Advertising in the U.S. Non-Alcoholic Beverage Industry: Are Spillover Effects Negative or Positive? Revisited using a Dynamic Approach

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Background

There are many different types of non-alcoholic beverages available today compared to say two decades ago. Support for this contention is evident with a visit to the non-alcoholic beverages isle of any grocery store. According to the Beverage Marketing Corporation (2009), the per capita consumption of bottled water increased from 13.5 gallons per year in 1997 to 28.5 gallons per year in 2008. On the other hand, milk consumption decreased from 28.7 gallons per person per year in 1975 to 20.4 gallons per person per year in 2008. Consumption of carbonated soft drinks (sodas) increased from 33.6 gallons per person per year in 1980 to 46.8 gallons per person in 2008.

In terms of advertising (both generic and branded), the non-alcoholic beverage industry spends an average of $2 billion per year (Zheng and Kaiser, 2008). Consequently, non-alcoholic beverages are among the most heavily advertised food and beverage groups in the United States. However, advertising and promotion expenditures for a particular non-alcoholic beverage potentially may influence not only the demand for that beverage but also the demand for a related beverage, either negatively or positively. For example, advertising and promotion expenditures directed to regular soft drinks may increase the demand for that particular category, while decreasing demand for a competing beverage such as bottled water. This cross-product advertising effect is called the “spillover effect”. Negative-type spillover effects are detrimental for beverage companies who are trying to sell both regular soft drinks and bottled water (for example Coca Cola® Company sells both regular Coke® and Dasani® bottled water). Therefore, identifying the appropriate spillover effects of

advertising is crucial for beverage manufacturers and marketers so that appropriate advertising strategies can be formulated.

Several studies pertaining to non-alcoholic beverages including the incorporation of advertising effects have been conducted, but most of these have centered attention on milk consumption (e.g. Kinnucan and Forker, 1986 and Kaiser and Roberte, 1996). Also, some studies have considered demand interrelationships for several beverages including advertising effects in systemwide analyses (e.g. Gao and Lee, 1995 for three different juices; Kinnucan et al., 2001 for milk, juice, soft drinks, and tea and coffee combined; and Zheng and Kaiser, 2008 for milk, juice, soft drinks, bottled water, and coffee and tea combined). Kinnucan et al. (2001) used annual time-series data for the United States from 1970 through 1994 and Zheng and Kaiser (2008) used annual time-series data from 1974 through 2005 in estimating impacts of advertising on the demand for non-alcoholic beverages. Approach used by Zheng and Kaiser (2008) centered attention to modeling advertising effects in a static setting where contemporaneous advertising effects on demand for non-alcoholic beverages were captured.

In our analysis, we develop and employ a unique monthly time-series data set based on Nielsen Homsescan panels for household purchases of non-alcoholic beverages from January 1998 through December 2003. This data set gives us per capita real total expenditure, per capita consumption and real price (unit value) for seven non-alcoholic beverage categories. Monthly real advertising expenditures for seven non-alcoholic beverages also were gathered for the same period (January 1998 through December 2003). Using such data along with a more disaggregate delineation of non-alcoholic beverage categories, we estimate own-price, cross-price and advertising elasticities for non-alcoholic

beverages using an unrestricted version of almost ideal demand system (AIDS) model (Deaton and Muellbauer, 1980) augmented with advertising expenditures modeled through dynamic advertising effects (we used a polynomial distributed lag model (PDL) (Almon, 1965 and Cooper, 1972) with end-point restrictions to capture advertising effects on demand for non-alcoholic beverages).

The specific categories of non-alcoholic beverages considered are: isotonics (sports drinks); carbonated soft drinks (regular soft drinks and diet soft drinks combined); milk (high-fat milk and low-fat milk combined); juices; bottled water; coffee; and tea. According to our knowledge, this work is the first attempt to model advertising effects on demand for isotonics (sports drinks), and tea and coffee (as separate categories). Also, this is the first attempt to use a polynomial distributed lag model (PDL) to capture the dynamic effects of advertising on demand for non-alcoholic beverages. Novelty also spans across our data set where we use a monthly time-series in contrast to annual time-series used in past studies.

Objectives

The objectives of this study are twofold: (1) to estimate own- and cross-advertising elasticities associated with the aforementioned non-alcoholic beverages; and (2) to assess positive and negative spillover effects associated with the advertising and promotion of the respective non-alcoholic beverages.

Data and Methodology

Initially, monthly household purchases of non-alcoholic beverages (expenditure and quantity information) were generated for each household in the Nielsen HomeScan data over the period January 1998 through December 2003. Next, the expenditure and quantity data were summed over all households for each month for each of the aforementioned non-

alcoholic beverage categories. As such, we generated monthly purchase data to arrive at a total of 72 observations for each non-alcoholic beverage category. Quantity data are standardized in terms of gallons per person per month and expenditure data are expressed in terms of inflation adjusted dollars. Then taking the ratio of real expenditure to volume, we generated unit values (or real prices) for each non-alcoholic beverage category for each month. We are not aware of past efforts to generate this type of monthly time-series data for the purpose of conducting demand analyses. To lend support to this approach, we find strong correlations of our data on an annual basis with annual USDA Economic Research Service disappearance data for similar beverage categories. Even though we lose household demographic information with this aggregation, we do not encounter data censoring problems inherent in trying to use micro-level data in estimating demand systems. Advertising data on non-alcoholic beverages, obtained from Leading National Advertisers, Inc. and *AdView*, an advertising tracking program maintained by ACNielsen, were merged with the time-series data generated through the use of the Nielsen HomeScan data for the same time period. Also, we have adjusted the advertising dollars for inflation. Quarterly seasonal dummies were generated to capture the potential seasonality effect present in this data.

To capture carryover effects inherent with the use of advertising and promotion expenditures, we used polynomial distributed lags with end-point restrictions. We recognize the degree of the polynomial, the length of the lag, and the use of endpoint restrictions may vary from one non-alcoholic beverage category to another. The degree of the polynomial of the distributed lag coefficient was set at two with both head and tail endpoint restrictions (requiring only estimating one parameter associated with the polynomial, hence recovering

coefficients associated with the advertising expenditure). Determination of number of lags in the advertising expenditure variable is an empirical question. We build into the unrestricted AIDS model the flexibility of ascertaining the appropriate lag structure for each of the non-alcoholic beverages considered. We chose the lag structures on the basis of the Schwarz Information Criteria (SIC) and/or Akaike Information Criteria (AIC) along with the statistical significance of key variables such as own-price and own-advertising effects on demand for selected non-alcoholic beverages.

Model Development

Two types of models were developed. One was static, where unrestricted AIDS model augmented with contemporaneous advertising effects of non-alcoholic beverages was developed. Also, we used quarterly seasonal dummies to take care of potential seasonality in data. Next, a dynamic model capturing dynamic advertising effects was developed. In the dynamic model, we augmented the unrestricted AIDS model with polynomial distributed lags of advertising variable with endpoint restrictions (both head and tail restrictions). Again, we used quarterly seasonal dummies to handle possible seasonality in data. Each non-alcoholic beverage was treated separately equation-by-equation. Model was estimated using a generalized least squares approach correcting for serial correlation of the disturbance term.

Estimated unrestricted AIDS model with contemporaneous advertising and quarterly seasonality effects can be depicted as follows:

(1) $$w_{it} = \alpha_i + \sum_{j=1}^{n} \gamma_{ij} lnp_{jt} + \beta_i ln\left[\frac{m}{f(P)}\right] + \sum_{j=1}^{3} d_j\, Q_{ijt} + \sum_{j=1}^{n} \theta_{ij} lnA_{jt} + e_{it}$$

where $p_{jt}$is the real price of non-alcoholic beverage, m is the real total expenditure, $f(P)$ is the Stone's price index; $f(P) = \sum_{i=1}^{n} w_i lnp_i$, $Q_{ijt}$is the quarterly dummy variable, A_{jt} is the real advertising expenditure and e_{it} is the additive disturbance term.

Estimated unrestricted AIDS model with polynomial distributed lags of the advertising expenditure and quarterly seasonality effects are shown below:

(2) $w_{it} = \alpha_i + \sum_{j=1}^{n} \gamma_{ij} lnp_{jt} + \beta_i ln\left[\frac{m}{f(P)}\right] + \sum_{j=1}^{3} d_j\, Q_{ijt} + \sum_{j=1}^{n} \sum_{k=0}^{k} \theta_{ijk} lnA_{jt-k} + e_{it}$

where A_{jt-k} is the polynomial distributed lag version of advertising expenditure. Notice that k is the lag length, $k = 0,1,2, \ldots., k$. The new coefficient associated with the polynomial distributed lag advertising expenditure variable isθ_{ijk}. We assume that θ_{ijk}can be represented with a polynomial of degree m, where $m = 0,1,2, \ldots., m$.

(3) $\theta_{ijk} = \varphi_0 + \varphi_1 k + \varphi_2 k^2 + \varphi_3 k^3 + \cdots + \varphi_k k^m$

Data Analysis

First, the model represented in equation (1) was estimated for seven non-alcoholic beverage categories. Contemporaneous own- and cross-advertising coefficients were obtained for all seven non-alcoholic beverage categories considered in this study.

Second, the model represented in equation (2) was estimated for seven non-alcoholic beverage categories. It must be noted that the number of lag length associated with advertising variable varied across each non-alcoholic beverage category. The polynomial associated with the advertising coefficient was restricted to represent a second degree polynomial. Also, we have restricted the aforementioned polynomial with both head and tail-end restrictions, thereby saving on available degrees of freedom. As a result, we have to estimate only one parameter associated with distributed lag advertising variable and recover the rest through imposed end-point restrictions. Long-run own- and cross-advertising coefficients were obtained.

Third, we used the following elasticity formula to calculate own- and cross-advertising elasticities for both contemporaneous (static advertising effects) and distributed

lag (dynamic advertising effects) models. It must be noted that the average budget share used to calculate aforementioned elasticities was taken averaging the budget shares of last 12 months of the data (average of budget shares from January 2003 through December 2003). Formula for own- and cross-advertising elasticities; E_{ij}^{A} can be depicted as follows:

(4) $$E_{ij}^{A} = \frac{\theta_{ij}}{w_i}$$

where, $\theta_{ij}$is the coefficient associated with advertising expenditure and w_i is the respective budget share of the non-alcoholic beverage concerned.

Results and Discussion

In the following paragraphs, first we discuss the contemporaneous and polynomial distributed lag advertising effects on demand for selected non-alcoholic beverages. Next, we compare the models using Akaike Information Criteria (AIC) and Schwarz Information Criteria (SIC) to determine the best model[1].

Contemporaneous Advertising Effects

Table 1 shows the advertising expenditure elasticities generated using contemporaneous advertising effects on demand for non-alcoholic beverages.

Table 1: Advertising Expenditure Elasticities for Selected Non-alcoholic Beverages: Contemporaneous (Short-Run) Advertising Effects (January 1998 - December 2003)[2]

	BW	COF	CSD	ISO	JUICE	MILK	TEA
BW	-0.010	**-0.043**	0.029	0.013	**0.079**	0.003	-0.007
COF	0.002	**0.046**	-0.034	**0.025**	-0.041	-0.006	-0.005
CSD	0.005	-0.003	**0.030**	**-0.027**	0.010	-0.0002	0.003
ISO	0.034	-0.077	-0.172	-0.016	-0.049	0.024	0.003
JUICE	-0.001	**0.025**	0.001	**0.016**	-0.028	0.007	-0.003
MILK	-0.003	0.006	**-0.024**	**0.010**	0.009	0.008	0.002
TEA	**-0.013**	**-0.036**	-0.011	-0.009	-0.006	**-0.040**	**0.011**

(Note: elasticity values expressed in bold font are significant at 10% level)

[1] Minimum of AIC or SIC is preferred in selecting the best model.
[2] BW=Bottled Water, COF=Coffee, CSD=Carbonated Soft Drinks, ISO=Isotonics, JUICE=Juice, MILK=Milk, TEA=Tea

According to Table 1, own-advertising elasticity with respect to coffee, carbonated soft drinks and tea are significant at 10% level. They all have the expected positive sign, indicating increase in demand with increase in advertising expenditure. One percent increase in advertising expenditure of coffee, carbonated soft drinks and Tea would increase the demand by 5%, 3% and 1% respectively. Coffee is found to be the most advertising responsive non-alcoholic beverage while tea the least. In terms of cross-advertising effects, Table 1 shows mixed results. One percent increase in bottled water advertising expenditure would increase the demand for juice by eight percent while it decreases demand for coffee by four percent. The former effect is considered a positive spillover effect and the latter is considered a negative spillover effect. Advertisement on coffee has a positive spillover effect for isotonics. In particular, one percent increase in advertising expenditure on coffee would increase the demand for isotonics by three percent. However, increase in advertisement on carbonated soft drinks (by one percent) would decrease the demand for isotonics (by three percent), indicating a negative spillover effect.

One percent increase in advertising expenditure on juice would increase the demand for coffee and isotonics by three and two percent respectively. In other words, advertisement on juice would have a positive spillover effects both on coffee and isotonics. On the other hand, one percent increase in advertising expenditure on milk would increase the demand for isotonics (positive spillover effect) by one percent and decrease the demand for carbonated soft drinks by three percent (negative spillover effects). Increase in advertising expenditure on tea would decrease the demand for bottled water, coffee and milk (all negative spillover effects). In particular, one percent increase in tea advertising expenditure would decrease the demand for bottled water, coffee and milk by two, four and four percent respectively.

Polynomial Distributed Lag Advertising Effects

Table 2 shows the advertising expenditure elasticities generated taking polynomial distributed lag (long-run) advertising effects on demand for non-alcoholic beverages.

Table 2: Advertising Expenditure Elasticities for Selected Non-alcoholic Beverages: Polynomial Distributed Lag (Long-Run) Advertising Effects (January 1998 - December 2003)[3]

	BW	COF	CSD	ISO	JUICE	MILK	TEA
BW	**0.027**	-0.021	0.035	**-0.060**	**0.218**	**-0.072**	-0.019
COF	-0.005	**0.044**	0.037	**0.032**	0.003	-0.031	-0.010
CSD	0.003	-0.012	0.015	**-0.023**	0.014	0.014	0.0004
ISO	-0.048	-0.029	**0.565**	**0.220**	-0.288	0.117	0.040
JUICE	0.012	0.032	0.012	**-0.039**	-0.051	**-0.059**	-0.0003
MILK	-0.001	0.011	**-0.029**	**0.009**	0.005	0.016	0.0005
TEA	**-0.016**	**-0.054**	**-0.087**	-0.010	-0.039	**-0.047**	**0.013**

(Note: elasticity values expressed in bold font are significant at 10% level)

According to Table 2, the own-advertising effects (elasticities) with respect to bottled water, coffee, isotonics, and tea are positive as expected. This result is indicative of increase in demand for bottled water, coffee, isotonics and tea due an increase in advertising expenditure. In particular, one percent increase in demand of advertising expenditure of bottled water, coffee, isotonics and tea would increase the demand by three, four, two and once percent respectively.

Increase in advertising expenditure for bottled water (by one percent) would invoke a positive spillover effect on juice (increase the demand for juice by 22 percent) while it would have a negative spillover effect on isotonics and milk. Demand for isotonics and milk would go down by six and seven percent respectively as a result of one percent increase in bottled water advertising. Increase in coffee advertising would have a positive spillover effect on

[3] BW=Bottled Water, COF=Coffee, CSD=Carbonated Soft Drinks, ISO=Isotonics, JUICE=Juice, MILK=Milk, TEA=Tea

isotonics. In particular, one percent increase in advertising expenditure for coffee would increase the demand for isotonics by three percent.

Increase in advertising expenditure for carbonated soft drinks (by one percent) would decrease the demand for isotonics (by two percent) indicating a negative spillover effect. Juice advertising would decrease the demand for both isotonics and milk. This is indicative of a negative spillover effect. Furthermore, one percent increase in juice advertising expenditure would decrease the demand for isotonics and milk by four and six percent respectively. On the other hand, increase in advertising on milk would have a negative and a positive spillover effect on carbonated soft drinks and isotonics respectively. In particular, one percent increase in milk advertising would decrease the demand for carbonated soft drinks by three percent and increase the demand for isotonics by 0.9 percent.

Increase in advertising expenditure on tea would have negative spillover effects on bottled water, coffee, carbonated soft drinks and milk. In percentage terms, one percent increase in advertising expenditure on tea would decrease the demand for bottled water, coffee, carbonated soft drinks and milk by two, five, nine and five percent respectively.

Model Selection

Following Table 3 shows the model selection criteria used to identify the best model associated with the effect of advertising on demand for selected non-alcoholic beverages. The model with smallest AIC and/or SIC is picked up to estimate the effect of advertising on demand for selected non-alcoholic beverages.

Table 3: Model Selection Criteria: Contemporaneous Advertising Effect versus Polynomial Distributed Lags Advertising Effect for Demand for Selected Non-alcoholic Beverages: January 1998-December 2003

	Contemporaneous Effect		Polynomial Distributed Lag Effect	
Beverage	**AIC**	**SIC**	**AIC**	**SIC**
BW	-8.416	-7.778	**-8.472**	**-7.852**
COF	-8.017	-7.342	**-8.021**	-7.341
CSD	**-6.754**	**-6.079**	-6.572	-5.892
ISO	-9.864	-9.226	**-10.175**	**-9.523**
JUICE	-7.543	-6.906	**-7.661**	**-7.008**
MILK	**-8.480**	**-7.843**	-8.463	-7.827
TEA	**-9.430**	**-8.829**	-9.394	-8.788

(Note: AIC and SIC values that are in bold font are the minimum of AIC/SIC associated with every contemporaneous and/or polynomial distributed lags model used to ascertain impact of advertising on the demand for non-alcoholic beverages).

According to Table 3, model with polynomial distributed lag advertising effects outperform the contemporaneous advertising effects model for bottled water, coffee, isotonics and juice.

Conclusions and Implications

Positive own-advertising effects for both contemporaneous advertising and polynomial distributed lag advertising effects models reveled the benefits of advertising on non-alcoholic beverages. However, as far as the cross-advertising elasticities are concerned, while positive spillover effects are beneficial in increasing demand for product B, when product A is advertised, negative spillover effects are detrimental. Therefore, advertisers/promoters of non-alcoholic beverages must pay attention to possible positive spillover effects and more importantly, negative spillover effects.

Also, the dynamic model represented by polynomial distributed lags in the advertising variable outperformed the static model for a majority of non-alcoholic beverages. Therefore, use of a dynamic model to represent the effects of advertising is a better choice over a static model.

A limitation of our study is that we can only capture the at-home consumption of non-alcoholic beverages. The Nielsen HomeScan Panels pertain to at-home consumption only. But these data do allow a different way of capturing patterns of non-alcoholic beverage consumption through time. In this way, more refined categories of non-alcoholic beverages can be considered without the econometric issues associated with micro-level data.

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