Coordinating on Reducing Advertising: Carbonated Soft Drinks Industry and Combating Obesity

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Abstract: With the rise in obesity levels across the nation, policy makers and public interest groups are taking more interest in advertising of unhealthful foods. The Better Business Bureau has formed the Children's Food and Beverage Advertising Initiative (CFBAI), which has recruited carbonated soft drink (CSD) manufactures to voluntarily restrict their advertising directed at children less than 12 years of age. This research explores the effects of the CFBAI on firm level advertising to children and adults using nonlinear time series processes. Estimated ARCH processes are significant in all models and capture varying pulse-advertising strategies by all major firms. We find that the market leader does in fact reduce its advertising to both adults and children and the second largest firm reduces advertising to adults. Advertising for the non-participating firm, however, increased for adults following the ban. The results emphasize the potential benefits and difficulty of coordinating cooperative behavior in this type of industry. It appears that policy strategies of this nature may be more effective if directed at industries as a whole and not at individual firms.

Key Words: television advertising, carbonated soft drink, oligopoly advertising, pulse advertising

JEL Classification: I18, L13, M37

Introduction

There are a multitude of factors that contribute to the high levels of obesity in the US and abroad. As such, researchers, policy makers and public interest groups have been attempting to find ways to target those factors which contribute to overconsumption and or sedentary lifestyles, which translates into obesity.

Over the last few years, advertising for unhealthful foods has been identified as a potential contributor to obesity. Advertising directed at children has received especially harsh criticism as it generates a high level of anxiety concerning the well being of young people. Consequently, several industry-lead initiatives have focused on ways to reduce or restrict levels of advertising directed at children, primarily through self-regulation. One example is the National Advertising Review Council's Children's Advertising Review Unit (CARU) which developed *Self-Regulatory Guidelines for Children's Advertising*, and provides monitoring and scrutiny of advertising directed at children. More recently, the Better Business Bureau has formed the Children's Food and Beverage Advertising Initiative (CFBAI), which has recruited firms to voluntarily restrict their advertising to children less than 12 years of age.

As many firms have voluntarily enrolled in initiatives such as the CFBAI, a natural question is what effect has this had on actual advertising levels. For one, even though advertising targeted to children may be restricted, children still watch television with their parents and older siblings. Even if firms restrict their advertising targeted at children, they may still increase their advertising targeted at adults, which could spillover to children as well. As a result, a reduction in advertising directed at children may have no effect or even a positive effect on children's advertising exposure.

Alternatively, it is suggested that oligopoly firms tend to over-advertise as a result of market competition and the need to product differentiate (Waldman and Jensen, 2007). The result of excessive advertising can be lower profits. While firms could increase their profits by reducing advertising levels, in a competitive market there is no incentive for a firm to move first; this result is demonstrated in a static game as a stag-hunt outcome. In this instance an outside mechanism could help coordinate reduced advertising levels by all participating firms. As such, following the CFBAI we might expect a decline in advertising to all age groups.

We estimate a time-series model of advertising by major carbonated soft drink (CSD) firms in the US to determine if the restriction on advertising directed at children had a statistical impact on their exposure to television advertising. Corresponding to the CFBAI initiative, we disaggregate advertising into two groups: advertising to ages under 12 and ages 12 and older. Rather than focus on expenditures, we measure advertising exposure using gross ratings points (GRPs). In addition, we model firm competition using a series of nonlinear time series models, which allow the data to determine competitive interaction.

To account for the commonly found heteroscedasticity in error terms of advertising data, a novel estimation approach is employed. We hypothesize that the main determinant of heteroscedasticity in television advertising models should be attributed to the pulse advertising strategy that firms typically utilize. This advertising strategy is a form of volatility clustering, which ARCH structured error terms are used to explicitly model (Engle, 1982; Franses and van Dijk, 2000). Therefore, we estimate a set of ARCH

class models and account for possible competitive interactions among firms using lagged values of GRPs.

As expected, the ARCH processes are significant, supporting the nonlinear model that allows for the variance grouping of pulse advertising. The difference between the estimated ARCH coefficients of the three firms suggests that while general advertising strategies are similar, specific applications vary across firm.

The market share leaders, Coca-Cola and Pepsi, exhibit the most significant results. The advertising restriction results in a decrease in both children and adult GRPs purchased by Coke and a decrease in adult GRPs purchased by Pepsi[1]. Therefore, it appears that the planned advertising restriction helped coordinate decreased advertising by participating CSD firms. The effect that this voluntary advertising ban had on GRPs appears to be much larger than first anticipated with decreased exposure of unhealthful foods to both children and adults. Following the voluntary ban on advertising, GRPs for adults increased for the non-participating firm, Dr. Pepper[2]. As the leading CSD firms decreased advertising, Dr. Pepper increased their GRPs.

The outcome of the presented model demonstrates the need for empirical analysis of non-market policy interventions and highlights the potential benefits and difficulty of coordinating cooperative behavior in this type of industry. Indeed, policy strategy of this type may be more effective if it gains industry-wide acceptance.

Motivation

[1] The effect on children's GRPs was negative but not significant.

[2] The effect on children's GRPs was positive but insignificant.

At a basic level, the purpose of advertising is to encourage consumers to purchase new products (increase demand), continue to buy certain products (prevent a reduction in demand), and make their willingness to pay for the product higher (rotate demand). Effective advertising then may lead to consumption of products that may not have otherwise been consumed (Dixit and Norman 1978). This causes some concern if the products have low nutritional value. This concern is especially poignant if the advertising is directed at children, as children are generally more susceptible to the effects of advertising (Friestad and Wright, 2005; Oates, Blades and Gunter, 2003). Additionally, research has identified, to some extent, a relationship between advertising and obesity, leading some to worry that advertising contributes to the growing obesity epidemic. For example, Chou, Rashad and Grossman (2008) find a positive relationship between children viewing TV ads for fast food restaurants, obesity and the probability of being overweight. Andreyeva, Kelly and Harris (2011) find that fast food advertising is associated with significantly higher weight outcomes for overweight and obese children as well[3].

Advertising is clearly an important consideration for firms as well. While advertising may increase demand, it is not without cost. For one, there is the financial burden of advertising. Since the economic impact of advertising is often difficult to

[3] Alternatively, Holt et al. (2007) find that children were not exposed to more food advertisements in 2004 than in 1977 and they find no evidence that children are seeing more advertising for low nutrition foods over the same time period. Zywicki, Holt and Ohlhausen (2004) further emphasize that food marketing to children has not grown during the same time that obesity has increased.

evaluate, firms are pressed to justify their advertising budget, especially in times of fiscal scarcity. Beyond that, some advertising can also contribute to a negative public image, as is the case with advertising directed at children. If advertising is costly and at the same time draws negative public attention, firms may be willing to reduce their level of advertising to reduce costs and improve their public image. However, firms may face a competitive environment where their decision to advertise is affected by other firms' behavior. More specifically, the benefit of restricting advertising may be conditional on cooperative behavior of all firms.

We discuss a simple two player Stag-Hunt game as an example (Figure 1). Each firm faces the discrete choice to advertise high or low. The payoff for each firm, π^i, is conditional on their own advertising choice and their competitors advertising choice. Since advertising is costly to the firm (due to financial costs and social perception) we assume that the high level advertising payoff is less than the low level advertising payoff. This is the excessive advertising argument which suggests that firms invest in too much advertising due to competition and that if they reduced their advertising, their costs would decline (without hurting their revenues) and their profits would go up. If advertising to children is receiving negative public attention, then advertising would in fact be excessive if the marginal costs of public attention outweigh the marginal benefits from increased demand.

Noting firm 1's choice with the first subscript and firm 2's with the second subscript, the payoffs for firm 1 and firm2 are ordered as: $\pi^1_{LL} > \pi^1_{HL} \geq \pi^1_{HH} > \pi^1_{LH}$ and $\pi^2_{LL} > \pi^2_{LH} \geq \pi^2_{HH} > \pi^2_{HL}$ respectively. In a Stag-Hunt, as opposed to a Prisoner's Dilemma, there are two pure Nash equilibria, one where both players choose to defect (advertise

high) and one where both choose to cooperate (advertise low). In our simple example, the decision to cooperate (advertise low, advertise low) provides a larger overall profit for both players. However, if both firms are already at the risk dominant payoff (advertise high, advertise high), they will continue to advertise high and receive lower profits. Clearly this creates a coordination problem between the firms. If they can simultaneously agree to advertise low, both firms could receive higher profits.

The introduction of the CFBAI could coordinate advertising reductions by participating firms. Essentially, the CFBAI provides the opportunity for any one firm to signal their desire for coordination without incurring any actual losses. That is, any firm can signal their intention to reduce their advertising by joining the CFBAI. If no other firms in the industry were to mimic this behavior, the initial firm could potentially excuse itself from participating in the CFBAI.

While it is possible that oligopolists in a market would be willing to reduce advertising levels given some coordination, there are other potential outcomes as well. Advertising to adults reaches a broader audience of decision makers. The introduction of the CFBAI could direct firm advertising expenditures from lower-return advertising (targeted at children) to higher return advertising (targeted at adults). As such, the implementation of the CFBAI may result in a reduction in advertising to children and an increase in advertising to adults. Finally, it is important to note that even if advertising directed at children is restricted, children's exposure to advertising may not change (or it

may increase) because children still view adult advertising which does not necessarily exclude children[4].

Data

The CSD market in the United States can be characterized as an oligopoly dominated by three major firms, Coca-Cola Company, PepsiCo Inc and Dr. Pepper-Snapple Group Inc. The industry relies largely on advertising with the majority of advertising expenditures going to television advertising and the majority of television advertising allocated to the major brand products for each company: the majority of Coca-Cola advertising expenditures are for Coca-Cola, PepsiCo Inc advertises Pepsi and Dr. Pepper-Snapple Group Inc. advertises Dr. Pepper. Not only do the major CSD brands receive the largest share of advertising expenditures, they are also advertised the most frequently. Some seasonal or promotional CSDs are advertised for a single period of time, whereas the major brands benefit from advertising pulsing strategies in which repetitive pulses of advertising occur with a certain frequency throughout the year. Rather than using data disaggregated by brand, the time series used in this research provide weekly measures of national advertising GRPs by *parent* company for five different age groups from January 2006 to December 2008 (152 weeks)[5]. GRPs are a measure of the number of people who see an advertisement multiplied by the frequency that it is viewed.

[4] Advertising to children is generally defined by the composition of the audience viewing the advertisement. For example, if 50 percent of the audience for a commercial is adults, then the advertisement is considered adult advertising by many company standards.

[5] National advertising includes network, cable and syndicated advertising.

The data also captures the introduction of the Children's Food and Beverage Advertising Initiative (CFBAI). The two largest CSD firms (Coca-Cola and Pepsi) voluntarily joined the CFBAI; however, the terms of their participation vary. For example, Coca-Cola was one of four companies to completely stop advertising directed to children where child directed advertising is defined as having 50 percent of more of the audience profile being children under 12[6]. In fact, Coca-cola claims that it has never advertised to children based on these standards (see Coca-Cola's CFBAI pledge, http://www.bbb.org/us/children-advertising-initiative/Coca-Cola/). Alternatively, Pepsi agreed to restrict their under 12 advertising to products that meet their SmartSpot nutrition guidelines, where regular CSDs do not meet these guidelines (http://www.pepsico.com/Download/PepsiCo_Pledge.pdf). Pepsi committed to implement their restrictions by January 1, 2008. Prior to this in 2005, Pepsi voluntarily restricted advertising their flagship cola (Pepsi) to children under 12 (Ward and Grant, 2005). These standards do not mean that children never see advertising for CSDs from Pepsi or Coca-Cola, only that those companies do not target audiences comprised of children (Coca-Cola) or advertise unhealthful products to children (Pepsi). Clearly there is room for questioning the effectiveness of these standards. At the same time, January 1, 2008 provides an opportunity to examine if Pepsi implemented any significant changes to their advertising to both children and adult advertising. Further, Pepsi's implementation date may have allowed Coca-Cola and Dr. Pepper to simultaneously reduce their advertising. That is, if Coca-Cola and Dr. Pepper were aware that Pepsi intended to

[6] Coca-cola has since amended this pledge to be an audience profile of children under 12 greater than 35 percent. However, our data set reflects the 50 percent level.

reduce their advertising, they may have done the same. To date, Dr. Pepper-Snapple Group Inc. has not joined the CFBAI.

To match our data to the advertising restriction guidelines we aggregate our five age groups into two groups: children (under 12) and teenager/adults (12 and older). It is important to note that the GRPs used in this data only identify if a child or adult saw an advertisement or a certain product, but it does not distinguish the type of advertisement that was seen. Advertising directed at children may also generate GRPs for adults who are also watching the advertisement. Likewise, advertising directed at adults may also generate GRPs for children who view the advertisement.

In Figures 2-4 we plot the aggregate advertising GRPs for all regular CSDs owned by Coca-Cola, Dr. Pepper and Pepsi respectively, broken down by children and teenager/adults. As shown, the GRPs for children tend to follow the GRPs for adults, with the level of advertising for adults almost consistently higher than that for children. Adult advertising is generally during prime-time advertising spots and thus is more expensive. The summer time advertising tends to be more active and there are also two peaks for Coca-Cola, which appear to correspond to the Winter Olympics (February 2006) and Summer Olympics (August 2008), which Coca-Cola sponsors. The advertising frequency for Dr. Pepper appears to increase each year. In 2006, Dr. Pepper's advertising pulsing starts in April. In 2007, their advertising pulsing starts in January. Finally in 2008, we notice that advertising starts in January and lasts until August and appears to have greater frequency i.e., more peaks.

In Table 1 we show average weekly real advertising expenditures for all three firms for regular and diet soft drinks by year. Coke spends the most each year, followed

by Pepsi and Dr. Pepper. Dr. Pepper puts a much greater emphasis on regular soft drinks whereas Pepsi spends relatively more on diet soft drinks. It appears that all three firms reduced their expenditures from 2006, suggesting a slow down in advertising which may be related to a decline in consumption or a slow down in the economy. After the end of 2007 expenditures for regular CSDs recovered for Coke and Pepsi, but at a modest rate. This could be due to a continual downward trend in the economy and is not necessarily associated with the CFBAI. Dr. Pepper, on the other hand, exhibits a much greater increase in expenditures for regular soft drinks in 2008. It is not clear based on this preliminary analysis if this is related to the CFBAI, but it does appear that the change in Dr. Pepper's expenditures were greater than the two leading firms.

The standard deviation of expenditures provides interesting information as well. For all three companies, the standard deviation of expenditures declines from 2006 to 2007. In 2008, the deviation increases greatly for Coke and Pepsi but remains low for Dr. Pepper. This shows that Coke and Pepsi advertising becomes much more sporadic, whereas Dr. Pepper's advertising is more consistent. As a prelude to our empirical model, this also suggests that our estimation approach should account for erratic variation.

Unfortunately, the expenditure data is not disaggregated by age group. However, we can compare the data on children and adult GRP's for each of the firms. In Table 2 we report the sum of GRPs for children and adults by year. For both Pepsi and Coke, we notice a consistent pattern of declining GRPs each year for both age groups. Again, this is likely due to the declining economy. For Dr. Pepper, however, the sum of GRPs increases from 2007 to 2008 for both children and adults. This may not be directly attributable to

the CFBAI as other factors may also have an effect, but it does show that the behavior of Dr. Pepper varies compared to Coke and Pepsi.

Exploratory Regression Analysis

While CSD advertising behavior is clearly a time-series question, we initially examine the advertising data to determine if the implementation date of the CFBAI had an effect on firm GRPs. We combine each of the firm's 152 weeks of advertising data into a panel and estimate the following model:

$$(1) \qquad GRP_{it}^{g} = \gamma_{it}' z_{it} + (\delta_{it} \cdot Oly + \beta_{it} \cdot CFBAI)(1 + Coke + Pepsi) + \alpha_i + \varepsilon_{it}.$$

GRP is for firm *i* at time *t* for group *g* (children, adult). The vector *z* contains firm sales and advertising prices. *Oly* is a dummy variable to indicate when the Olympics are being held and *CFBAI* is a dummy variable to indicate the implementation of the CFBAI. Since we want to compare the effect between the three firms, we also include two dummy variables to identify different effects for *Coke* and *Pepsi*. We include firm fixed effects, α_i, and cluster the errors by firm.

To measure the cost of advertising we considered several different approaches. Our data provides advertising expenditures per advertisement allowing us to calculate the price paid for GRPs. This price time series is likely to be endogenous, however. As an alternative we use the Bureau of Labor Statistics Producer Price Index (PPP) for television broadcasting. While this is not a perfect measure of the cost for advertising GRPs, it represents the costs of television broadcasts and is likely correlated with the prices that would be charged for advertising by television companies to raise revenues. The sales data are taken from 16 major metropolitan regions in the US and is an

approximate measure of national weekly sales by each firm. Since sales is likely to be endogenous, we use sales lagged by 1 period.

We report the estimates for equation (1) in Table 3. The estimates for children GRPs (column 1) show that the Olympics has a significant impact on CSD firms with Coke increasing their advertising GRPs to children and Dr. Pepper and Pepsi decreasing their advertising GRPs to children. The lag of sales (*L1.sales*) has a significant positive effect on children GRPs as well. The sign on prices (*ppitv*) is negative as expected, but insignificant. The parameters of interest are the CFBAI dummy variables. Based on our model estimates, the implementation of the CFBAI lead to a decrease in both Coke and Pepsi's advertising GRPs for children. This is not surprising for Pepsi, as they pledged to reduce advertising to children by their implementation date. The fact that Coke also appears to follow suit suggests that their may be some coordination effect. Alternatively, Dr. Pepper GRPs to children significantly increased following the implementation of the CFBAI.

The estimates for adult GRPs (column 2) show similar results as the model for children. Most interesting is the significant change in adult GRPs for all three firms. Again, Pepsi and Coke reduce their advertising to adults while Dr. Pepper increases their advertising to adults. This result is interesting considering that the CFBAI pertains to advertising to children, not adults.

The results provide preliminary evidence that the CFBAI may have had an effect on firm advertising behavior. At the same time, however, there are clearly time series dynamics not being considered in this estimation. While dynamic panel series estimation is possible, the majority of statistical tests rely on panels where both N and T are large

(Cameron and Trivedi 2005). Since our $N = 3$, we will rely on time-series methods using separate equations for each firm (described in the next section).

Theoretical Model

The most common approach to examining firm behavior is to specify a profit maximizing model and estimate various forms of interfirm competition. When firm pricing behavior is of concern, this is the ideal approach. Given the vast number of firm products and our interest in advertising behavior, we find it parsimonious to focus on just firm advertising. To estimate the effect of the implementation of the CFBAI on firm's weekly GRPs, we employ duality results of the cost minimization problem to specify advertising GRPs as a factor of production, thereby separating advertising from the firm pricing decision and consumer demand. In this approach, we assume that different factors are used for production and advertising of the firm's product, allowing for separability of the cost function as $\Phi(W, P; Q) = \phi_P(W; Q) + \phi_A(P; Q)$ where W is a vector of prices for production inputs, P is a vector of prices for advertising media, Q is the desired level of output, $\phi_P(W; Q)$ is the production cost function and $\phi_A(P; Q)$ is the advertising cost function. Implicitly then, this framework separates out a firms cost of advertising required to achieve some desired level of output without having to explicitly model demand. As suggested by Seldon et al. (2000), one theoretical justification for separating production and advertising is that advertising can be altered after production has occurred.

Focusing on the advertising cost function, the minimization problem is: $\min_A \phi_A = A'P \; such that \; Q = \Gamma(A)$, where A is a vector of advertising units and $\Gamma(A)$ is a

function that translates the number of advertising units into the desired output. Solving the minimization problem produces a vector of advertising equations,

(2) $A = A(P, Q)$.

Corresponding to our data set, the advertising units, *A*, are the number of GRPs selected by a firm. Specifying GRPs as a factor of production may not be intuitive, since firms purchase advertising blocks from networks. However, the decision of how much to spend for a block of advertising is a function of how many GRPs will be acquired in a block of advertising. Given that advertising is purchased via competitive advertising markets, firms understand the number of GRPs that can be acquired for a given price. For example, if a firm has a limited budget, they can acquire low-cost GRPs, which typically consist of an advertising block aired during non-prime-time viewing.

Several other papers have used a cost-minimization approach to examine advertising behavior of firms. Seldon et al. (2000) specifies a translog cost function and solve for the factors of production to examine beer industry advertising shares. Silk et al. (2002) also specify a translog model to examine eight different forms of national media advertising in the US. Fare et al. (2004) and Vardanyan and Tremblay (2006) study the beer industry and use a cost minimization approach to evaluate the efficiency of firm advertising decisions. Finally, Iwasaki and Tremblay (2009) examine how advertising regulations impact efficiency in the cigarette industry.

It is common, as in the literature cited above, to estimate the factors of production given by equation 2 by specifying a functional form. Specifically, the cost function, $\phi_A(P; Q)$, is specified using a flexible functional form such as the translog and the factors of production are recovered using Shephard's lemma. Adding such structure ensures

consistency with economic theory, however it also imposes restrictions on the model. As noted by Manera (2006, p 128) regarding such models, "The variables of an economic system are interrelated in a complex way, where non-stationarities, dynamics and specific events play a crucial role." Further, the data generation process may not be known to the econometrician and will contain both deterministic and stochastic components. As opposed to enforcing structure on the cost minimization problem a few authors specify linear models, and instead focus on the dynamic processes affecting the error term. Manera (2006), for example, employs a vector auto-regressive model (VAR) with deterministic components. Hyde and Gloy (2007) also use a VAR model to examine competitive advertising between branded and generic meat. Steenkamp et al. (2005) specify a VAR model to simultaneously examine advertising, pricing and market shares.

The potential benefit of a data driven time-series approach such as a VAR model is that instead of enforcing restrictions on the model, the researcher lets the data describe the interactions. Advertising strategies of firms are complex and the interactions of firm competition are dynamic and complex as well. Many researchers choose to provide structure and assume some type of formal competition (for example, Cournot or Bertrand behavior) or some dynamic equilibrium process such as Markov-Perfect Equilibrium. While such approaches are clearly important, it can be difficult to account for structural change in the market since the behavior of the game being played is likely to change as well (Perloff, Karp and Golan 2007).

A VAR model of advertising factors can be specified as,

(3) $$B(L)A_t = \alpha \cdot z_t + \varepsilon_t,$$

where over some time trend *t*, z_t is a vector of deterministic components (constant term, time trend, structural breaks, seasonal variable, etc.), *B(L)* is a p^{th} order matrix polynomial in the lag operator *L*, and ε_t is a vector of i.i.d. normally distributed error terms. The vector A_t contains elements representing advertising GRPs for all firms in the industry.

While the lagged time series model (equation 3) allows for dynamic interaction among firms, it neglects to account for commonly used pulse advertising strategies undertaken by firms. Statistically speaking, pulse advertising can be viewed as a form of volatility clustering, where periods of high volumes of advertising, and GRPs, appear as regions of increased volatility in a time series and are typically followed with low periods of advertising, represented as regions of low volatility. These regions are easily identified in a plot of Coca-Cola GRPs (Figure 2). For example, in 2008 there are four periods where GRPs peak, with the largest peak occurring August 1st.

To account for pulse advertising in GRP's we specify equation (3) as a system of independent time series equations with autoregressive conditional hetersokedastic (ARCH) error terms as well as a set of exogenous variables. ARCH time series models were originally developed to account for variance clustering in financial time series (Engle, 1982). For each of the *i* firms, the error term, $\varepsilon_{i,t}$, is assumed to be conditionally heteroskedastic and is modeled using an ARCH model of order *p* such that $\varepsilon_{i,t} = w_{i,t}\sqrt{h_{i,t}}$ and $h_{i,t} = \omega_i + \lambda_i \eta_{i,t-p}^2$, where $w_{i,t}$ is i.i.d. with zero mean and unit variance, ω_i and λ_i are parameters to be estimated, and the series $\eta_{i,t}$ is conditionally homoskedastic. The use of ARCH class models over VAR class models will allow for a

more efficient specification of the nonlinear dynamic process involved in CSD advertising. The interaction between firms is specified as independent lagged variables in each CSD firm's equation of GRPs.

Empirical approach

We specify equation (3) to estimate advertising GRPs for children under 12 and teens and adults for each of the three CSD firms' non-diet major brands resulting in six reduced form equations:

$$(4) \qquad A_{i,t}^{g} = \sum_{m} \alpha_{i,m}^{g} z_{i,m,t} + \sum_{k} \beta_{i,k}^{g} A_{i,t-k}^{g} + \sum_{j} \sum_{l} \delta_{i,j}^{g} A_{j,t-1}^{g} + \varepsilon_{i,t}^{g}, i \neq j .$$

For the $i = 3$ firms, the advertising equations are for g = children or adult advertising GRPs over t =152 weeks. $z_{i,m,t}$ contains m exogenous time varying variables specific to each firm, including an intercept, a dummy variable to capture the effects of the winter and summer Olympics, the national producer price index for television advertising, and an estimate of total sales for the respective CSD firms over 16 major markets in the US. It also includes the variable of interest, a dummy variable identifying the implementation of the CFBAI. The α's are parameters to be estimated corresponding to each of the exogenous variables. The β's are parameters to be estimated corresponding to own-firm lagged advertising and the δ's are parameters to be estimated corresponding to competitor j lagged advertising. Each equation has k AR lags, l lagged competitor GRPs, and p ARCH lags. The optimal number of AR lags k and l, and ARCH lags p, are selected based on overall model fit, consistency across firm equations, t-statistics, Log Likelihood estimates, and the Akaike Information Criterion (Tsay, 2002).

Identification

The choice to restrict advertising by firms is clearly endogenous to their advertising behavior. Estimating the effect of the CFBAI based on the date that firms chose to join the initiative would create bias, as it would be correlated with unobserved variables captured by the error term. However, we estimate the effect of the CFBAI based on the *actual* implementation date of the advertising restriction, which is not necessarily chosen by the firms. Further, the implementation data we examine in this analysis is relevant for Pepsi, not the other firms. An important question then is whether or not unobserved factors that affect Pepsi's weekly advertising decisions are correlated with the implementation of the CFBAI. If advertising is planned far enough in advance, there could be unobservables which affect the stream of advertising we observe in our data that also have an effect on the chosen implementation date for the advertising restriction. As such, the dummy variable for the CFBAI would be correlated with the error term for the Pepsi model. Given the dynamic nature of advertising, however, it would seem unlikely that any decision to restrict future advertising would be highly correlated with factors that affect the choice of advertising GRPs in the future. For one, changing market conditions affect advertising costs and therefore advertising choices. While Pepsi might anticipate changes in market competition and adjust their advertising accordingly, there are numerous exogenous factors, such as the recent economic crisis, that they could not account for. They could plan for future prices based on expectations of competitive behavior, but the changing economy would ensure instability of prices and therefore varying advertising expenditures. For example, the economic crisis in the US has lead to a reduction in advertising by many large advertising firms, creating a greater supply of available television advertising time. Finally, changes in consumer behavior would likely

have an affect on advertising decisions as well. As obesity concerns have spread there has been a growing trend away from carbonated soft drinks. We assume that the implementation of the CFBAI initiative is exogenous to the stream of Pepsi advertising GRPs we observe in our data.

Another important consideration lies with the general Dorfman-Steiner result, which implies that firms select prices and advertising simultaneously. In our modeling approach we treat the desired output (Q) as chosen and then select the appropriate advertising level to achieve that output. If prices were simultaneously chosen with advertising, then prices would be endogenous to the advertising equations. We would then have to account for this in our estimation. There are two reasons why simultaneity of prices and advertising is not a concern in our approach. First, we use national level advertising data, whereas prices that directly affect demand (i.e. output) are set by retailers at the store level. From the firm's perspective, advertising and retail prices are not simultaneously chosen. Second, even if the firm has some expectations of retail price mark-ups and coordinates advertising and pricing decisions, this would occur at a regional level since prices vary by location. As such, we would expect regional spot market advertising to be correlated with regional retail prices. In fact, the greatest variation in city-level advertising is explained by spot market advertising[7]. As our analysis relies on national level advertising, we assume that pricing is not endogenous to our estimation.

Empirical Findings

[7] There is also variation in advertising due to cable advertising and syndication advertising, but far less than spot market advertising.

We present the results of six time series equations (Tables 4-6). As expected, the ARCH processes are significant in all models supporting the hypothesis that the use of pulse-advertising strategies has a significant effect on overall model fit. The AR lags are significant for Coke, Pepsi, and Dr. Pepper at varying degrees suggesting that the time series approach is effective at capturing the dynamic advertising behavior of the firms. Further, we find that the appropriate AR lag structure based on various fit criteria is to include four period lags in each equation. In addition to model fit criteria the time series parameters are specified the same for all equations for consistency and to allow for comparison of potentially different advertising strategies. Indeed, the estimated ARCH coefficients and autoregressive lags are different between CSD firms and between age groups, suggesting that general advertising strategies vary across manufactures. While the time series lags are not individually interpretable due to their interaction with each other and the ARCH parameters, it appears that the majority of all non-redundant dynamic processes are confined to a single month's periods.

The equations for the market share leaders, Coca-Cola (Table 4) and Pepsi (Table 6), exhibit the most statistically significant results. The advertising restriction parameter identifies a significant decrease in Coke GRPs for both children and adults and Pepsi GRPs for adults[8]. The fact that Pepsi's children GRPs do not have a significant change is not terribly surprising since they had already voluntarily restricted advertising their flagship soda in 2005. However, as previously discussed, it is interesting to find that Coca-Cola's advertising to children significantly changed. As suggested earlier, this

[8] The CFBAI had a negative effect on Pepsi's GRPs for children, but this value was not significant at the 10 percent level.

outcome may have been motivated by a coordinated effort to move to higher profit equilibrium. That is, if Coca-Cola suspected that Pepsi would reduce their advertising, they may have decided to do the same.

The fact that advertising to adults also decreased implies that participating firms did not attempt to increase their advertising to adults to compensate for reduced advertising to children. Just because firms do not advertise directly to children does not guarantee that children will not be exposed to advertising. Firms could increase their advertising directed at adults with the anticipation that children would also see the advertising. Rather, their overall advertising levels appeared to have decreased.

It is important to note that participating firms could have *only* reduced their advertising targeted to children and the impact on adults was a consequence of reduced spillover from children's advertising. That is, less advertising directed at children meant less advertising for adults as well. While this might have some impact on the results, the magnitude of the effects suggests that this does not explain the entire effect. Many adults do not have children; as such the reduction in children's advertising would have a minimal impact on adults GRPs.

The voluntary ban on advertising appears to have had an opposite effect on the non-participating firm. Dr. Pepper's adult GRPs (Table 5) increased after the onset of the CFBAI ban and the sign on the children's GRPs was positive, although not significant. As the leading CSD firms decreased advertising, Dr. Pepper increased their GRPs. Whether this decision was solely in reaction to the behavior of the other firms is indiscernible. It could be that Dr. Pepper anticipated the advertising reductions and then chose to increase their advertising levels to attempt to gain market share. At the same

time, however, if the two largest CSDs reduced their advertising expenditures the price of advertising would decrease and the availability of advertising would increase, reducing the cost of advertising to others in the market. The optimal advertising decision as implied by Equation (2) suggests advertising by Dr. Pepper would increase, $\partial A / \partial P < 0$. Whatever the exact motivation for the advertising increase by Dr. Pepper, the results emphasize the potential difficulty of coordinating cooperative behavior in this type of industry. Firms in such oligopolistic industries are highly competitive and product differentiation is key to maintaining profits. As such, advertising plays an important role in creating brand value.

The Olympics dummy variable is significant and negative for Pepsi and positive for Coca-Cola, the official sponsor of the Olympics. This captures the ramp up of advertising by Coke and the reaction by Pepsi, which is to reduce their advertising. This highlights interesting behavior by Pepsi; instead of attempting to combat Coke's advertising campaign they instead reduce their expenditures. Television advertising prices (PPITV) are significant for Pepsi with a negative signed coefficient whereas they are not significantly different from zero for Coca-Cola or Dr. Pepper. This could suggest that the marginal cost of advertising does not affect Coca-Cola or Dr. Pepper as much as Pepsi. It may also be that PPI for TV broadcasting does not sufficiently capture the price of advertising for these firms. Individual sales and competitor GRP's are significant at various levels for the different CSD firms.

Implications of Results

Due to a coordinated initiative by the Better Business Bureau, the two leading CSD firms agreed to reduce advertising directed at children under the age of 12. While it is easy to

observe that advertising targeted at children did stop at a certain date, the actual impact on advertising effectiveness as measured by GRPs was not clear and various possibilities existed as to the actual outcome. Ex ante, a net increase or decrease in GRPs for both the younger and older age groups could be expected. In addition to restricting advertising to children, firms could choose to reduce, increase or maintain advertising to adults, which would have varying effects on the amount of advertising children see.

Empirically, we find that GRPs were negatively affected for both children and adults for the two largest firms with the onset of the CFBAI. The effectiveness of this policy creates hope for future efforts to reduce incentives of unhealthy eating. Whether television advertisements have a significant effect on childhood obesity is of lesser importance in this case as we see a possible Pareto improving outcome where the participating firms reduce potentially excessive operating expenses. On the other hand, it appears the CFBAI has had a different effect on nonparticipating firms. Those not directly involved in the agreement now appear to be benefiting in a non-cooperative way.

There is an important tradeoff for firms to consider when deciding to regulate their own advertising. Advertising generates lasting goodwill for a firm's product. Advertising goodwill, much like other forms of capital, depreciates over time and requires maintained investment. At the same time, voluntarily reducing advertising to children also creates goodwill with the public. Firms must consider the tradeoff of advertising goodwill with public goodwill. That is, the benefit they get from advertising their products versus the benefit they get from being perceived as being socially responsible. To this point, it is perhaps less surprising that Pepsi would play a role in the CFBAI as they are part of larger brand, PepsiCo Inc, which produces a broad range of

products, not just soft drinks. As such, they may have more to gain in terms of public goodwill. While Coco-Cola is primarily a beverage company, they are the largest beverage firm in the world and have more at stake with the public. Alternatively, Dr. Pepper is the third largest carbonated soft drink firm and may have more to gain from increasing their advertising expenditures rather than appealing to public goodwill. It appears that policy strategies of this nature may be more effective if directed at industries as a whole and not at individual firms.

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Tables

Table 1. Weekly national advertising expenditures for diet and regular CSDs by firm, and year ($1,000's).

		Regular		Diet	
Manufacturer	**Year**	**Average**	**St. Deviation**	**Average**	**St. Deviation**
Coca-Cola	2006	$ 2,734	$ 3,019	$ 1,728	$ 2,378
	2007	$ 1,751	$ 2,681	$ 1,137	$ 1,753
	2008	$ 1,785	$ 3,271	$ 1,204	$ 1,923
Dr. Pepper	2006	$ 1,190	$ 1,161	$ 790	$ 1,310
	2007	$ 857	$ 962	$ 407	$ 731
	2008	$ 967	$ 969	$ 270	$ 722
Pepsi	2006	$ 1,272	$ 801	$ 1,624	$ 1,618
	2007	$ 864	$ 692	$ 1,280	$ 1,206
	2008	$ 870	$ 1,127	$ 852	$ 1,005

Table 2. Yearly national advertising GRPs for regular CSDs by firm, age group, and year.

		Regular		Yearly Change	
Manufacturer	**Year**	**Children**	**Adult**	**Children**	**Adult**
Coca-Cola	2006	3618.92	11996.73	--	--
	2007	2495.36	6881.83	(1,123.56)	(5,114.90)
	2008	1199.13	4042.41	(1,296.22)	(2,839.43)
Dr. Pepper	2006	1850.92	7128.40	--	--
	2007	1735.57	7311.28	(115.35)	182.88
	2008	2155.72	8612.42	**420.15**	**1,301.14**
Pepsi	2006	2593.11	9372.76	--	--
	2007	1683.77	6802.35	(909.35)	(2,570.41)
	2008	1430.27	4607.49	(253.49)	(2,194.86)

Table 3. Results of panel data estimation.

	model	
variable	**children**	**adult**
Olympics-Dr. Pepper	-25.86	-85.7
	-6.04	-20.02
Olympics-Coca-Cola	99.78	348.7
	-0.126	-0.807
Olympics-Pepsi	4.057	-0.925
	-0.0891	-0.569
cfbai-Dr. Pepper	11.89	42.79
	-1.662	-6.263
cfbai-Coca-Cola	-51.53	-161.3
	-0.0984	-0.628
cfbai-Pepsi	-20.75	-93.01
	-0.0506	-0.323
L1.sales	20.9	84.28
	-2.228	-14.23
ppitv	-2.992	-9.286
	-1.247	-4.197
Constant	-13.99	-348.1
	-102.4	-210.3
Observations	456	456

Robust standard errors below estimates

Table 4. Results of ARCH models of children and adult advertising for Coke.

	Childrens Advertising			Adult Advertising		
	Variable	**Coefficient**	**S.E.**	**Variable**	**Coefficient**	**S.E.**
Exogenous	L1.Pepsi adv	-0.150	0.014	L1.Pepsi adv	-0.008	0.010
	L1.Dr.P adv	0.010	0.019	L1.Dr.P adv	-0.038	0.007
	olympics	84.091	7.687	olympics	305.012	10.704
	cfbai	-8.518	1.795	cfbai	-22.922	3.877
	L1.Coke Sales	11.226	3.060	L1.Coke Sales	-25.379	6.338
	ppitv	9.938	10.194	ppitv	27.726	31.943
	constant	-196.394	52.882	constant	452.705	112.766
AR Lags	L1.	-0.066	0.031	L1.	0.171	0.022
	L2.	0.136	0.031	L2.	0.267	0.015
	L3.	0.228	0.027	L3.	0.220	0.017
	L4.	0.307	0.025	L4.	0.043	0.011
ARCH	L1.	3.774	0.566	L1.	6.231	0.656
	constant	0.638	4.079	constant	0.073	5.973
	n	152		n	152	
	Chi-squared (12)	3358.18		Chi-squared (12)	7498.19	
	LL	-738.7238		LL	-900.9744	

Table 5. Results of ARCH models of children and adult advertising for Dr. Pepper.

	Childrens Advertising			Adult Advertising		
	Variable	**Coefficient**	**S.E.**	**Variable**	**Coefficient**	**S.E.**
Exogenous	L1.Coke adv	0.062	0.015	L1.Coke adv	0.092	0.025
	L1.Pepsi adv	0.222	0.026	L1.Pepsi adv	0.253	0.030
	olympics	-5.009	7.618	olympics	-65.872	49.070
	cfbai	5.212	4.527	cfbai	43.497	17.769
	L1.Dr.P. sales	9.624	5.911	L1.Dr.P. sales	-32.831	30.026
	ppitv	17.048	43.195	ppitv	46.784	209.566
	constant	-157.781	95.507	constant	557.849	478.001
AR Lags	L1.	0.282	0.051	L1.	0.124	0.043
	L2.	0.609	0.042	L2.	0.686	0.034
	L3.	-0.186	0.039	L3.	-0.264	0.043
	L4.	0.026	0.036	L4.	0.097	0.037
ARCH	L1.	3.742	0.638	L1.	3.373	0.632
	constant	36.928	16.217	constant	1110.828	758.589
	n	152		n	152	
	Chi-squared (12)	1099.63		Chi-squared (12)	1439.2	
	LL	-728.0901		LL	-955.7031	

Table 6. Results of ARCH models of children and adult advertising for Pepsi.

	Childrens Advertising			Adult Advertising		
	Variable	**Coefficient**	**S.E.**	**Variable**	**Coefficient**	**S.E.**
Exogenous	L1.Coke adv	0.038	0.044	L1.Coke adv	0.041	0.050
	L1.Dr.P. adv	-0.013	0.043	L1.Dr.P. adv	-0.018	0.038
	olympics	-18.513	10.656	olympics	-52.017	30.882
	cfbai	-6.733	6.648	cfbai	-42.288	19.971
	L1.Pepsi Sales	19.770	11.225	L1.Pepsi Sales	70.827	36.823
	ppitv	-287.023	141.552	ppitv	-1019.924	428.012
	constant	-19.124	227.903	constant	-67.381	749.782
AR Lags	L1.	0.570	0.107	L1.	0.499	0.113
	L2.	-0.097	0.118	L2.	-0.056	0.115
	L3.	-0.003	0.130	L3.	-0.040	0.118
	L4.	-0.146	0.106	L4.	-0.170	0.104
ARCH	L1.	0.143	0.116	L1.	0.168	0.127
	constant	433.328	49.453	constant	5129.740	691.143
	n	152		n	152	
	Chi-squared (12)	45.88		Chi-squared (12)	47.71	
	LL	-686.1397		LL	-876.0559	

Figures

		Firm 2: Advertise-High	Firm 2: Advertise-Low
Firm 1	Advertise-High	π^1_{HH}, π^2_{HH}	π^1_{LH}, π^2_{LH}
	Advertise-Low	π^1_{HL}, π^2_{HL}	π^1_{LL}, π^2_{LL}

Figure 1. Two-player Stag-Hunt advertising game.

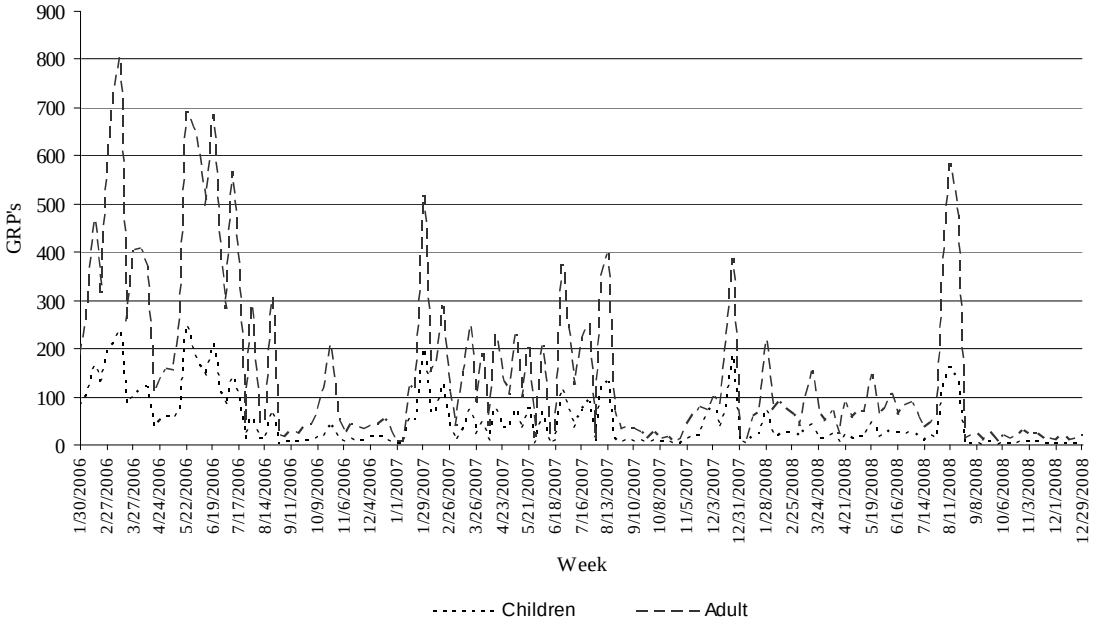

Figure 2. Coca-Cola GRPs for children under 12 and teens and adults.

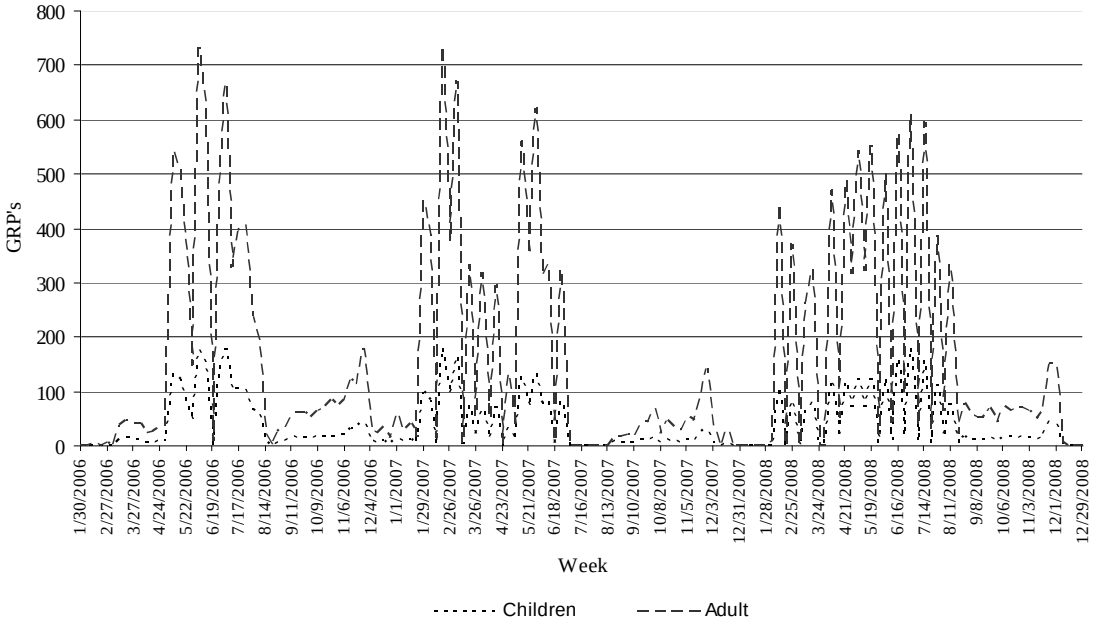

Figure 3. Dr. Pepper GRPs for children under 12 and teens and adults.

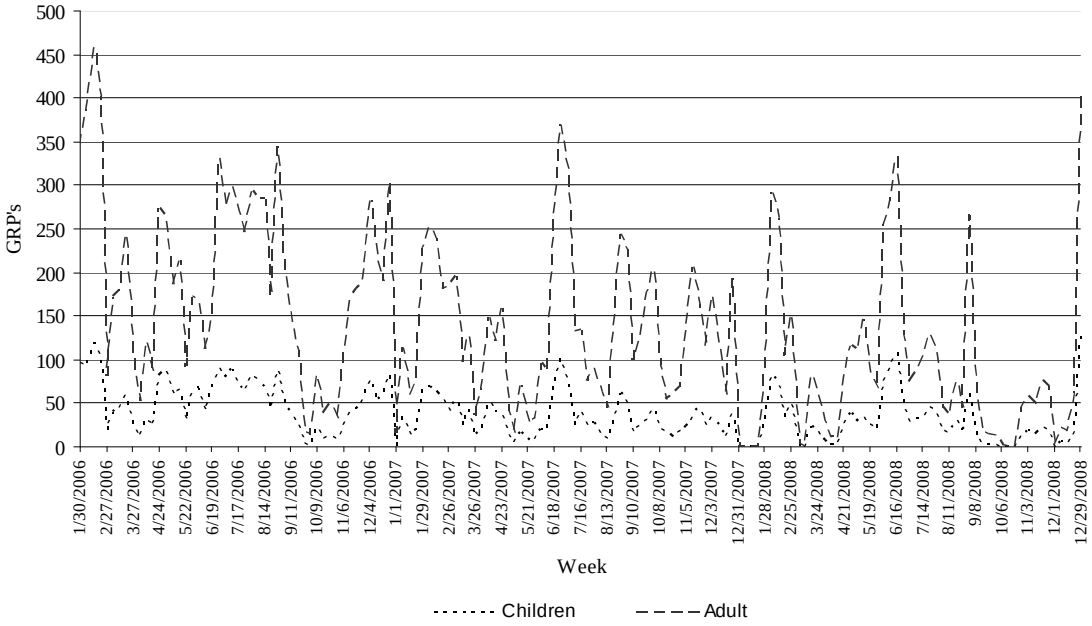

Figure 4. Pepsi GRPs for children under 12 and teens and adults.