The Advertising–price Relationship: Theory and Evidence

NATSUKO IWASAKI, YASUSHI KUDO, CAROL HORTON TREMBLAY and VICTOR J. TREMBLAY

ABSTRACT The relationship between advertising and price is important because the welfare effect of advertising depends upon the price effect of advertising. We attempt to provide a better understanding of the theoretical relationship between advertising and price. We establish theoretical conditions sufficient for advertising to raise prices. This will occur, for example, when firms play a supermodular game—a structure that considers the type of advertising (i.e., persuasive, image creating, or informative) and the effect that advertising has on a firm’s demand and costs. We also compare results from two simple duopoly models, one with horizontal and the other with vertical differentiation, and find that only the model with horizontal differentiation is supermodular for the forms of advertising that are thought to raise price (e.g., persuasive advertising). In consideration of these theoretical issues, we then develop an empirical model to determine whether advertising raises prices in the US brewing and cigarette industries.

Key Words: Advertising; Price; Supermodularity; Brewing Industry; Cigarette Industry.

JEL Classifications: L13; L66; M37.

1. Introduction

Theoretical work demonstrates that the welfare effect of advertising in imperfectly competitive markets depends critically upon the advertising–price relationship. In their seminal study, Dixit and Norman (1978) show that advertising will raise market power and lower (raise) social welfare when it raises (lowers) prices.
in imperfectly competitive markets. Becker and Murphy (1993) and Stivers and Tremblay (2005) demonstrate that this simple test is invalid, however, when advertising produces sufficient positive externalities and/or sufficiently lowers consumer search costs. In this case, advertising that raises price need not be socially excessive, but advertising that lowers price will be undersupplied from society’s perspective. Regardless of the circumstances, however, a first step in estimating the welfare effect of advertising is to determine whether advertising raises prices and market power.

Advertising can affect price by influencing a number of demand and cost factors. Because most advertising costs are sunk, for example, advertising expenditures may deter entry and lower price competition (Sutton, 1991). Alternatively, advertising could lower price when it increases firm demand and substantially lowers marginal cost due to the presence of scale economies.

Most theoretical research on the advertising–price relationship has focused on the demand effect of advertising in imperfectly competitive markets. In his extensive survey, Bagwell (2005) summarizes three important ways that advertising may influence demand. First, advertising may change consumer tastes through persuasive means by creating spurious or subjective product differentiation. This form of advertising strengthens consumer brand loyalty, which generally results in more inelastic demand functions and less competitive pricing. Second, advertising may provide consumers with useful information about prices and product characteristics. With better informed consumers, demand becomes more price elastic and market prices generally become more competitive.¹ When advertising can be both informative and persuasive, Banerjee and Bandyopadhyay (2003) show that prices will be higher or lower depending on the relative mix of persuasive versus informative ads. Finally, advertising may be viewed as simply a complement to output (Becker and Murphy, 1993). In this case, advertising does not change consumer preferences. It may provide information but its primary influence comes from the creation of a particular image that becomes tied to the product. Consumers who value these images will be willing to pay a higher price for advertised brands.

Given the variety of theoretical possibilities, it is not surprising that the results of empirical studies of the advertising–price relationship are mixed and appear to vary across industries.² Several studies confirm that a ban on advertising increases market prices, which suggests that advertising is primarily informative in nature and/or allows firms to benefit from scale economies.³ Consistent with the persuasive viewpoint, however, is the evidence that heavily-advertised brands are more expensive than like brands that receive little advertising.⁴ This conclusion is problematic, however, because heavily-advertised brands may be higher priced because of subtle quality differences. If firms use advertising as a signal to inform consumers of high-quality experience goods, then the higher price for heavily-advertised goods reflects a difference in quality and is not due to persuasion. Consistent with the viewpoint that advertising is a complement to output, recent evidence by a team of psychiatrists indicates that consumers do gain utility from the images created by advertising (McClure et al., 2004). This study found that test subjects who drank Coca-Cola experienced greater pleasure, measured by functional magnetic resonance imaging (fMRI), when they were informed that they were drinking the Coke brand than when they were uninformed.⁵ Thus, the brand name provides utility in-and-of itself.⁶
One goal of this research is to analyze the theoretical relationship between advertising and prices in imperfectly competitive markets when there is persuasive, informative or image creating advertising. In section 2, we show how recent theoretical work on supermodular games identifies a set of sufficient conditions that guarantee a positive relationship between advertising and price. We use two simple duopoly models, one with horizontal and the other with vertical product differentiation, to show that supermodularity is sufficient but not necessary for there to be a positive relationship between price and advertising. In both models, advertising raises price when it is persuasive, yet only the model with horizontal differentiation is supermodular. Thus, in section 3 we turn to empirical analysis to shed additional light on the issue. We develop an empirical model to estimate the advertising–price relationship in the US brewing industry using firm level data and the US cigarette industry using market level data. We also estimate changes in the Lerner Index due to advertising. We find that beer and cigarette advertising are associated with higher prices and market power. In section 4, we suggest that advertising in these industries has been primarily persuasive and image enhancing, and conclude that cigarette and beer advertising has reduced social welfare.

2. The Theoretical Relationship between Advertising and Price

Advances in economic theory shed some light on the relationship between advertising and price in imperfectly competitive markets. When firms compete in a strictly supermodular game, for example, the structure of the game is sufficient to assure a positive relationship between advertising and price (Milgrom and Roberts, 1990). To illustrate this concept, consider a smooth supermodular game where n firms compete in a market by maximizing profit ($\pi$) with respect to price ($p$) and advertising ($A$). Firm i’s strategies are identified as $p_i$ and $A_i$, and a particular rival’s strategies as $p_j$ and $A_j$. Each firm is assumed to have complete information and to choose price and advertising simultaneously to maximize its own profit.

Two important assumptions are critical to supermodularity. First, a firm’s own strategic variables must be complementary: $\partial^2 \pi_i / \partial p_i \partial A_i > 0 \forall i = 1, 2, 3, \ldots n$. This implies, for example, that an increase in $A_i$ raises the marginal returns of price ($\partial \pi_i / \partial p_i$) and induces the firm to increase $A_i$, a condition that will hold when advertising and price are complements in the firm’s demand function and an increase in advertising does not lead to lower marginal costs (through scale effects). Thus, $A_i$ and $p_i$ move together, ceteris paribus. Second, firm and rival prices and advertising levels are strategic complements (Bulow et al., 1985): $\partial^2 \pi_i / \partial p_i \partial p_j > 0$, $\partial^2 \pi_i / \partial p_i \partial A_j > 0$, $\partial^2 \pi_i / \partial A_i \partial p_j > 0$, and $\partial^2 \pi_i / \partial A_i \partial A_j > 0$. This means that an increase in each of firm i’s strategic variables raises the marginal returns of each of firm j’s strategic variables.

One can think of this as a game of super-complementarity where all strategic variables move together. For example, an exogenous shock, such as a reduction in the price of advertising that increases firm i’s advertising, will cause the firm to raise its price (because $A_i$ and $p_i$ are complements) and induce firm j to raise its price and advertising spending (given the strategic complementary assumption). Feedback effects reinforce these changes, as the increases in $A_i$ and $p_i$ cause firm i to further raise its price and advertising, etc. Thus, the supermodularity structure guarantees a positive relationship between advertising and price. In the next section, we examine this idea with two models of duopoly, one with horizontal
and the other with vertical product differentiation. In the simple Hotelling model of horizontal differentiation, supermodularity is both necessary and sufficient for advertising to raise price. In contrast, we find that a duopoly model with vertical product differentiation is not always supermodular even though advertising raises price. This underscores the point that supermodularity is sufficient but not necessary for there to be a positive relationship between advertising and price.

2.1. Duopoly with Horizontal Product Differentiation

Consider a duopoly market where products are substitutes and differentiated along a single horizontal characteristic, \( \theta \), as in Hotelling (1929) and d’Aspremont et al. (1979). For simplicity, assume that \( 0 \leq \theta \leq \theta_H \). Examples of horizontal characteristics include the location of a bank or the colour of a particular model of car. Each firm (1 and 2) produces a single product or brand, and a brand’s characteristic is predetermined, such that firm 1’s product is located at 0 and firm 2’s product is located at \( \theta_H \).

Consumers have different preferences over the horizontal characteristic, and each consumer’s type is identified by his or her ideal characteristic location (e.g., a car colour that is either black, white, or a particular shade of gray). For simplicity, assume that preferences are uniformly distributed over the interval \([0, \theta_H]\). With only two brands, a white and a black car, consumers with preferences closer to 0 prefer brand 1 (a white car) and consumers with preferences closer to \( \theta_H \) prefer brand 2 (a black car) when output prices are the same. The indirect utility function for a \( \theta \)-type consumer is \( U_1(\theta) = s - t_1 \theta - b p_1 \) when brand 1 is purchased and \( U_2(\theta) = s - t_2 (\theta_H - \theta) - b p_2 \) when product 2 is purchased. Parameter \( s \) identifies a consumer’s willingness to pay for an ideal product and is assumed to be large enough to assure that each consumer purchases either brand 1 or brand 2 (i.e., the market is covered). The \( t \) parameters capture the unit cost or disutility associated with purchasing a product that is less than ideal. For example, the consumer at preference location \( \theta = 0 \) would receive no disutility from purchasing brand 1 (located at 0), because brand 1 is ideally located for this consumer. That same consumer would receive a total disutility of \( t_2 \theta_H \) when brand 2 is purchased, however. Notice that there is no product differentiation when \( t_1 = t_2 = 0 \) (i.e., utility does not depend on \( \theta \)) and that product differentiation increases as these parameters increase. Parameter \( b \) represents the disutility associated with a unit increase in the price. One could imagine, for example, that \( b \) is lower when consumers have greater brand loyalty or a low willingness to substitute one brand for another.

Firm demand depends on the location of the marginal consumer, \( \theta_m \), defined as the consumer who is indifferent between purchasing brands 1 and 2. For this consumer, \( U_1(\theta_m) = U_2(\theta_m) \), implying that: \( \theta_m = (t_2 \theta_H - b p_1 + b p_2) / (t_1 + t_2) \). Assuming each consumer purchases a single unit (i.e., unit demands), firm demand functions are:

\[
D_1 = \theta_m = \frac{t_2 \theta_H - b p_1 + b p_2}{t_1 + t_2}, \tag{1}
\]

\[
D_2 = \theta_H - \theta_m = \frac{t_2 \theta_H + b p_1 - b p_2}{t_1 + t_2}, \tag{2}
\]
where \( D_i \) represents quantity demanded for brand \( i \). Ignoring advertising for the moment, firm \( i \)'s profit equation is \( \pi_i(p_1, p_2) = p_1 D_i(p_1, p_2) - c_i(D_i) \), where \( c_i \) is total cost. In this stage of the game, assume that firms have complete information and compete by simultaneously choosing prices. Thus, Nash equilibrium prices are:

\[
p_1^* = mc + \frac{(t_1 + 2t_2)\theta_H}{3b},
\]

\[
p_2^* = mc + \frac{(2t_1 + t_2)\theta_H}{3b},
\]

where \( mc \) is marginal cost.

With this result, we can now investigate how advertising influences Nash prices by influencing the primitives of the model. The simplest way to do this is to assume that firms play a multistage game of perfect and complete information by choosing advertising simultaneously in the first stage and price in the second stage.\(^{15}\) Firms would use backwards induction to obtain the optimal level of advertising in a subgame perfect equilibrium by looking forward and basing their advertising decisions on the Nash equilibrium prices correctly anticipated in the last stage of the game. Advertising that changes the parameters of the model will have predictable effects on equilibrium prices as indicated in equations (3) and (4).

Assuming it is profitable to do so, the theory of advertising suggests that advertising may influence Nash prices in three ways. It may change tastes by increasing brand loyalty (lowering \( b \)), create a product image that increases perceived product differentiation (increasing \( t_1 \) and \( t_2 \)), or it may inform people of a product’s existence (increasing \( \theta_H \)). In this model, all conditions of supermodularity are met when: (1) advertising increases brand loyalty (lowering \( b \)), (2) advertising increases perceived product differentiation (increasing \( t_1 \) and \( t_2 \)), or (3) advertising attracts new people to the market (increasing \( \theta_H \)). Thus, these forms of advertising will increase Nash equilibrium prices.

Graphically, a game is supermodular when changes such as these cause each firm’s best reply functions to shift away from the origin. This can be seen in Figure 1, which plots the best reply functions with respect to price for each firm (\( BR_1 \) and \( BR_2 \)) and identifies the Nash equilibrium prices (\( p_1^*, p_2^* \)) where the best reply functions intersect. As the figure indicates, advertising will move the intercepts of the best reply functions away from the origin and raise Nash equilibrium prices when advertising lowers \( b \), raises \( t_i \), and raises \( \theta_H \).\(^{16}\) When advertising has the opposite effect (e.g., it lowers brand loyalty or reduces perceived differentiation), the structure of the model is not supermodular and advertising lowers Nash prices. In the simple Hotelling model, supermodularity is necessary and sufficient for advertising to raise prices, an outcome that is not true in the next example.

### 2.2. Duopoly with Vertical Product Differentiation

We now assume that the two brands are differentiated over a vertical characteristic. A good example of such a characteristic is product quality, indexed by \( z \). As in the previous example, we assume that a product’s characteristic is predetermined and that brand 1 is of higher quality, \( z_1 > z_2 > 0 \).\(^{17}\) Consumer preferences for quality are identified by the taste parameter \( \phi \), which varies by consumer and is uniformly distributed over the interval \([\phi_L, \phi_H]\), where \( 0 < \phi_L < \phi_H \). Consumers
with a higher $\phi$ have a stronger preference or willingness to pay for high quality goods. Unlike the case with horizontal differentiation, consumers agree over the preference ordering of the vertical characteristic. That is, all consumers prefer brand 1 over brand 2 when $p_1 = p_2$. We use a Mussa and Rosen (1978) indirect utility function to model the preferences of a $\phi$-type consumer: $U_i(\phi) = s + z_i \phi - b p_i$ when product $i$ (1 or 2) is purchased. In our application, we assume that $s$ is large enough to assure a covered market. As in the model with horizontal differentiation, $b$ represents the disutility associated with a unit increase in the price.

Firm demand depends on the location of the marginal consumer, $\phi_m$, the individual who is indifferent between purchasing products 1 and 2. For this consumer, $U_1(\phi_m) = U_2(\phi_m)$ when $\phi_m = (b p_1 - b p_2)/z$, where $z = z_1 - z_2$ defines the degree of vertical product differentiation. Assuming that consumers have unit demands, firm demand functions are:

\begin{align}
D_1 &= \phi_H - \phi_m = \phi_H - \frac{b p_1 - b p_2}{z}, \\
D_2 &= \phi_m - \phi_L = \frac{b p_1 - b p_2}{z} - \phi_L.
\end{align}

If costs are linear as in the previous model, then the Nash equilibrium prices in the model with vertical differentiation are:

![Figure 1. Best Reply Functions, Horizontal Product Differentiation. Note: The slope of $BR_2$ equals 2, and slope of $BR_1$ equals 1/2.](image)
Now, if it is profitable to advertise, the model of vertical differentiation is supermodular when advertising increases the size of the market (increases $\phi_H - \phi_L$) but not when it raises brand loyalty (increases $b$) or raises the degree of product differentiation (increases $z$). Yet, Nash prices rise when advertising increases $\phi_H - \phi_L$, $b$, or $z$. It is quite clear from Figure 2, which plots the best reply functions for each firm, that prices rise when advertising increases $\phi_H - \phi_L$. It is less clear from the figure whether advertising that increases $z$ and $b$ increases or decreases Nash prices. For example, an increase in $z$ raises the $BR_1$ intercept but lowers the $BR_2$ intercept. The net effect is for Nash prices to rise, however, because $BR_1$ shifts up by more than $BR_2$ shifts left. This demonstrates the limitation of supermodularity: advertising can raise prices in markets that are not supermodular.

To summarize, supermodularity defines a set of market and advertising conditions that assure a positive relationship between advertising and price in an imperfectly competitive market. An exogenous shock that increases advertising will unambiguously raise equilibrium prices when two important conditions are met: (1) A firm’s own advertising and price are complements, which occurs when

\[
p_1^* = mc + \frac{z(2\phi_H - \phi_L)}{3b},
\]

\[
p_2^* = mc + \frac{z(\phi_H - 2\phi_L)}{3b}.
\]

Figure 2. Best Reply Functions, Vertical Product Differentiation. Note: The slope of $BR_2$, and the slope of $BR_1$ equals 2.
advertising and price are complements in the firm’s demand function and when an increase in advertising does not lead to lower marginal costs, and (2) advertising and price are strategic complements among competitors.

The strategic complementarity condition is the most difficult to interpret. It will hold when one firm’s advertising increases each competitor’s marginal returns to increasing price and advertising spending. This requires that advertising is constructive (i.e., a firm’s advertising increases its own and its rivals’ demand). As the model with vertical differentiation illustrates, however, supermodularity need not hold when advertising is purely persuasive or image creating (i.e., it increases brand loyalty or perceived differentiation), conditions normally associated with higher prices. This demonstrates that supermodularity provides sufficient but not necessary conditions for a positive relationship between advertising and price. In any case, models with both horizontal and vertical differentiation indicate that advertising will lower (raise) equilibrium prices when it reduces (raises) brand loyalty, perceived differentiation, and the marginal cost.

This explains why the advertising–price relationship is so complex and ultimately an empirical question. Given the difficulty of testing for supermodularity and the fact that it provides only sufficient conditions, we proceed by developing an empirical model to directly estimate the advertising–price relationship using data from two industries: the US brewing industry and the US cigarette industry. We then use the estimated models to predict the effects of advertising on the Lerner Index.

3. **Empirical Tests of the Advertising–price Relationship**

In this section, we derive an empirical model to estimate the advertising–price relationship. We use firm level data from the US brewing industry and industry level data from the US cigarette industry. These are worthwhile industries to study, because they are imperfectly competitive and because advertising has played an important role in their development.

One might expect advertising to increase prices in these industries because beer and cigarette ads have persuasive and image enhancing elements. In their comprehensive consumer survey of over 1,800 consumers, for example, Bauer and Greyser (1968) find that consumers felt that only 4% of beer ads and 8% of cigarette ads were informative. These markets need not be supermodular, however, as advertising that is persuasive and image-enhancing need not be consistent with supermodularity. In addition, most of the empirical evidence indicates that advertising has not increased market demand for beer and cigarettes during the sample period. Thus, the ultimate answer is still uncertain.

We use demand and supply side equations to identify the important determinants of a firm’s equilibrium price in an imperfectly competitive setting. Firm $i$’s inverse demand function is given by $p_i(q_i, A_i, q_{-i}, A_{-i}, \mathbf{x})$, where $q_i$ is firm $i$’s output, $q_{-i}$ is aggregate rival output, $A_{-i}$ is aggregate rival advertising, and $\mathbf{x}$ is a vector of other relevant demand determinants. Following Bresnahan (1989) and Kadiyali et al. (2001), a firm’s supply relation, which nests a range of possible equilibria, would take the following form: $p_i = m_i + \lambda q_i$, where $m_i$ is marginal cost and $\lambda$ is an unknown conduct parameter. Firm behaviour is competitive when $\lambda$ equals 0, and less competitive when $\lambda > 0$. Solving these two equations for the equilibrium price produces the following equation:
The right-hand side of (9) contains one non-exogenous variable, advertising. If advertising is pre-determined when price decisions are being made, we can estimate equation (1) using OLS. If advertising is determined simultaneously with price, then an instrumental variable (IV) approach is warranted. Thus, we estimate the models using OLS and IV estimators. In the empirical applications that follow, we assume that equation (9) can be accurately approximated by a linear specification.

3.1. The Advertising–price Relationship in the Brewing Industry

We first use data from the brewing industry. The sample consists of 439 observations of annual data from 36 macro brewers from 1950 through 2003. Advertising is defined as the quantity of advertising messages per (31 gallon) barrel, measured as advertising expenditures per barrel divided by a price index of advertising. In addition to marginal cost, advertising, and the strategic variables of rivals, previous studies show that an important determinant of beer demand is the fraction of the population from 18 to 44 years old (Tremblay and Tremblay, 2005). We control for this with a demographics variable ($DEM$). Because national brands command a price premium over regional brands, a premium that may be due to differences in quality, a national dummy variable ($DN$) is included in the model. This variable takes on the value of 1 when a firm markets its beer nationally and 0 otherwise. One concern with our sample is that the degree of competition may have changed over time. This is especially true in brewing, as the number of independent macro brewers declined from 350 to 21 from 1950 to 2003. In spite of this rise in industry concentration, however, previous studies show that the beer market has remained competitive. For example, Tremblay and Tremblay (2005) find that firms with less successful marketing campaigns experienced a decline in demand and an increase in excess capacity. In response, many slashed prices in order to reduce excess capacity. To control for factors that may influence price competition, we include the Herfindahl-Hirschman index of industry concentration ($HHI$) and the firm’s capacity utilization rate ($CUR$), defined as the firm’s annual production divided its brewing capacity. The data and sources are more completely described in the Data Appendix.

The empirical results for the model described above are presented in the first two columns of Table 1. Because advertising may be predetermined or endogenous, we estimate the regression model using ordinary least squares (OLS) and the method of instrumental variables (IV). Following Greene (2003: 79–80), instruments for a firm’s advertising include the exogenous price of advertising and all exogenous variables in the model from the current and the preceding period. The $t$-ratios listed in Table 1 are derived from estimates of the heteroskedasticity and autocorrelation consistent (HAC) covariance matrix (Davidson and MacKinnon, 2004, p. 362). Comparing estimates in columns (1) and (2), all of the parameters that are significantly different from zero have the same sign. Consistent with simple static models of price competition such as Bertrand, the marginal cost parameter estimate is close to one, not significantly different from one but significantly different from zero. An increase in the primary drinking age population ($DEM$) leads to a significant increase in price. Price falls significantly with rival output ($q_{-i}$). As expected, a lower capacity utilization rate ($CUR$) leads to
significantly tougher price competition. Price competition appears to increase with industry concentration ($HHI$), a result that contradicts simple static models of oligopoly such as a Cournot model with $n$ firms. In any case, the evidence is consistent with Tremblay and Tremblay (2005), who find that price competition has been tough in brewing. The national dummy variable ($D_{N}$) is small and insignificantly different from zero. This suggests that the model adequately captures quality differences between national and regional brands.

Finally, the results provide strong evidence that advertising is associated with higher beer prices. A firm’s own advertising has a positive and significant effect on its own price. Rival advertising is insignificant. The net effect of a firm’s own and its rivals’ advertising is always positive, however, indicating that advertising raises prices in the US brewing industry.

To control for possible dynamic effects missing in the model, we consider an alternative specification which appends a squared time trend variable ($T^2$) to the original model. The estimated OLS and IV parameters of this specification appear in columns (3) and (4) of Table 1, along with t-ratios derived from estimates of the HAC covariance matrix. The parameter estimate on $T^2$ is marginally

<table>
<thead>
<tr>
<th>Independent variables</th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
</tr>
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<tbody>
<tr>
<td>Constant</td>
<td>−52.202a</td>
<td>−49.361a</td>
<td>−62.854a</td>
<td>−62.106a</td>
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<td></td>
<td>(8.017)</td>
<td>(6.569)</td>
<td>(6.851)</td>
<td>(4.769)</td>
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<td>Marginal cost ($mc$)</td>
<td>1.022a</td>
<td>0.998a</td>
<td>1.024a</td>
<td>0.980a</td>
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<td>Demographics ($DEM$)</td>
<td>153.488a</td>
<td>157.863a</td>
<td>177.539a</td>
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<tr>
<td>Capacity utilization rate ($CUR$)</td>
<td>6.978a</td>
<td>7.362a</td>
<td>7.496a</td>
<td>8.745a</td>
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<td></td>
<td>(4.367)</td>
<td>(3.979)</td>
<td>(4.327)</td>
<td>(3.402)</td>
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<td>Herfindahl–Hirschman index ($HHI$)</td>
<td>−0.786a</td>
<td>−0.831a</td>
<td>−1.369a</td>
<td>−1.628a</td>
</tr>
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<td></td>
<td>(11.260)</td>
<td>(7.009)</td>
<td>(3.773)</td>
<td>(2.660)</td>
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<td>Rivals’ output ($q_{-i}$)</td>
<td>−0.031a</td>
<td>−0.048b</td>
<td>−0.020</td>
<td>−0.050b</td>
</tr>
<tr>
<td></td>
<td>(2.072)</td>
<td>(1.984)</td>
<td>(1.479)</td>
<td>(1.714)</td>
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<td>National dummy ($D_{N}$)</td>
<td>0.878</td>
<td>−0.086</td>
<td>0.857</td>
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<td></td>
<td>(0.873)</td>
<td>(0.076)</td>
<td>(0.837)</td>
<td>(0.529)</td>
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<td>Own advertising ($A_{i}$)</td>
<td>1.281a</td>
<td>2.621a</td>
<td>1.287a</td>
<td>3.762a</td>
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<td></td>
<td>(5.467)</td>
<td>(2.428)</td>
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<td>(2.774)</td>
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<tr>
<td>Rivals’ advertising ($A_{-i}$)</td>
<td>0.065</td>
<td>−0.689</td>
<td>0.291</td>
<td>−1.065</td>
</tr>
<tr>
<td></td>
<td>(0.269)</td>
<td>(0.968)</td>
<td>(1.203)</td>
<td>(1.437)</td>
</tr>
<tr>
<td>Time–squared ($T^2$)</td>
<td>0.007c</td>
<td>0.009</td>
<td>(1.685)</td>
<td>(1.376)</td>
</tr>
</tbody>
</table>

$R^2$ | 0.951 | 0.943 | 0.951 | 0.931 |

F-statistic | 1118.37a | 895.47a | 987.81a | 647.69a |

Number of observations | 467 | 439 | 467 | 439 |

Notes: OLS represents ordinary least squares estimates and IV represents instrumental variables estimates. The absolute values of t-statistics are in parentheses, and are estimated from the heteroskedasticity-autocorrelation consistent covariance (HAC) matrix estimates. p-values: Statistical significance at 0.01 or better (a); between 0.01 and 0.05 (b); between 0.05 and 0.10 (c).
The Advertising–price Relationship

significant (at 10%) using OLS but insignificant using IV. Regardless of model specification or the estimation technique, own advertising has a positive and highly significant effect on price in the US brewing industry.\textsuperscript{26}

We conduct Hausman specification tests and find that the null hypothesis that OLS is consistent is rejected for the models with and without $T^2$. This indicates that the IV estimator is appropriate for these models. We also check for weak instruments by using the value of the F-statistic for the joint significance of the excluded variables in the first stage (the lagged exogenous variables and the price of advertising). The test-statistic in both models exceeds 10, indicating that weak instruments are not a cause for concern (Staiger and Stock, 1997). These tests support the IV findings that advertising significantly increases brewing industry prices.

To put these results into perspective, we next analyze how advertising has affected the Lerner index of market power. We compare its actual value, evaluated at sample mean values, with its predicted value when advertising increases by 1%.\textsuperscript{27} As indicated in Table 2, actual Lerner Index estimates are close to 0, only 0.070 in the IV models. This is consistent with previous studies that find that the brewing industry has been relatively competitive. Based on IV model estimates, a 1% increase in advertising causes the Lerner Index to rise by 1.30 to 1.86\% ($\%\Delta L$).\textsuperscript{28} Because there is very little real difference in quality between the brands of beer produced by the macro brewers (e.g., Bud Light and Coors Light), these results suggest that the little market power exercised by the US macro brewers is likely due to advertising. This is consistent with the theoretical work by Tremblay and Polasky (2002) and Soberman and Parker (2004), who show that firms may use advertising in markets with little real product differentiation to avoid the Bertrand paradox of perfectly competitive pricing.

3.2. The Advertising–price Relationship in the Cigarette Industry

Next, we estimate the model using market level data from the US cigarette industry. This requires that we derive the structural model from the market demand function and the industry supply relation. Under a set of regularity conditions, industry supply is simply the aggregate of individual firm supply relations.

Table 2. Estimated Lerner Indexes for the US Brewing Industry

<table>
<thead>
<tr>
<th>Model</th>
<th>$L$</th>
<th>$L'$</th>
<th>$%\Delta L$</th>
</tr>
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Notes: $L = \left( \bar{P} - \bar{AC} \right) / \bar{P}$, where $\bar{P} = \frac{1}{T \cdot N} \sum_i \sum_n P_{i,n}$, and $\bar{AC} = \frac{1}{T \cdot N} \sum_i \sum_n AC_{i,n}$, $L' = \left( P' - \bar{AC} \right) / P'$, where $P'$ is a predicted price evaluated at means of independent variables except advertising, which is increased by 1%. $P_{i,n}$ and $AC_{i,n}$ are firm $n$'s price and average costs in year $t$, respectively. $T$ is the final time period, and $N$ is the total number of firms in our sample. $\%\Delta L = (L' - L) / L \times 100$, the estimated percent change in the Lerner index due to a 1% increase in advertising.
Solving for the equilibrium price from the market demand function and the industry supply relation produces the following price equation:

\[ p = f(A, \bar{x}, mc; \lambda), \]  

(10)

where \( p \) is the market price, \( A \) is the number of advertising messages per cigarette for the entire industry, and \( mc \) is the marginal cost of production. In this case, \( \bar{x} \) is a vector that includes all other variables relevant to the cigarette market.

Unlike brewing, the cigarette industry has experienced a number of information shocks and government regulations that affect demand. The most important regulations include: (1) the Fairness Doctrine Act (1968–1970), which required one anti-smoking advertisement for every four pro-smoking advertisements on television and radio, (2) the Broadcast Advertising Ban (1971–), which made all television and radio advertising (pro- and anti-smoking) illegal, and (3) the National Tobacco Settlement (enacted at the end of 1998 through the present), which placed further restrictions on cigarette advertising. We use the following dummy variables to control for these regulations: \( D_{68-70} \) controls for Fairness Doctrine Act and equals 1 from 1968–1970, 0 otherwise; \( D_{71-98} \) controls for the Broadcast Advertising Ban and equals 1 from 1971–1998, 0 otherwise; \( D_{98-02} \) controls for both the Ban and the National Tobacco Settlement and equals 1 from 1998 through the present, and 0 otherwise. Local and state clean air legislation, making it illegal to smoke in many public establishments, may have also influenced demand. To control for these laws, we use a measure developed by Farr et al. (2001) and Iwasaki et al. (2006), defined as the weighted average over all states of the degree of clean indoor air restrictions, weighted by state population (LAW). For cigarettes, the relevant population is 18 years of age and older, which we control for with a demographic variable (DEM). Finally, because cigarette smoking is addictive, we use the level of aggregate consumption in the previous period as a control (\( Q_{t-1} \)). The Appendix provides more information about the data and sources.

On the supply side, an important difference between the beer and cigarette industries is that the number of cigarette producers has been fairly constant during our sample period (1955–2002). According to Tauras et al. (2006), the only behaviour change not controlled for by the regulation dummy variables discussed above is the break in pricing behaviour associated with what has come to be called ‘Marlboro Friday.’ As public pressure mounted against cigarette smoking in general and cigarette advertising in particular, Philip Morris reduced the price of its Marlboro brand by 40 cents per pack on 2 April 1993. Other cigarette producers followed suit, leading Tauras and colleagues to conclude that price competition was high from 1993 until the Master Settlement Agreement. We use a dummy variable to control for this behavioural break (\( D_{93-98} \)), which equals 1 from 1993–1998, and 0 otherwise.

Empirical results for the cigarette industry are listed in Table 3. Columns (1) and (2) show the OLS and IV parameter estimates for the model without the squared time trend, and columns (3) and (4) present estimates for the model with \( T^2 \). As in brewing, instrumental variables include current and lagged values of all exogenous variables and the price of advertising.

There is little difference in the results regarding the regulatory variables when we use ordinary least squares or the method of instrumental variables regardless of the presence of \( T^2 \). Most of the regulatory control variables are
significantly different from zero and have stable signs across specifications. The exception is the sign reversal on $D_{99-02}$ when $T^2$ is added to the model, which may have resulted from multicollinearity. In any case, because marketing regulations may affect demand elasticity as well as the level of demand, their influence on price is indeterminate. The marginal cost parameter is close to one in the model without $T^2$ but is less than 0.8 when $T^2$ is in the model. Again, this may have resulted from multicollinearity. The sign and statistical significance of the parameter of interest, however, remains stable. Like brewing, the results show that advertising raises equilibrium cigarette prices, regardless of the specification.

We conduct a number of specification tests for the cigarette models with and without $T^2$. In either specification, there does not appear to be a problem with weak instruments using the approach discussed above. The data do not exhibit autocorrelation according to Breusch-Godfrey tests. A Hausman specification test for the model without $T^2$ indicates that the OLS estimator is not consistent and that IV should be used. In contrast, a Hausman test for the model with $T^2$ indicates that OLS is the appropriate estimator.
Using the same method as in brewing, we next investigate how advertising affects the Lerner index in the cigarette market. These results are presented in Table 4. Lerner index estimates are consistent across specifications, at 0.415, and are considerably higher in the cigarette market than in brewing. This is not surprising because concentration has been consistently higher, and real product differentiation is more pronounced, in cigarettes than in brewing. Predictions of the effect of a 1% increase in advertising on the Lerner index are actually lower for cigarettes than for beer. For the models indicated by the Hausman tests, estimates of $\%\Delta L$ are 0.114% (OLS with $T^2$) and 0.083% (IV without $T^2$).

These results indicate that advertising can raise price and market power in markets where advertising is primarily persuasive and image enhancing, such as beer and cigarettes. The results are quite different for these two industries, however. Market power is greater but advertising is less effective at increasing market power for cigarettes than for beer. This suggests that the many marketing restrictions on the cigarette industry may have diminished the effectiveness of advertising to raise price.

4. Conclusion

Our main goal has been to analyze the relationship between advertising and price in imperfectly competitive markets. Theoretical work on supermodular games provides a set of conditions that guarantee that advertising causes higher Nash prices. Advertising raises prices when a firm’s own advertising and price are complements and when its advertising raises each of its rival’s marginal returns to increasing advertising and price. These are only sufficient conditions, however, and advertising may still raise prices when one or more of these conditions are violated. For example, we show that for a duopoly with vertical differentiation, advertising that is purely persuasive or image creating need not support supermodularity even though it leads to higher prices. In the Hotelling model of duopoly with horizontal differentiation, however, we demonstrate that supermodularity is necessary and sufficient for persuasive, image creating or informative advertising to raise prices.

To further examine the advertising–price relationship, we develop an empirical model of prices in an oligopoly setting. We apply the model to firm level data from the US brewing industry and to industry level data from the US cigarette

<table>
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<th>$L$</th>
<th>$L'$</th>
<th>$%\Delta L$</th>
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Notes: $L = (\bar{P} - \bar{AC})/\bar{P}$, where $\bar{P} = \sum P_t/T$, $\bar{AC} = \sum AC_t/T$, and $L' = (P' - \bar{AC})/P'$, where $P'$ is a predicted price evaluated at means of independent variables except advertising, which is increased by 1%. $P_t$ and $AC_t$ are price and average costs in year $t$, respectively. $T$ is the final time period. $\%\Delta L = (L' - L)/L \times 100$, the estimated percent change in the Lerner index due to a 1% increase in advertising.
industry. These are markets where one might expect advertising to raise prices, as beer and cigarette ads have been more persuasive and image enhancing than informative. Consistent with our expectations, we find that advertising raises prices and market power in these markets. Because beer and cigarette advertising raises market power, provides consumers with little information, and generates little or no positive externalities, our results suggest that advertising has been excessive from society’s perspective.

Notes
1. The one exception is the model by Stivers and Tremblay (2005), which shows that purely informative advertising can lower the full price paid by consumers (i.e., the market price plus unit search costs) and raise market prices.
2. The literature is too extensive for a complete review. For discussion of early and more recent studies see Comanor (1985) and Bagwell (2005).
3. In his seminal study, Benham (1972) found that advertising restrictions led to higher prices for eyeglasses. This result is confirmed in subsequent studies, such as Cady (1976) for prescription drugs, Maurizi and Kelly (1978) for retail gasoline, Kwoka (1984) for optometry services, and Milyo and Waldfoogel (1999) for alcoholic beverages. For a review of this evidence, see Carlton and Perloff (2005) as well as Bagwell (2005).
5. It appears that consumer preferences for soft drinks are processed in two separate regions of the prefrontal cortex; the ventromedial region judges purely sensory information, and the dorsolateral region judges cultural and image influences created by advertising (McClure et al., 2004: 385).
6. Of course, advocates of the persuasive view might argue that this enhanced pleasure results from the deceptive nature of advertising rather than the creation of a desirable image.
8. One could assume more generally that strategies are complete lattices instead of smooth functions without affecting the main conclusions of the paper. For further discussion, see Milgrom and Roberts (1990) and Vives (1999).
9. The other assumptions are that the profit function is twice continuously differentiable and all strategic variables are bounded between positive and negative infinity. Regarding price, it is reasonable to assume that the equilibrium price is bounded by zero and the monopoly price. Regarding advertising, it is reasonable to assume that advertising is bounded by 0 and total revenue.
10. This will occur when advertising and price are separable in the firm’s demand function and when advertising increases firm demand. This definition follows from Bulow et al. (1985).
11. Spence (1977: 543) is a precursor to this line of research, as he showed that advertising will increase price in a monopoly setting when $\partial^2 \pi / \partial p \partial A > 0$.
12. Because our focus is on advertising, we ignore firm decisions regarding product characteristics. When two firms compete in a dynamic game of location choice and price competition, however, d’Aspremont et al. (1979) show that firms will locate at the two extremes of the characteristic space. See Tremblay and Polasky (2002) and Soberman and Parker (2004) for a discussion of how advertising may affect consumer perceptions of product location.
13. As one referee pointed out, we could also set $t_1 = t_2 = t$ and let advertising influence a consumer’s willingness to pay (i.e., $s_1 \neq s_2$). The comparative statics are unchanged by this modification. Allowing $t$ rather than $s$ to vary focuses attention on the impact of advertising on perceived product differentiation.
14. The marginal consumer will have a positive utility when $s_i$ is sufficiently large. To assure a duopoly market, $\theta_m$ must lie between 0 and $\theta_H$, a condition that holds at the Nash equilibrium.
15. Alternatively, if price and advertising are chosen simultaneously, then all first order conditions with respect to price and advertising would need to be solved simultaneously to obtain Nash equilibrium prices. In any case, the main conclusions of this section hold whether the model is static or dynamic.
16. Note that if marginal costs rise with output, advertising that increases production could also lead to higher prices. Alternatively, advertising that raises output could lead to lower prices if
substantial scale economies exist, ceteris paribus. For the remainder of the paper, we ignore scale effects.

17. See Waithy (1996) and Tremblay and Martins (2001) for a discussion of duopoly models with vertical differentiation when product quality is endogenous.

18. For example, a wealthier consumer will have a greater ability to pay and, therefore, may have a greater willingness to pay for high quality goods.

19. Seldon et al. (1993) provide such a test for just one strategic variable, a firm’s own and its rivals’ advertising.

20. For recent studies that discuss how advertising helped shape these industries, see Tremblay and Tremblay (2005; 2007) on brewing and Bihari and Seldon (2006), Iwasaki et al. (2006), Tan (2006), Tauras et al. (2006), and Chaloupka (2007) on cigarettes.

21. For brewing, see Tremblay and Tremblay (2005); for cigarettes, see Farr et al. (2001).

22. We ignore the domestic specialty brewers, sometimes called micro or craft brewers, because price and marketing data are unavailable for these small firms. In any case, the craft sector is very small, accounting for less than 3.2% of domestic sales during our sample period, and craft style beer does not compete directly with the brands produced by the macro brewers, such as Budweiser, Miller Lite, and Coors Light.

23. Breusch-Godfrey tests reveal fifth-order autocorrelation in the errors in the OLS and IV models. Due to the difficulty in accurately determining the appropriate weighting matrix for generalized least squares estimation, particularly for a fifth-order process, and due to the possibility of heteroskedasticity given the cross-section aspect of the data, we use the HAC estimator.

24. We would like to thank the editor for suggesting this specification.

25. We find third-order autocorrelation for both the OLS and IV models that include \( T^2 \).

26. We also investigate two additional specifications. Although previous research shows that consumer income has little or no effect on beer demand, we added per-capita disposable income to the model. Second, because the parameter on HHI is negative and because Tremblay and Tremblay (2005) speculate that concentration may have reached a critical level by 1996, we replaced HHI with a dummy variable that equals 1 for the 1996–2003 period and 0 otherwise. For both of these alternative specifications, OLS and instrumental variable estimation results confirm that firm advertising leads to significantly higher prices in brewing.

27. That is, the new price is predicted from the regression model when advertising increases from its mean value by 1%, ceteris paribus.

28. Given that our models are linear approximations of the true data generation process, this analysis is only valid for a marginal change in advertising.

29. This requires that firms charge similar prices, use the same technology, and behave symmetrically. With asymmetric firms, Bresnahan argues that the conduct parameter can be interpreted as a measure of average firm conduct.

30. These include bans on outdoor advertising, the use of cartoon characters in marketing campaigns, and product placement in movies and television programs. For further discussion of these and other government policies designed to curb cigarette demand, see Iwasaki et al. (2006).

31. Because pricing decisions are dynamic in markets with addiction, this parameter should be interpreted with caution (Roberts and Samuelson, 1988, and Iwasaki et al., 2006).

32. Correlation coefficients (r) indicate time-squared is highly correlated with LAW (r = 0.95), advertising (r = 0.84), and DEM (r = 0.88).

33. See Johnson and Myatt (2006) for a discussion of how marketing and marketing restrictions may affect demand elasticity.

34. Our estimate is somewhat lower than the Lerner index estimates of Bihari and Seldon (2006), which was 0.59 for the 1971–1984 period.

35. In fact, beer and cigarette ads may produce negative externalities. That is, cigarettes may cause non-smokers to start smoking, and beer ads may encourage alcohol abuse. In this case, beer and cigarette advertising would be excessive even if it had no effect on prices.

References


The Advertising–price Relationship


Appendix. Data Description and Sources

Firm level beer data include 439 observations of 36 firms from 1950–2003. These data derive from a variety of sources. For a complete description and a copy of the data, see Tremblay and Tremblay (2005). The price is measured as a firm’s total revenue from the sale of beer divided by its total output. Rival output (advertising) is defined as industry output minus firm i’s output (advertising). Marginal cost is approximated by average production cost. Except for differences in capacity utilization rates, which are accounted for in the model, this approximation will be accurate since the macro brewers generally produce at a large enough scale to reach constant returns to scale. To estimate the Herfindahl-Hirschman index, we use the actual output data from the largest 100 brewers. Output data for the remaining brewers are very small and are assumed to be equal.

Industry level data for the cigarette industry include annual observations from 1955–2002. These data are obtained from Iwasaki et al. (2006). Price is measured as the retail price per cigarette. Marginal cost is approximated by average production cost, which will provide an accurate approximation given that six large firms accounted for almost all US cigarette production during the sample period. To control for the demand effects of the clean indoor air laws and health information, we use a variable developed by Iwasaki et al. (2006). This variable, LAW, is defined as the sum of each state’s share of the US population times a measure of restrictiveness of each states clean indoor air laws. We use the US Department of Health and Human Services definition of overall anti-smoking restrictiveness, which equals: 0 if there are no statewide anti-smoking restrictions, 1 if the state regulates smoking in 1–3 public places (excluding restaurant and private work sites), 2 if the state regulates smoking in 4 or more public places (excluding restaurant and private work sites), 3 if the state regulates smoking in restaurants (but not private work sites), and 4 if the state regulates smoking in private work sites. See Iwasaki et al. (2006) for a more complete description of the cigarette data and their sources.

Total disposable income, population, the Consumer Price Index, and the Producer Price Index data are obtained from the Statistical Abstract of the United States. The advertising cost index for the years 1950–1959 is obtained from Schmalensee (1972); for the years 1960–2003, the index is obtained from Universal McCann Inc., 622 Third Avenue, New York, NY 10017. Advertising expenditures are deflated by the advertising cost index.