exposed to the bad, advertising. In Becker and Murphy's [6, 961] words, "advertisers throw in free programming to generate the audience for utility-reducing ads." In this case, revenue goes from the producer to consumers ($T < 0$). In this model, advertising does not change tastes, but is assumed to increase firm demand by acting as a complement to output.

The welfare effect of advertising is determined by totally differentiating equation (1) with respect to $A$.

$$dS / dA = V_A + V_p (dp / dA) + V_T (dT / dA) + d\pi / dA.$$  \hspace{1cm} (2)

Note that $V_A \equiv \partial V / \partial A$, $V_p \equiv \partial V / \partial p = -q$, $V_T \equiv \partial V / \partial T = -1$, $d\pi / dA \equiv [\pi_A + \pi_p (dp / dA) + \pi_T (dT / dA)]$, $\pi_A \equiv \partial \pi / \partial A$, $\pi_p \equiv \partial \pi / \partial p$, and $\pi_T \equiv \partial \pi / \partial T$. In addition, if the firm is a profit maximizer, $d\pi / dA = 0$. Thus, equation (2) simplifies to:

$$dS / dA = V_A - dT / dA - q (dp / dA).$$  \hspace{1cm} (3)

Given that $S$ is strictly concave in advertising, advertising is excessive if $dS / dA < 0$, is optimal if $dS / dA = 0$, and is underproduced if $dS / dA > 0$.

Considerable research has been devoted to determining the impact of advertising on social welfare. For example, Dixit and Norman’s [16; 17; 18] model implicitly assumes that advertising is unpriced to consumers ($dT / dA = 0$) and that advertising does not affect utility ($V_A = 0$). From equation (3), this implies that advertising is excessive from society’s point of view ($dS / dA < 0$) if advertising raises the equilibrium output price ($dp / dA > 0$). This implication has theoretical support from Hochman and Luski [28] and has been used to test the welfare implications of advertising in a number of previous empirical studies.

Similarly, Becker and Murphy’s test for the suboptimality of advertising depends on the sign of $dp / dA$. They show [6, 958] that profit maximization and consumer rationality imply that $V_A \geq dT / dA$. Therefore, $dS / dA \geq 0$ if $dp / dA \leq 0$ by equation (3). Advertising would be insufficient from society’s point of view if advertising causes the equilibrium price to fall, but it need not be excessive if advertising causes the price to rise in this model.

Both the Dixit-Norman and the Becker-Murphy outcomes hinge on the sign of $dp / dA$, the price effect of a marginal, but not a large, change in advertising. Given the evidence indicating that a total ban on advertising leads to higher prices, there appears to be general agreement among economists that an advertising ban is sub-optimal. Becker and Murphy [6, 956] are incorrect to conclude, however, that this evidence implies that a marginal decrease in advertising from its market equilibrium level will lead to a higher equilibrium price. Figure 1 illustrates that if there is a convex relationship between price and advertising, a marginal reduction in advertising from

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3. Using the same framework, Fisher and McGowan [23] and Shapiro [47] argue that $V_A$ should be positive, but still implicitly assume that $dT / dA = 0$.


5. Pioneering studies include Benham [7], Steiner [51], and Cady [12]. After reviewing the evidence, Scherer and Ross [44] conclude that advertising bans lead to higher prices.
its equilibrium level \( A_1 \) may lead to a lower price even though a total ban on advertising \( A_0 \) raises price.\(^6\) Therefore, the sign of \( dp/DA \) at the equilibrium level of advertising remains an empirical question.

The social welfare function given in equation (1) is incomplete for brewing, however, because there is more than one firm and because alcohol consumption causes negative externalities. For example, McKim [35] finds that alcohol abuse reduces labor productivity and is an important cause of motor vehicle accidents and violent crimes. Further, the Center for Science in the Public Interest and consumer groups united under Project SMART (Stop Marketing Alcohol on Radio and Television) petitioned the Federal Trade Commission to restrict the advertising of alcoholic beverages in 1985 [70; 62; 72]. Although the FTC rejected the petition, public support for such restrictions appears to be growing. A recent survey [33, B1] shows that 73 percent of adults polled believe that “alcohol advertising is a major contributor to underage drinking.” Finally, after reviewing available evidence, most members of a recent conference sponsored by the U.S. Department of Health and Human Services were convinced that alcohol advertising contributes to alcohol abuse and favored restrictions on beer advertising.\(^7\)

The above discussion suggests that the social welfare function should incorporate potential negative externalities when analyzing the welfare effect of advertising in brewing. In addition, there is more than one firm in the market for beer and there is more than one market in the economy. Thus, the social welfare function becomes:

\[
S = V(A, p, T, E) + \pi(A, p, T, E),
\]

where \( \pi \) is now the aggregate profit or producer surplus from all firms in the economy and \( E \) captures the dollar value of the externalities associated with beer consumption (i.e., \( \partial V/\partial E < 0 \) and \( \partial \pi/\partial E < 0 \)).\(^8\) In this case, the change in welfare due to a change in beer advertising becomes:

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\(^6\) For example, Wills and Mueller [63] and Rizzo and Zeckhauser [41] find that marginal decreases in advertising cause lower prices.

\(^7\) The conference was titled “The Effects of the Mass Media on the Use and Abuse of Alcohol” and was organized by the Department of Health and Human Services, National Institute on Alcohol Abuse and Alcoholism, Washington, D.C., 24–25 September 1992. A published transcript is forthcoming [73].

\(^8\) Other possible general equilibrium and spillover effects are assumed to be of minor importance and are ignored.
\[ dS/dA = V_A - dT/dA - q(dp/dA) + (V_E + \pi_E)dE/dA + \Phi, \]  
where \( V_E \equiv \partial V/\partial E, \pi_E \equiv \partial \pi/\partial E, \) and \( \Phi \equiv [\pi_A + \pi_p(dp/dA) + \pi_T(dT/dA)]. \) For more than one firm, \( \Phi \) will equal 0 in a cartel setting or if competition is sufficient to ensure that long-run profit is zero; otherwise, \( \Phi \) will be less than 0 (see Appendix B for a proof). Given there is no evidence of economic profit in brewing,\(^9\) we assume that \( \Phi = 0 \) and equation (5) can be rewritten as the partial differential:

\[ dS = V_A dA - (dT/dA)dA - q(dp/dA)dA + (V_E + \pi_E)(dE/dA)dA. \]  

Based on equation (6), we estimate the change in social welfare for an increase in beer advertising. First, we calculate estimates of \( V_A, dT/dA, \) and \( (\pi_E + V_E)(dE/dA) \) from other sources for 1983, the most recent year for which all data are available. Second, subsequent empirical work provides an estimate of \( dp/dA, \) enabling estimation of the remaining term in equation (6). Because we will show that advertising is excessive, our estimates of the components of equation (6) are biased against this conclusion when simplifying assumptions must be invoked. Thus, our estimate of \( dS \) will be biased upward.

The change in advertising \( (dA) \) is set equal to 6.5 million dollars, which amounts to 1 percent of the 1983 industry level of advertising [66, 1986 edition]. We assume that all additional advertising expenses fund desirable television and radio broadcasting. That is, there are no expenses on other media and no leakages to advertising agencies, for example. Thus, \( dT/dA = -1, \) and \( -(dT/dA)dA \) increases by the full $6.5 million.

The \( V_A \) term equals the change in the money value of consumer utility with respect to a marginal increase in beer advertising, ceteris paribus. Tremblay and Tremblay [56] estimate that a 1 percent increase in advertising causes the sum of consumer surplus and total expenditures to increase by $6.3 million in 1983, an estimate of \( V_A dA.\)\(^10\)

The welfare effect of externalities resulting from a 1 percent increase in advertising is predicted as follows. First, Pogue and Sgontz [38] estimate that the external cost of alcohol consumption was about $26.1 billion in 1983. Beer consumption is assumed to contribute 49 percent or $12.8 billion of these external costs since approximately 49 percent of U.S. ethanol consumption is ingested in the form of beer [22; 38]. Second, based on a 1983 sample of 17 countries, Saffer [42] concludes that a ban on beer and wine advertising reduces per capita mortality rates for cirrhosis of the liver by 47 percent and for motor vehicle accidents by 39 percent. Since beer accounts for approximately 83 percent of U.S. ethanol consumption from beer and wine [22; 38], a total ban on beer advertising would reduce these external costs by 32 percent [39 percent (the lower Saffer estimate) times 83 percent]. Because a total ban is a 100 percent reduction, a 1 percent increase in advertising is expected to raise external costs by 0.32 percent. This information implies that a 1 percent increase in beer advertising raises external social costs by approximately $41 million ($12.8 billion times 0.32 percent).

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9. For example, Brewer's Almanac [66 (1992), 31] reports that the profit to sales ratios for all manufacturing exceeded that of brewing in every year from 1957 through 1989. The mean profit rates for this period are 2.18 percent for brewing and 5.16 percent for all manufacturing.

10. This estimate seems reasonable since it is less than our \( dT/dA \) estimate of $6.5 million, a result predicted by the Becker and Murphy [6, 958] model when firms are profit maximizers and advertising does not change tastes. For the Dixit and Norman [16; 17; 18] model in which advertising changes tastes, Tremblay and Tremblay [56] estimate that \( V_A dA \) equals $2.27 million when advertising is assumed to be purely informative and $2.26 million when advertising is assumed to be purely persuasive.
Substituting the above estimates into equation (6) indicates that a 1 percent increase in advertising has the following effect on social welfare (measured in millions of 1983 dollars):

\[ dS \leq 6.3 + 6.5 - q(dp/DA)dA - 41. \]

Equation (7) implies that beer advertising is socially excessive if advertising causes the equilibrium price of beer to increase (i.e., \( dp/DA > 0 \)). Consequently, the remainder of this study will focus on determining the effect of advertising on the equilibrium price of beer.

III. Advertising and Price

The new empirical industrial organization (NEIO) approach provides a method for estimating the determinants of a firm's equilibrium price in an imperfectly competitive setting [4; 39; 10]. To illustrate, assume that firm \( i \), a profit (\( \pi \)) maximizer, faces the following profit function:

\[ \pi_i = p_i(q_i, Q_j)q_i - C_i(q_i), \]

where \( p_i \) is price, \( q_i \) is firm \( i \)'s output, \( Q_j \) is the total output of firm \( i \)'s rivals (i.e., industry output minus \( q_i \)), and \( C_i(q_i) \) is firm \( i \)'s total cost function. The firm's first order condition of profit maximization is:

\[ \frac{\partial \pi_i}{\partial q_i} = p_i + q_i(\frac{\partial p_i}{\partial q_i} + (\frac{\partial p_i}{\partial Q_j})(\frac{\partial Q_j}{\partial q_i}) - MC_i = 0, \]

where \( \frac{\partial Q_j}{\partial q_i} \) is the firm's conjectural variation and \( MC_i \) is marginal cost. For the purpose of empirical estimation, this condition is normally rewritten as:

\[ p_i = MC_i + \lambda q_i, \]

where the market power parameter, \( \lambda \), equals \(-[\frac{\partial p_i}{\partial q_i} + (\frac{\partial p_i}{\partial Q_j})(\frac{\partial Q_j}{\partial q_i})]\). This rearranged first order condition, frequently called the firm's supply relation, summarizes the actions of the firm under different behavioral assumptions. The market is efficient if price equals marginal cost, which occurs when \( \lambda \) equals zero. Positive and larger values of \( \lambda \) imply a divergence of price from marginal cost and a greater degree of exerted market power or allocative inefficiency.\(^\text{11}\)

It should be noted that game theorists have been critical of this modeling approach since conjectural variations do not appear in game-theoretic equilibria [46]. On theoretical grounds, however, Dockner [19] proves that it is "possible and justified to interpret a conjectural variations equilibrium as the outcome of a dynamic . . ." game. In addition, Bresnahan [10] and Schmalensee

\(^{11}\) To illustrate, assume homogeneous goods so that \( \frac{\partial p_i}{\partial q_i} = \frac{\partial p_i}{\partial Q_j} \equiv \frac{\partial p}{\partial q} \). Then equation (9) can be rewritten as:

\[ p_i = MC_i - (\frac{\partial p}{\partial q})(1 + v)q_i, \]

where \( v \), the firm's conjectural variation, equals \( \frac{\partial Q_j}{\partial q_i} \) and \( \lambda \), the market power parameter, equals \(-\frac{\partial p}{\partial q}(1 + v)\). In this setting, competitive (Bertrand) behavior implies that \( v = -1 \) (\( \lambda = 0 \)), Cournot behavior implies that \( v = 0 \) (\( \lambda = -\frac{\partial p}{\partial q}, \)) and cartel behavior implies that \( v = N - 1 \) (\( \lambda = -\frac{\partial p}{\partial q}N \)), where \( N \) is the number of firms in the market. Note that if \( v \geq -1 \) and \( \frac{\partial p}{\partial q} \leq 0 \), then \( \lambda \geq 0 \).
argue that this approach may be more suited to the empirical study of imperfectly competitive markets where a conjectural variation is understood to estimate the degree to which firm conduct is collusive. Thus, the NEIO approach provides a useful foundation for the empirical work in this study.

Equation (10) can be modified to determine how variables such as advertising will cause price to deviate from marginal cost. Following Porter [39], this can be accomplished by including in the supply relation a vector of variables (\( \mathbf{x} \)) that is most likely to affect the market power of the firm. This transforms equation (10) to:

\[
p_i = MC_i + \alpha_0 q_i + \alpha \mathbf{x},
\]  

where \( \alpha \) is a vector of parameters that is conformable to \( \mathbf{x} \). With this specification, the market is efficient if \( \alpha_0 = \alpha = 0 \). The advantage of this specification is that it allows the degree of inefficiency to vary with a firm’s particular conduct variables such as advertising.

A number of structure and conduct variables are likely to affect a brewery’s market power [40; 9; 45]. First, the primary goal is to determine the effect of advertising on the firm’s equilibrium price, ceteris paribus. As described above, advertising may inform customers of the presence of new or lower priced commodities, which would lead to lower equilibrium prices, ceteris paribus. Alternatively, if advertising strengthens brand loyalties, then it will increase market power and raise prices. Because the firm’s own and its rivals’ advertising are likely to influence the firm’s price, they are both included in the model. Second, the work by Demsetz [15] suggests that superior or rapidly growing firms are likely to behave differently than declining firms. This effect can be captured by the firm’s previous growth rate in sales. Third, Shepherd [48] has argued that large firms (measured by market share) may have greater market power than small firms. Finally, the collusion hypothesis suggests that exerted market power may increase with industry concentration.

The above discussion implies that the supply relation for brewing firms can be represented by:

\[
p_{it} = MC_{it} + \alpha_0 q_{it} + \alpha_1 A_{it} + \alpha_2 A_{Rt} + \alpha_3 SS_{it} + \alpha_4 MS_{it} + \alpha_5 HHIt
\]  

where \( A_{it} \) is firm \( i \)’s advertising in year \( t \), \( A_{Rt} \) is rivals’ advertising in year \( t \), \( SS_{it} \) is the firm’s growth in sales in year \( t \), \( MS_{it} \) is market share for firm \( i \) in year \( t \), and \( HHIt \) is the Herfindahl-Hirschman Index of concentration for the industry in year \( t \).

Because marginal cost is unobservable, this study follows the NEIO approach by substituting a marginal cost function for \( MC_{it} \) in equation (11). In brewing, firm \( i \)’s short-run marginal cost function is specified as \( MC_{it}(PL_{it}, PM_{it}, CAP_{it}, V_{it}, t, tt) \), where \( PL_{it} \) is the price of labor in beer production, \( PM_{it} \) is the price of materials used to make beer, \( CAP_{it} \) is the quantity of the fixed input capital measured as the firm’s brewing capacity, and technological change is controlled by a vintage variable \( (V_{it}, measured as the average age of plant and equipment) \), a time trend \( (tt) \), and a squared time trend \( (tt^2) \). The functional form derives from a translog specification of the restricted total cost function.12 This specification is substituted for \( MC_{it} \) in equation (12). The

12. The marginal cost function is derived from the following short-run (restricted) translog total cost specification:

\[
TC = a_0 + a_4 q + \sum_i a_ip_i + a_K K + a_V V
\]
supply relation also includes firm dummy variables, which may capture cost and/or market power differences among individual firms, and a conglomerate dummy variable, which controls for the fact that several firms in the sample are conglomerate firms with unobservable beer costs and revenues. The empirical model for estimation is therefore given by:

\[ p_{it} = MC_{it}(PL_{it}, PM_{it}, CAP_{it}, V_{it}, l_t, l_t) + \alpha_0q_{it} + \alpha_1A_{it} + \alpha_2A_{lt} \]

\[ + \alpha_3SS_{it} + \alpha_4MS_{it} + \alpha_5HH_{it} + \beta D_{it} + \epsilon_{it} \]  

(13)

where \( D_{it} \) is a vector of dummy variables, \( \beta \) is a conformable vector of parameters, and \( \epsilon_{it} \) is an additive error term. To account for the endogeneity of output and advertising, equation (13) is consistently estimated by the method of instrumental variables.

Advertising is frequently measured as expenditures, messages (quantity), or as a capital stock (total advertising minus depreciation). However, Grabowski [25] finds that the effect of beer advertising depreciates almost completely within one year. In addition, Lee and Tremblay [32] find that the market demand for beer is invariant to the use of different depreciation rates and to the measurement of advertising as expenditures or messages. Therefore, advertising is measured as current advertising expenditures.

The data consist of over 250 annual observations from up to 22 mass-producing beer companies for the period 1950–88. Table 1 lists the definitions of the supply relation variables, the marginal cost variables, and the instruments for firm output and firm advertising. Appendix A contains data sources, a more complete description of the data, and a description of the sampling procedure.

\[ + \sum a_{iq}p_{iq} + a_{K_{iq}}K_{iq} + a_{qv}q \]

\[ + 1/2 \sum_{i} \sum_{j} a_{ij}p_{ij} + a_{K_{ij}}K_{ij} + a_{qv}p_{ij} \]

\[ + 1/2 a_{K_{ij}}K_{ij}^2 + a_{K_{i}}K_{i} + (1/2)a_{v}v^{2} \]

\[ + a_{it} + a_{it}q_{it} + 1/2a_{it}q_{it}^2 + \sum_{i} a_{it}p_{it} + a_{K_{it}}K_{it} + a_{vt}v_{it} \]

\[ + \sum a_{it}p_{it} + a_{K_{it}}K_{it} + a_{qv}q_{it} \]

\[ + 1/2 \sum_{i} \sum_{j} a_{ij}p_{ij} + a_{K_{ij}}K_{ij} + a_{qv}p_{ij} \]

\[ + 1/2 a_{K_{ij}}K_{ij}^2 + a_{K_{vt}}K_{vt} + (1/2)a_{vt}v_{it}^2 \]

where: \( TC \) equals the natural log of short-run total cost, \( p \) equals the natural log of the price of input \( i \) or \( j \) [where \( i, j = L \) (labor) and \( M \) (materials)], \( K \) equals the natural log of firm capacity, \( v \) equals the natural log of capital vintage, and \( t \) is a linear time trend. A short-run cost function is appropriate because there is evidence that beer companies have been in long-run disequilibrium during the sample period and, therefore, have not operated on their long-run cost function [26; 21].

13. Various trade journals indicate, however, that these companies produce significantly less than 10 percent of their revenues from the sale of non-beer commodities. See Tremblay [58; 59] for further discussion.

14. Instruments include variables that influence demand, costs, market structure, and market conduct. For \( q_{it} \) these are: the primary drinking age population (20–44 years old; according to Brewers Almanac [66 (1980), 82] persons aged 21 to 44 account for approximately 68 percent of all U.S. beer consumption), per capita income, quantity of U.S. beer imports, price of labor in brewing, a weighted average price index of brewing materials (corn, rice, sugar, malting barley, hops), firm brewing capacity, vintage (the average age of plant and equipment), firm and time dummy variables, a conglomerate firm dummy variable, industry output, industry advertising, the Herfindahl-Hirschman index, and lagged market share. The instruments for \( A_{it} \) include all of the \( q_{it} \) instrumental variables plus lagged firm advertising. The substantive results found in Table 11 proved insensitive to the deletion of the lagged advertising instrument.
Table I. Variable Definitions

Supply Relation Variables:
- $p_t$ ≡ real price per barrel (1972 dollars)
- $q_{it}$ ≡ firm output (millions of 31-gallon barrels of beer)
- $A_{it}$ ≡ firm $i$’s real advertising expenditures (millions of 1972 dollars)
- $A_{ii}$ ≡ industry advertising expenditures
- $SS_{it}$ ≡ firm success rate measured as previous period’s three year growth rate = $(q_{t-1} - q_{t-3})/q_{t-3}$
- $MS_{it}$ ≡ market share (firm output divided by industry output)
- $HHI_t$ ≡ the Herfindahl-Hirschman Index (times 100)
- $D_{it}$ ≡ vector of firm dummies and a conglomerate dummy: $CO = 1$ if firm is a conglomerate; $= 0$ otherwise.

Marginal Cost Variables:
- $PL_t$ ≡ real average hourly wage rate of production workers in the beer industry (1972 dollars)
- $PM_t$ ≡ real weighted average price of all materials contributing at least 0.1 pounds per barrel of beer: corn, rice, malted barley, sugar, and hops (1972 dollars)
- $CAP_t$ ≡ total brewing capacity of the firm (millions of barrels)
- $V_{it}$ ≡ weighted average age of each plant owned by the firm (vintage, in years)
- $t_t$ ≡ time trend = year – 1949
- $t^2_t$ ≡ $t$ squared

Instruments for $q_{it}$ and $A_{it}$:
- $PL_t$, $PM_t$, $CAP_t$, $V_{it}$, $D_{it}$, and $HHI_t$ defined above
- $POP_t$ ≡ primary drinking age (20-44) population (thousands)
- $PCI_t$ ≡ per capita income (1972 dollars)
- $IM_{it}$ ≡ U.S. beer imports (thousands of barrels)
- $DT_t$ ≡ vector of time dummies
- $Q_t$ ≡ industry output (millions of barrels)
- $A_{it}$ ≡ industry advertising expenditures (millions of 1972 dollars)
- $MS_{it-1}$ ≡ lagged market share
- $A_{it-1}$ ≡ lagged firm advertising expenditures (instrument for $A_{it}$ only)

Note: Appendix A contains data sources and a more detailed description of the data.

IV. The Empirical Results

Instrumental variables estimation of equation (13) produces a set of estimated error terms. Regressing the estimated residual on its lagged residuals reveals significant second-order autocorrelation (no higher order autocorrelation is detected). To correct for autocorrelation, the data are transformed by the Cochrane-Orcutt procedure extended to a second-order process. Given the cross-section component of the data set, heteroskedasticity is suspected and White’s [61] heteroskedastic-consistent variance-covariance matrix estimator is used to obtain consistent standard errors. The empirical estimates of the strategic parameters in equation (13) are presented in Table II. Given the work by Leamer [31], several specifications are estimated.

The empirical results from the simple supply relation in column (1) reject the hypothesis that beer companies are price takers. The coefficient on output is positive and significantly greater than zero, which indicates the presence of exerted market power. However, given the estimated

15. The parameter estimates on the marginal cost variables, the firm dummy variables, and the conglomerate dummy are not reported. Parameter estimates on the translog marginal cost determinants are omitted to conserve space and are available from the authors upon request. The firm specific parameter estimates will remain confidential, however (see Appendix A).
Table II. Supply Relation Results

<table>
<thead>
<tr>
<th>Strategic Independent Variables</th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
<th>(5)</th>
</tr>
</thead>
<tbody>
<tr>
<td>(q_t)</td>
<td>0.2040(^a)</td>
<td>0.2050(^b)</td>
<td>0.2290(^b)</td>
<td>0.2730(^a)</td>
<td>0.3950(^c)</td>
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<tr>
<td>(8.424)</td>
<td>(2.075)</td>
<td>(2.202)</td>
<td>(2.679)</td>
<td>(1.645)</td>
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</tr>
<tr>
<td>(A_{R_t})</td>
<td>-</td>
<td>0.0585(^a)</td>
<td>0.0949(^a)</td>
<td>0.0901(^a)</td>
<td>0.0918(^a)</td>
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<tr>
<td>(3.308)</td>
<td>(4.573)</td>
<td>(4.407)</td>
<td>(4.416)</td>
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<tr>
<td>(A_{N_t})</td>
<td>-</td>
<td>-</td>
<td>0.0205(^a)</td>
<td>0.0210(^a)</td>
<td>0.0211(^a)</td>
</tr>
<tr>
<td>(4.688)</td>
<td>(4.630)</td>
<td>(4.642)</td>
<td></td>
<td></td>
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<tr>
<td>(SS_{R_t})</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-2.6530(^a)</td>
<td>-2.6831(^a)</td>
</tr>
<tr>
<td>(9.990)</td>
<td>(3.015)</td>
<td></td>
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<tr>
<td>(MS_{R_t})</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-21.7790</td>
</tr>
<tr>
<td>(0.642)</td>
<td>(0.137)</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>(HHI_t)</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-0.0759</td>
</tr>
<tr>
<td>(N)</td>
<td>322</td>
<td>268</td>
<td>266</td>
<td>252</td>
<td>252</td>
</tr>
<tr>
<td>(R^2)</td>
<td>.4657</td>
<td>.5214</td>
<td>.5626</td>
<td>.5484</td>
<td>.5473</td>
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<tr>
<td>(F)</td>
<td>10.36(^a)</td>
<td>10.73(^a)</td>
<td>11.69(^a)</td>
<td>10.56(^a)</td>
<td>9.96(^a)</td>
</tr>
</tbody>
</table>

Note: The estimation procedure is weighted instrumental variables, and the figures in parentheses are White's [61] \(t\)-ratios. Only strategic parameter estimates are reported.
a. Significant at the 1 percent level.
b. Significant at the 5 percent level.
c. Significant at the 10 percent level.

slope of the firm demand for beer found in Tremblay [58], the resulting conjectural variation estimate is close to Bertrand at \(-0.92\). Thus, although significant, the degree of exerted market power appears to be modest.\(^{16}\)

There is little support for the traditional hypotheses that large firms and high concentration generate market power. Large firms do not charge higher prices, ceteris paribus, suggesting that market power is not positively related to firm size. The finding that an increase in concentration does not lead to a significant increase in the price of beer is consistent with Lynk [34] and Tremblay [57]. Alternatively, the growth in firm sales has a significant negative effect on market power. Assuming that growth is an appropriate proxy for superiority, this supports Demsetz's [15] hypothesis that superior firms may be more efficient and able to charge lower prices, ceteris paribus.

Finally, the most robust effect is that of advertising. In every specification, the firm's own advertising has a positive and significant effect on its output price. In addition, rivals' advertising has a significant positive though relatively small effect on firm \(i\)'s price. This is consistent with the result found in Tremblay [58] and parallels the impact of rivals' advertising in the cigarette industry. For example, the president of the American Tobacco Company, George Hill, is quoted as saying:

The impetus of those great advertising campaigns not only built this for ourselves, but built the cigarette business as well... Of course, you benefit yourself more than the other fellow... but you help the whole industry if you do a good job [55, 137].

In order to further verify these result, several other specifications are investigated. First, a generalized Leontief functional form is used to specify marginal cost in equation (13). Second,

\(^{16}\) As indicated in footnote 9, this seems reasonable since the accounting data indicate that beer companies do not earn high profits relative to the manufacturing sector as a whole.
$SS_t$ is replaced by the growth rate in industry sales [20]. Finally, the $HHI_t$ measure of industry concentration is replaced by the five firm concentration ratio. In addition, a search is performed for a critical concentration ratio [24]. These new specifications produced no change in the main empirical results, however. In every case, advertising has a positive and significant effect on output price.

One concern is that advertising may simply be capturing differences in product quality. That is, high quality goods may be more heavily advertised than low quality goods. Previous research suggests, however, that there is little difference between the brands of beer that are produced by the U.S. mass-producers. On the production side, an identical technology and similar inputs are used to brew most domestic malt beverages. On the demand side, most consumers are unable to detect any "quality" differences in blind taste tests. For example, in one blind taste test Allison and Uhl [3] find that beer drinkers could not distinguish one brand from another and could not identify their favorite brands. In addition, Ackoff and Emshoff [1; 2] conducted blind taste tests by placing four different labels on the same product and presenting them to their subjects as four different brands. Ackoff and Emshoff [2, 12] find that "All of the subjects believed that the brands were different and that they could tell the difference between them. Most (of the 250 subjects) felt that at least one of the four labels was not fit for human consumption." This implies that consumers could generally purchase cheaper, less-advertised brands without sacrificing quality.

Thus, the results show that advertising leads to higher prices. This is not to imply that the price of beer will be lower with a total ban on advertising, however, as this analysis measures the marginal and not the total effect of advertising. Nevertheless, by equation (7), the result that advertising leads to an increase in price demonstrates that beer advertising is excessive from society's point of view. For example, the most conservative parameter estimates (column 3) indicate that if all firms increase their advertising by 1 percent, then $-q(dp/da)dA = -$24.5 million. This, along with the estimates summarized in equation (7), implies that a 1 percent increase in beer advertising reduces social welfare by at least $52.7 million.

V. Concluding Remarks

Different beliefs about the nature of advertising influence the debate regarding its effect on social welfare. Recently, Becker and Murphy have developed a theoretical model that clarifies the relationship between advertising and welfare. We have shown how the Becker and Murphy framework, the NEIO technique, and other available evidence can be used to estimate the welfare effect of advertising in the U.S. brewing industry.

This is an important issue because of the recent interest in legally restricting beer advertising. Proponents favor such restrictions because they claim that beer advertising promotes alcohol consumption and contributes to the negative externalities associated with alcohol abuse.

Our results show that a 1 percent increase in advertising from its equilibrium level leads to both added costs and benefits to society. Advertising may benefit consumers directly by providing useful information and by paying for television and radio programming. Nevertheless, these benefits are outweighed by the costs of higher prices and greater negative externalities generated by beer advertising. Thus, our results indicate that there may be a substantial social gain from restricting beer advertising below its current level.
Appendix A: The Data

The data set consists of annual observations over the period 1950–88 for 22 beer companies. The total number of observations varies from between 254 and 322 observations because some firms exited the industry during the sample period and because data availability varies by variable from firm to firm and year to year. The sample contains only the U.S. mass producers. Microbreweries and brewpubs are excluded because they are very small, having a combined market share of only 0.016 percent in 1990 [71], and produce beer that is significantly different from that of companies that produce mass-produced beer [60]. The sample of firms was initially limited by data availability, however, which resulted in a truncated sample of only large national and regional firms. As a result, a number of small regional firms were surveyed and asked to provide the necessary data. Two brewers agreed to provide their data under the condition that their identities and data remain confidential. This led to a more representative sample.

The price is measured in dollars per (31 gallon) barrel of a firm’s representative product. Revenue data are found in Moody’s Industrial Manual and Moody’s OTC Industrial Manual. Output, measured in millions of barrels of beer sold per year (1947–88), is obtained from various issues of Advertising Age (1950–82) and Beer Industry Update: A Review of Recent Developments (1983–88) [65]. Because the success variable (SS) requires data on output for three previous periods, data on output originate in 1947 while data on the remaining variables originate in 1950.

Measurement procedures and data sources for the marginal cost variables are as follows. The price of labor is measured as the average hourly wage rate of production workers in the beer industry from Brewer’s Almanac (various issues) [66]. The price of materials is measured as the weighted average price of all materials contributing at least 0.1 pounds per barrel of beer, which include: corn, rice, malted barley, sugar, and hops. The quantity of inputs used is from Brewer’s Almanac (various issues). Material prices are from Commodity Yearbook [68] (various issues) for corn, rice, malt, and sugar and from Agricultural Statistics [64] (various issues) for hops. Brewing capacity is measured as the total brewing capacity of the firm (in millions of barrels) as reported in Brewer’s Digest, Brewers Guide and Brewery Directory [67] (various issues). Vintage is defined as the weighted average age of each plant owned by the firm [11; 67; 59].

The raw data used to generate the other independent variables are obtained as follows. Advertising expenditures are measured in millions of dollars and are taken from various issues of Advertising Age (1950–82) and Beer Industry Update: A Review of Recent Developments [65] (1983–88). Industry output is measured in millions of barrels from Brewer’s Almanac [66] (various issues). The Herfindahl-Hirschman index is measured as the sum of the squared market share (in barrels sold) for all firms with sales exceeding one million barrels per year and the average squared market share of remaining firms times the number of remaining firms in the industry.

Finally, all dollar figures are in real (1972) dollar terms. Output dollar figures are deflated by the consumer price index and input dollar figures are deflated by the wholesale price index from the U.S. Bureau of Labor Statistics.

Appendix B: Advertising and Profit

This appendix proves the proposition that the aggregate producer surplus or profit in an economy will decrease for a marginal increase in an industry’s aggregate advertising under the following conditions: 1) there is more than one firm, 2) firms behave non-cooperatively, 3) there are no advertising restrictions, and 4) the aggregate profit function is strictly concave and is twice continuously differentiable in advertising.

Assume that firm $i$’s profit function can be written as $\pi_i(A_1, A_2, A_3, \ldots, A_i, \ldots A_N)$ for $i = 1, 2, 3, \ldots N$ firms in the economy. The only choice variable is advertising, and firm $j$’s advertising is assumed to reduce firm $i$’s profit if firm $j$ is a rival (i.e., $\partial \pi_i/\partial A_j \leq 0$, for $i \neq j$) and have no effect on firm $i$’s profit otherwise, ceteris paribus.

Now assume that all firms cooperate to maximize joint profit, and $A^*$ is the vector of advertising that maximizes joint profit. At this optimum, it must be true that:

$$\frac{\partial \pi_j(A^*)}{\partial A_j} + \sum_{i \neq j} \frac{\partial \pi_i(A^*)}{\partial A_j} = 0.$$
However, \( \partial \pi_i(A^*)/\partial A_j \) is less than 0 for rivals and equals 0 for all other firms. Therefore, \( \partial \pi_j(A^*)/\partial A_j \) must be greater than 0. Thus, in a non-cooperative setting, it is optimal for each firm to advertise more than that which maximizes joint profit. As a result, the non-cooperative equilibrium level of advertising \( (A_1) \) will exceed \( A^* \).

Finally, because \( A_1 > A^* \) and the aggregate profit function is strictly concave in aggregate advertising, a small increase in advertising from \( A_1 \) will reduce aggregate profit. QED

References


Government and Industry References