Journal of Agribusiness 35, 1 (Spring 2017)

U.S. Non-alcoholic Beverage Demand: Evidence from AIDS Model with Dynamic Effect

GwanSeon Kim and Yuqing Zheng

This study estimates the degree of habit formation and demand for the U.S. non-alcoholic beverage market by incorporating a dynamic effect in five different beverages. This study employs a linear-approximate almost ideal demand system (LA-AIDS) to model demand for five non-alcoholic beverages from 1974 through 2014. The results show that current consumption of all non-alcohol beverages is positively related to previous consumption by controlling price and expenditure. This study mainly finds that bottled water is the most habitual product of the non-alcoholic beverage group.

***Key words**:* Almost ideal demand system (AIDS), habit formation, non-alcoholic beverage

People are increasingly consuming non-alcoholic beverages. At the same time, non-alcoholic beverages are closely related to healthier lifestyles or choices because they are important sources of nutrients (Pokharel, 2016). According to Capps, et al. (2005), non-alcoholic beverages provide 10% of daily value for calories, 20% of the daily value for calcium, and 70% of daily value for vitamin C. In general, non-alcoholic beverages can be defined as drinks that contain less than 0.5% alcoholic content by volume, and those beverages include milk, soft-drinks such as soda pop, juices, bottled water, energy drinks, and coffee and tea. Based on Transparency Market Research (TMR, 2015), the value of the global non-alcoholic drinks market is reported at $1,435.2 billion, and the United States is one of the largest markets for non-alcoholic beverages in the world.

Several studies have been conducted previously to estimate demand for non-alcoholic beverages and to examine what factors affect demand for non-alcoholic beverages. Zheng and Kaiser (2008) investigate the impact of advertising on demand for non-alcoholic beverages in the United States by using an Almost Ideal Demand System (AIDS) model with annual time-series data for the United States for 1974 through 2005. They estimate five demand equations jointly for fluid milk, juice, soft drinks, bottled water, and coffee/tea to measure annual U.S. consumption of non-alcoholic beverages, also adding advertising expenditures as explanatory variables. From the five joint demand equations, they calculate own and cross advertising elasticities. They find that the demand for most

---

GwanSeon Kim is a Ph.D. student and Yuqing Zheng is an assistant professor, both in the Department of Agricultural Economics, University of Kentucky. This is Kentucky Experiment Station Manuscript Number: 17-04-028. We appreciate the anonymous reviewer's comments. Any remaining errors are the sole responsibility of the authors.

non-alcoholic beverages except juice and bottled water are positively affected by advertising. In addition, advertising for soft drink and coffee/tea have the strongest significant correlations for the beverage group. Okrent and MacEwan (2014) estimate a demand system for 10 different non-alcoholic beverages for 1999 through 2010. They find that decreasing demand for milk, regular carbonated soft drinks, and coffee and tea are largely explained by prices and advertising expenditures. Increasing demand for bottled water, on the other hand, is predominately explained by demographic compositions of the population. Pokharel (2016) estimates the demand for five non-alcoholic beverages in the United States by using a first difference version of the AIDS model. Pokharel (2016) finds non-diet beverages are normal goods with significant positive coefficients in demand estimations whereas caloric beverages and coffee/tea are necessary goods.

Based on many previous studies related to the AIDS model to estimate demand equations, a dynamic concept (or framework) has been used to account for habit formation in the AIDS model. A habit formation is generally explained as a repeated behavior pattern.[1] Especially Zhen et al. (2010) investigate habit formation by estimating demand for nine sugar-sweetened beverages plus milk. They find the presence of habit formations in all nine non-alcoholic beverages. Particularly, milk consumption is the most habit forming beverage whereas consumption of sports/energy drinks are the least compared to other non-alcoholic beverages. The degree of habit formation for bottled water and coffee/tea remains unknown.

This study estimates the degree of habit formation and demand for the U.S. non-alcoholic beverage market. Our study builds on the model used by Zheng and Kaiser (2008) but differs in two important ways. First, we incorporate a longer, more recent period of data by using nine additional years of data, from 2006 to 2014, to the original study. This is due to the fact that eating trends have changed recently with the introduction of organic drinks, energy drinks, and sports drinks. Therefore, consumers' preferences from alcoholic drinks to non-alcoholic beverages have changed, inspired by healthy eating trends (TMR, 2015). Second, we incorporate a dynamic effect by using a lagged budget share in five different beverages. We hypothesize that current consumption of non-alcoholic beverages is substantially affected by the consumption of the same beverage in the previous year.[2] Findings from this paper contribute not only to testing

[1] See Lluch (1974), Boyer (1983), Blanciforti and Green (1983), Zhen et al. (2010), and Zheng et al. (2016) for more information about habit formation.

[2] Inclusion of a dynamic effect by using a lagged budget share to capture habit formation is practically different from other recent studies that use habit formation. However, our estimation using a dynamic effect will provide information about habit formation when we control price and expenditure effects.

whether findings from the previous study are consistent with updated data, but also to supporting existing literature related to habit formation for non-alcoholic beverages in a demand system analysis.

Empirical Model

This study employs a linear-approximate AIDS (LA-AIDS), which was initially developed by Deaton and Muellbauer (1980), to model demand for five non-alcoholic beverages. The AIDS model provides not only an arbitrary first-order approximation for any demand system, but also the simplicity of estimation (Zheng and Kaiser, 2008). The budget share for the *i*th good is defined as follows:

$$(1) \quad w_{it} = a_i + b_i \ln(Y_t/P_t) + \sum_{j=1}^{5} c_{ij} \ln p_{jt} + \sum_{j=1}^{5} d_{ij} \ln A_{jt} + e_i \ln Age5_t + f_i \ln Fafh_t + g_i w_{it-1} + \varepsilon_{it}$$

where subscription *i* (=1, 2, 3, 4, and 5) represents five different categories of non-alcoholic beverages: fluid milk, juice, soft drinks, bottled water, and coffee/tea, respectively; *t* is time; Y_t is the nominal group expenditures defined by $Y_t = \sum_{i=1}^{5} p_{it} q_{jt}$; P_t represents Stone's geometric price index defined by $\ln P_t = \sum_{i=1}^{5} w_{it} lnp_{it}$; p_{jt}, q_{jt}, and A_{jt} are nominal price, per capita consumption, and real advertising expenditures for item *j* item in year *t*; $Age5_t$ is the population less than five years of age in year *t*; $Fath_t$ is food-away-from-home expenditures as a proportion of food expenditures in year *t*; and w_{it-1} is the budget share of item *i* in the previous year. Zheng and Kaiser (2008) include the variables of $Age5_t$ and $Fath_t$ to maintain the singularity of the demand system and to capture the impact of eating habits on non-alcoholic beverage consumption.[3] However, they did not account for a lagged budget share variable as one of the independent variables. As we discussed before, one of our innovations is to include the lagged dependent variable, which is the budget share.

[3] Other previous studies include demographic characteristics in the demand system equation for non-alcoholic beverages. For example, Yen et al. (2004) include the number of children, race, and residence in rural areas. Okrent and MacEwan (2014) include average household size, age, level of education, percentage of married people, white non-Hispanic size, and whether subjects earn below the poverty line.

Data

We use annual time-series data for the United States for 1974 through 2014 due to the fact that the less aggregated data, such as state-level panel data or quarterly data, were not previously available (Zheng and Kaiser, 2008). The data set for 1974 through 2005 is obtained directly from Zheng and Kaiser (2008). The price and quantity data for five different non-alcoholic beverages are obtained from the *CPI Detailed Report* from the U.S. Bureau of Labor Statistics and the *Food Availability (Per Capita) Data System* from the Economic Research Service (ERS) at the U.S. Department of Agriculture, except bottled water. Price and per capita consumption of bottled water are obtained from Beverage Marketing Corporation. Particularly, carbonated soft drinks and fruit juices are used in this study as an original data set. Since ERS has removed per capita consumptions for carbonated soft drinks and coffee, data from 2003 are no longer available in ERS. Therefore, we update and obtain data from *Euromonitor International from Trade Sources* for carbonated soft drinks and the International Coffee Organization for coffee. Figure 1 shows how per capita consumption for all five non-alcoholic beverages is changing over time, from 1970 to 2014. Based on Figure 1, percentage changes of per capita consumption for fluid milk, juice, soft drinks, bottled water, and coffee/tea between 2005 and 2014 are -9.84, -23.93, -19.65, 33.71, and 6.42, respectively. It also indicates that a market structure for the U.S non-alcoholic beverages has changed in the most recent decade.

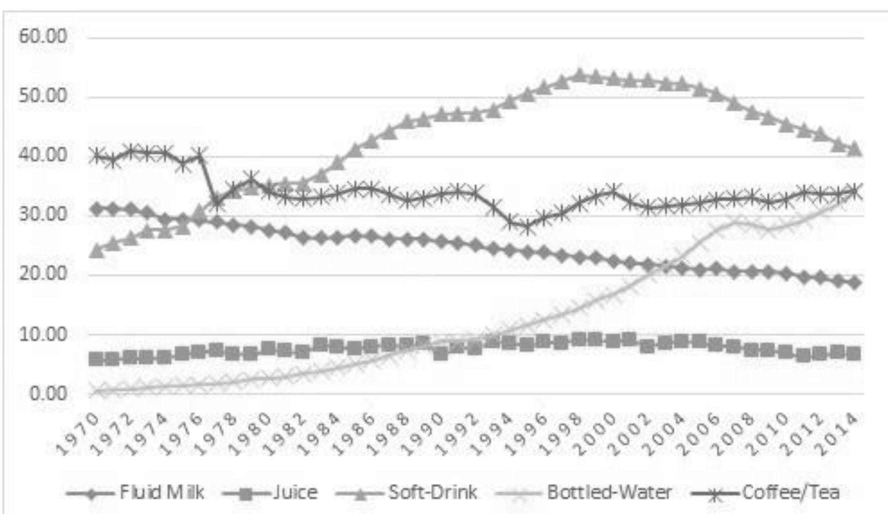

Figure 1. Per Capita Consumption for Five Non-alcoholic Beverages, 1970-2014.

The advertising data are obtained from private sources, chiefly *AD $ Summary* published by Leading National Advertisers, Inc., and then produced by Kantar Media since 2009. In detail, advertising for milk, juice, and the other three beverages are generic, generic and brand, and brand advertising, respectively. Data for demographic variables of Age5$_t$ and $Fath_t$ are updated and obtained from ERS. Table 1 shows descriptive statistics for this data.

Table 1. Variable Definitions and Summary Statistics, 1974-2014.

Variable	Definition	Mean	Min.	Max/	S.D.
q1	Per capita fluid milk consumption, gallons/person	24.19	18.91	29.50	3.17
q2	Per capita juice consumption, gallons/person	7.74	6.15	9.10	0.85
q3	Per capita soft-drink consumption, gallons/person	44.35	27.60	53.80	7.56
q4	Per capita bottled-water consumption, gallons/person	13.86	1.26	34.00	10.53
q5	Per capita coffee/tea consumption, gallons/person	33.35	28.16	40.62	2.41
p1	Nominal retail price for fluid milk, $/gallon	2.45	1.23	3.80	0.77
p2	Nominal retail price for juice, $/gallon	4.17	1.50	6.16	1.40
p3	Nominal retail price for soft drinks, $/gallon	1.83	0.83	2.57	0.45
p4	Nominal retail price for bottled water, $/gallon	1.10	0.70	1.36	0.18
p5	Nominal retail price for coffee/tea, $/gallon	0.94	0.33	1.47	0.26
A1	Advertising expenditures for fluid milk, million $	72.28	9.77	160.57	49.57
A2	Advertising expenditures for juice, million $	265.41	31.33	730.42	137.74
A3	Advertising expenditures for soft drinks, million $	449.96	97.00	807.77	187.41
A4	Advertising expenditures for bottled water, million $	54.94	6.97	200.79	56.16
A5	Advertising expenditures for coffee/tea, million $	219.51	73.86	340.45	57.65
w1	Budget share for fluid milk, conditional	0.27	0.21	0.44	0.05
w2	Budget share for juice, conditional	0.15	0.11	0.17	0.02
w3	Budget share for soft drinks, conditional	0.37	0.28	0.42	0.03
w4	Budget share for bottled water, conditional	0.06	0.01	0.13	0.04
w5	Budget share for coffee/tea, conditional	0.15	0.11	0.23	0.03
Fafh (%)	Food-away-from-home expenditures/total food expenditures	44.67	34.10	50.12	4.34
Age5 (%)	Proportion of the U.S. population younger than age five	7.10	6.21	7.71	0.40
Lag w1	Lagged Budget share for juice, conditional	0.27	0.21	0.44	0.05
Lag w2	Lagged Budget share for juice, conditional	0.15	0.11	0.17	0.02
Lag w3	Lagged Budget share for soft drinks, conditional	0.37	0.28	0.42	0.03
Lag w4	Lagged Budget share for bottled water, conditional	0.06	0.01	0.13	0.04
Lag w5	Lagged Budget share for coffee/tea, conditional	0.15	0.11	0.23	0.03

Note: Fath (%) is calculated as food-away-from-home expenditure divided by total food expenditure.

Estimation and Parameter Estimates

We estimate the LA-AIDS model with an autoregressive (AR) 1 process model by using the PROC MODEL procedure in SAS 9.4. In this study, we assume the presence of autocorrelation due to the fact that the demand system in modeling consumer behavior is more feasible by allowing autocorrelation (Blanciforti and Green, 1983).[4] The autoregressive (AR) 1 process is defined as follows:

(2) $$\varepsilon_{it} = \rho_{i1}\varepsilon_{i,t-1} + u_{it}$$

where ρ_{i1} is the first-order autoregressive parameters and u_{it} is a white-noise disturbance. This paper employs the full information maximum-likelihood method (FIML) to fit the model compared to the iterative seemingly unrelated regression (ITSUR). There are three main reasons to use FIML. First, the ITSUR is not maximum likelihood under the presence of the autocorrelation. Second, the equations share a common autoregressive parameter given a limited degree of freedom. Finally, the multivariate normality assumption is satisfied (Seale et al., 2003; Zheng and Kaiser, 2008).

To estimate five demand equations, we estimate four of them by dropping one equation due to $\sum_{i=1}^{5} w_i = 1$ based on adding-up conditions. Therefore, we drop a juice equation so that the parameters of the juice equation is calculated by adding up restrictions as follows:

(3) $$\sum_{i=1}^{5} b_i = \sum_{i=1}^{5} c_{ij} = \sum_{i=1}^{5} d_{ij} = \sum_{i=1}^{5} e_i = \sum_{i=1}^{5} f_i = 0 \text{ and } \sum_{i=1}^{5} a_i = 1$$

In addition, we impose two more restrictions which are $\sum_{i=1}^{5} c_{ij} = 0$ (called Homogeneity) and $c_{ij} = c_{ji}$ (called Symmetry). Okrent and MacEwan (2014) mention that inclusion of homogeneity and symmetry restrictions allow the LA-AIDS model to conform to demand theory. Therefore, we estimate the LA-AIDS model with AR (1) by imposing homogeneity and symmetry restrictions. Table 2 shows FIML parameter estimates of conditional demand equations for U.S. non-alcoholic beverages.

According to the estimated conditional equations in Table 2, all of the estimated own price coefficients are statistically significant even though estimated cross-price coefficients are statistically significant in only six out of 10. Only seven advertising

[4] The original paper by Zheng and Kaiser (2008) tests the autocorrelation by using Godfrey's serial autocorrelation test and finds the presence of autocorrelation.

coefficients are significant out of 25 total. For the variable of the proportion of food away from home expenditure, is statistically significant in the consumption of soft drinks, bottled water, and coffee/tea even though estimated signs are not the same for all the significant beverages. For instance, the consumption of the soft drinks is positively related to the proportion of food away from home expenditure, whereas consumption of bottled water and coffee/tea are negatively related. These findings indicate people prefer to consume less bottled water and coffee/tea as away from home expenses. The variable for the proportion of the U.S. population younger than age five is significant in all beverages except juice. This variable is positively related to soft drinks and bottled water, whereas it is negatively related to milk and coffee/tea. Finally, we include the lagged dependent variable and we find that current consumption of all non-alcoholic beverages is statistically and positively related to previous consumption.

Table 2. FIML Parameter Estimates of Conditional Demand Equations for U.S. Non-alcoholic Beverages, 1974-2014.

	Price Coefficients					Advertising Coefficients				
Equations	c_{i1}	c_{i2}	c_{i3}	c_{i4}	c_{i5}	d_{i1}	d_{i2}	d_{i3}	d_{i4}	d_{i5}
Milk	0.159**					0.001	0.002	-0.015**	-0.001	0.016**
	(0.013)					(0.003)	(0.005)	(0.006)	(0.003)	(0.005)
Juice	-0.032**	0.037*				0.001	0.001	0.010	-0.015	-0.018
	(0.018)	(0.034)				(0.005)	(0.007)	(0.011)	(0.004)	(0.007)
Soft drinks	-0.093**	0.031	0.102**			0.007**	0.002	0.009	0.003	-0.0003
	(0.013)	(0.021)	(0.021)			(0.003)	(0.006)	(0.007)	(0.003)	(0.005)
Bottled water	0.003**	-0.003	-0.013	0.019**		-0.002	-0.006**	0.008**	-0.0004	-0.001
	(0.006)	(0.009)	(0.008)	(0.007)		(0.001)	(0.002)	(0.003)	(0.001)	(0.002)
Coffee/tea	-0.037**	-0.033**	-0.026**	-0.006	0.101**	-0.007**	0.001	-0.012*	-0.001	0.006
	(0.008)	(0.013)	(0.009)	(0.004)	(0.009)	(0.003)	(0.005)	(0.006)	(0.003)	(0.004)

	Intercept	Expend.	*Age5*	*Fafh*	*Lag* w_i	*Adj.* R^2
Equations	a_i	b_i	e_i	f_i	g_i	
Milk	1.795**	-0.144**	-0.254**	0.017	0.161**	0.99
	(0.236)	(0.053)	(0.052)	(0.032)	(0.059)	
Juice	0.394	-0.002	0.195	0.007	0.161**	0.73
	(0.202)	(0.076)	(0.071)	(0.044)	(0.086)	
Soft drinks	-1.166**	-0.001	0.217**	0.128**	0.299**	0.96
	(0.220)	(0.061)	(0.056)	(0.034)	(0.074)	
Bottled water	-0.510**	-0.112	0.065**	-0.064**	0.904**	0.99
	(0.206)	(0.061)	(0.023)	(0.015)	(0.058)	
Coffee/tea	0.487**	0.259**	-0.223**	-0.088**	0.101**	0.96
	(0.196)	(0.061)	(0.044)	(0.033)	(0.041)	

*Notes: **, * represents estimates that are significant at the 5% level or less and 10% level, respectively.*
Standard errors are in parenthesis.

Elasticities

We calculate the expenditure, own-price, cross-price, and advertising elasticities by given estimated coefficients in Table 2. The following elasticity equations are based on Zheng and Kaiser (2008) and derived from their literature.

(4) $E_i = 1 + b_i/w_i$
(Expenditure elasticity)

(5) $E_{ii}^C = -1 + c_{ij}/w_i + w_i$
(Compensated own-price elasticity)

(6) $E_{ii}^C = c_{ij}/w_i + w_j$
(Compensated cross-price elasticity)

(7) $E_{ii}^U = -1 + c_{ii}/w_i - b_i$
(Uncompensated own-price elasticity)

(8) $\alpha_{ij} = d_{ij}/w_i$
(Advertising elasticity)

All elasticities are calculated by using the budget share for non-alcoholic beverages in 2014. Zheng and Kaiser (2008) mention that these are due to the fact that two parameters are involved in uncompensated own-price elasticities.[5] The calculated elasticities are reported in Table 3.

Based on Table 3, we find all of the compensated and uncompensated own-price elasticities are not only negative in that the demand function is an inverse relationship between price and quantity, but also less than 1 (i.e., inelastic demand). A general interpretation for the own price elasticity is that the percentage change in the quantity demanded is affected by a percentage change in price. For example, demand for milk decreases by 0.081% for compensated price elasticities, whereas 0.168% is seen for uncompensated price elasticities for each 1% increase in the milk price when holding other factors constant.

[5] They calculated elasticities based on the conditional budget share for non-alcoholic beverages in 2005.

Table 3. Elasticities.

	Compensated Price Elasticities					Expenditure Elasticities	Uncompensated Price Elasticities
Quantity of	E^C_{i1}	E^C_{i2}	E^C_{i3}	E^C_{i4}	E^C_{i5}	E_i	E^U_{ii}
Milk	-0.081**	-0.005**	-0.055**	0.148**	-0.007**	0.377**	-0.168**
Juice	-0.009**	-0.589*	0.580	0.112	-0.094**	0.985	-0.720**
Soft drinks	-0.037**	0.223	-0.359**	0.098	0.079**	0.997	-0.705**
Bottled water	0.253**	0.111	0.251	-0.724**	0.109	0.170	-0.747**
Coffee/tea	-0.010**	-0.082**	0.178**	0.096	-0.188**	2.688**	-0.601**

	Advertising Elasticities				
cont'd.	α_{i1}	α_{i2}	α_{i3}	α_{i4}	α_{i5}
Milk	0.004	0.009	-0.065**	-0.004	0.069**
Juice	0.008	0.008	0.075	-0.113	-0.135
Soft drinks	0.020**	0.006	0.026	0.009	-0.001
Bottled water	-0.015	-0.044**	0.059**	-0.003	-0.007
Coffee/tea	-0.046**	0.007	-0.078*	-0.007	0.039

*Notes: **, * represents estimates that are significant at the 5% level or less and 10% level, respectively.*
Standard errors are in parenthesis.

The cross-price elasticities generally represent whether the beverage *i* is a substitute or complement for beverage *j*. For example, E^C_{12} is cross-price elasticity for milk with respect to juice, and E^C_{12} = -0.005 indicates that demand for milk decreases by 0.005% for each 1% increase in juice prices. In addition, milk and juice are complements since the cross-price elasticity is negative. From the cross-price elasticities in Table 3, we find that not only milk and bottled water, but also soft drinks and coffee/tea are substitutes for each other, whereas other beverages are mostly complements to each other.

For the expenditure elasticities, we find that demand for milk and coffee/tea increases by 0.377% and 2.688%, respectively, for 1% increases in non-alcoholic beverage expenditures by holding other factors constant. Especially for coffee/tea, we cannot conclude that they are luxury goods due to the fact that the elasticities between conditional and unconditional expenditures are not equivalent (Zheng and Kaiser, 2008). For the advertising elasticities, we find none of the non-alcoholic beverages are a statistically significant own-advertising effect. However, seven of 20 cases show statistically significant spillover effects. Based on Table 3, milk and soft drinks advertising have a most significant impact within the group. For example, the demands for milk and coffee/tea decrease by 0.065 and 0.078, respectively, for 1% increases in soft drink advertising, whereas demand for bottled water increases by 0.059%.

So far, the group beverage expenditure has been treated as exogenous. One might wonder how our key results will change if this assumption is relaxed. Therefore, we re-estimated the system by using income as an instrumental variable (IV) for the expenditure.[6] We find that all the estimated signs and coefficients of elasticities are robust with the main result shown in Table 3, except cross-price elasticities between soft drinks and bottled water and advertising elasticity of bottled water. Those elasticities are not statistically significant in Table 3. Re-estimated elasticities by using the instrument variable of income for the expenditure is reported in Appendix A.

Comparison with Zheng and Kaiser's Study

We compare our results of compensated and uncompensated own-price, own-advertising, and expenditure elasticities with the results of Zheng and Kaiser's 2008 study. The comparisons are reported in Table 4.

Table 4. Comparison of Price, Advertising, and Expenditure Elasticities with Zheng and Kaiser (2008).

				Own Elasticities			
	Model	Data	Products	Compensated Price	Uncompensated Price	Advertising	Expenditure Elasticities
This Study	AIDS model	Annual time series	Milk	-0.081**	-0.168**	0.004	0.377**
		for 1974-2014	Juice	-0.589*	-0.720*	0.008	0.985
			Soft Drinks	-0.359**	-0.705**	0.026	0.997
			Bottled water	-0.724**	-0.747**	-0.003	0.170
			Coffee/tea	-0.188**	-0.601**	0.039	2.688**
Zheng and Kaiser	AIDS model	Annual time series	Milk	-0.154**	-0.301**	0.024**	0.614**
(2008)		for 1974-2005	Juice	-0.172**	-0.272	-0.013	0.656
			Soft Drinks	-0.151**	-0.521**	0.060**	0.997
			Bottled water	-0.498**	-0.501**	0.040	0.029
			Coffee/tea	-0.083**	-0.462**	0.138**	3.144**

*Notes: **, * represents estimates that are significant at the 5% level or less and 10% level, respectively. Standard errors are in parenthesis.*

By extending nine more years and including the habit formation (lagged dependent) variable from the original paper, we find that all the compensated and uncompensated own-price elasticities are robust and consistent based on estimated signs with the original paper. However, the juice demand equation in this study is statistically significant at 10%, whereas it is statistically significant at 5% in the original paper. In addition, absolute values of compensated and uncompensated elasticities in this paper are higher than found in the original paper, except for milk, likely because more substitute products emerged in the last decade. For the advertising own, elasticities are not robust since the 2008 study found that own advertising elasticities are statistically significant in milk, soft

[6] The annual income data from 1974 to 2014 is obtained from the U.S. Census Bureau.

drinks, and coffee/tea. This current study finds none of the advertising own elasticities are statistically significant. Finally, the expenditure elasticities are robust and consistent with the original paper even though those found in this current study are less elastic than the 2008 paper.

Conclusion

Since many people are aware of their health and seek healthier foods, consumer eating and drinking trends have changed over time.[7] For example, organic food consumption has been increasing over time, whereas conventional food consumption has been decreasing (Nemati and Saghaian, 2016; Kim et al., 2017). Especially for the non-alcoholic beverages category, consumers' preferences and market structures have changed and are closely related to better choices for sources of nutrients. This study extends the original work of Zheng and Kaiser (2008) by incorporating nine more years of data and incorporating a dynamic effect by introducing a lagged budget share in each equation. By adding these nine years, we investigate whether or not demands for non-alcoholic beverages in the original study are consistent with updated data sets. By including a lagged budget share, we investigate a presence of habit formation that current consumption of non-alcoholic beverage i is significantly affected by the same beverage in the previous year.

We find that current consumption of all non-alcoholic beverages are statistically and positively related with previous consumption by controlling price and expenditure. For instance, a 1% increase in the previous year consumption of milk, juice, soft drinks, bottled water, and coffee/tea results in a 0.161%, 0.161%, 0.299%, 0.904%, and 0.101% increase in the current year consumption, respectively. This finding indicates that habit formation exists. All of the compensated and uncompensated own-price elasticities are negative and inelastic. Based on cross-price elasticities, we find that most of the beverages are complements to each other, whereas milk and bottled water are substitutes for each other, as well as soft drinks are substitutes for coffee/tea. For the advertising elasticities, we find none of the non-alcoholic beverages are significantly affected by their own-advertising effects. For instance, an advertisement for a juice beverage does not induce people to consume more juice beverages. Note that the advertising data are mainly TV, radio, and magazine advertising and, therefore, do not include advertising

[7] See more information on non-alcoholic beverage trends at http://www.marketwired.com/press-release/top-five-non-alcoholic-drinks-trends-in-north-and-south-american-countries-1860630.htm.

expenditures on platforms such as social media. The demands for milk and coffee/tea are negatively affected by soft drink advertising, whereas demand for bottled water is positively affected. Milk advertising has a positive impact on demand for soft drinks but a negative impact on coffee/tea. Demand for bottled water is negatively affected by juice advertising. Finally, coffee/tea advertising has a negative impact on demand for milk. Compared to Zheng and Kaiser (2008), all the compensated and uncompensated own-price elasticities are robust and consistent. We find none of the own-advertising elasticities are statistically significant despite the original study finding that own-advertising elasticities were statistically significant in milk, soft drinks, and coffee/tea. The expenditure elasticities in this current study are robust and consistent with the original paper. Finally, we find that bottled water is the most habitual product in the non-alcoholic beverage group, while the least habitual products are coffee/tea, milk, and juice.

One limitation of the study is the treatment of advertising expenditures. Zheng and Kaiser (2008) used a media cost index in order to deflate the advertising expenditures. However, the advertising expenditures are deflated by the consumer price index in this study in that the data for the media cost index are no longer available. This fact may cause slightly different results compared to the original paper. For a future study, the first different AIDS (called FD-AIDS) model could be considered because it provides better estimates than the level AIDS model (Bryant and Davis, 2008; Pokharel, 2016). Furthermore, recent studies such as Zhen et al. (2010), Okrent and MacEwan (2014), Li and Lopez (2015), and Zheng et al. (2016) estimate a demand system equation by using Nielson data. The Neilson data are rich sets, and they allow researchers to use household-level panel data. In addition, the Nielsen data provide product characteristics; location and time of each purchase; and household demographics such as average household size, age and level of education, the percentage of married people; race; and poverty thresholds. Therefore, our estimates based on a U.S. time series likely would be less elastic than the elasticities reported from studies using the Nielsen data. Finally, Lin et al. (2010) state that consumption of sugar-sweetened beverages (SSBs) have significantly increased over time, and the causes of obesity are positively associated with SSB consumption. Therefore, this study could be expanded to estimate the impacts of changes in SSB advertising and consumption on obesity rates by incorporating health-related data such as from the National Health and Nutrition Examination Survey (NHANES) provided by Centers for Disease Control and Prevention (CDC).

References

Blanciforti, L., and R. Green. (1983.) "An almost ideal demand system incorporating habits: an analysis of expenditures on food and aggregate commodity groups." The Review of Economics and Statistics, 511-515.

Boyer, M. (1983.) "Rational demand and expenditures patterns under habit formation." Journal of Economic Theory, 31:27-53.

Bryant, H.L., and G.C. Davis. (2008.) "Revisiting Aggregate US Meat Demand with a Bayesian Averaging of Classical Estimates Approach: Do We Need a More General Theory?" American Journal of Agricultural Economics, 90:103-116.

Capps, O., A. Clauson, J.F. Guthrie, G. Pittman, and M. Stockton. (2005.) "Contributions of Nonalcoholic Beverages to the US Diet." USDA-ERS Economic Research Report.

Deaton, A., and J. Muellbauer. (1980.) "An almost ideal demand system." The American Economic Review, 70:312-326.

Kim, G., J. Seok, and M. Tyler. (2017.) “A Hierarchical Model for Organic Food Expenditures in the U.S.” Available at https://ssrn.com/abstract=2916250.

Li, X., and R.A. Lopez. (2015.) "Do Brand Advertising Spillovers Matter?" Agribusiness, 31:229-242.

Lin, B.-H., T.A. Smith, J.-Y. Lee, and K.D. Hall. (2011.) "Measuring weight outcomes for obesity intervention strategies: the case of a sugar-sweetened beverage tax." Economics & Human Biology, 9:329-341.

Lluch, C. (1974.) "Expenditure, savings and habit formation." International Economic Review, 786-797.

Nemati, M., and S.H. Saghaian. (2016.) "Dynamics of Price Adjustment in Qualitatively Differentiated Markets in the US: The Case of Organic and Conventional Apples." In 2016 Annual Meeting, February 6-9, 2016, San Antonio, Texas. Southern Agricultural Economics Association.

Okrent, A.M., and J.P. MacEwan. (2014.) "The Effects of Prices, Advertising, Expenditures, and Demographics on Demand for Nonalcoholic Beverages." Agricultural and Resource Economics Review, 43:31-52.

Pokharel, K.P. (2016.) "Demand Analysis for Non-Alcoholic Beverages Consumptin in the United States." International Journal of Social Sciences and Management, 3:38-46.

Seale, J.L., M.A. Marchant, and A. Basso. (2003.) "Imports versus domestic production: A demand system analysis of the US red wine market." Review of Agricultural Economics, 25:187-202.

Transparency Market Research. (2015.) "Non-Alcoholic Drinks Market - Global Industry Analysis, Size, Share, Growth, Trends, and Forecase, 2014-2020." Available at http://www.transparencymarketresearch.com/pressrelease/non-alcoholic-drinks-industry.htm.

Yen, S.T., B.-H. Lin, D.M. Smallwood, and M. Andrews. (2004.) "Demand for nonalcoholic beverages: The case of low-income households." Agribusiness, 20:309-321.

Zhen, C., M.K. Wohlgenant, S. Karns, and P. Kaufman. (2010.) "Habit formation and demand for sugar-sweetened beverages." American Journal of Agricultural Economics.

Zheng, Y., and H.M. Kaiser. (2008.) "Advertising and US nonalcoholic beverage demand." Agricultural and Resource Economics Review, 37:147-159.

Zheng, Y., C. Zhen, J. Nonnemaker, and D. Dench. (2016.) "Advertising, Habit Formation, and US Tobacco Product Demand." American Journal of Agricultural Economics.

Appendix A. Elasticities with IV (Income) Variable.

	Compensated Price Elasticities					Expenditure Elasticities	Uncompensated Price Elasticities
Quantity of	E^C_{i1}	E^C_{i2}	E^C_{i3}	E^C_{i4}	E^C_{i5}	E_i	E^U_{ii}
Milk	-0.078**	-0.005**	-0.021**	0.126**	-0.028**	0.067**	-0.093**
Juice	-0.009**	-0.582*	0.557	0.105	-0.072**	0.316	-0.624**
Soft drinks	-0.014**	0.214	-0.356**	0.074**	0.081**	0.992	-0.701**
Bottled water	0.216**	0.104	0.192	-0.643**	0.131	1.211	-0.806**
Coffee/Tea	-0.043**	-0.062**	0.184**	0.115	-0.195**	2.830**	-0.629**

	Advertising Elasticities				
cont'd.	α_{i1}	α_{i2}	α_{i3}	α_{i4}	α_{i5}
Milk	0.003	0.003	-0.062**	-0.009	0.056**
Juice	0.008	0.015	0.068	-0.013	-0.120
Soft drinks	0.017**	0.006	0.029	0.009	-0.006
Bottled water	-0.015*	-0.044**	0.052**	-0.007	-0.003
Coffee/Tea	-0.039**	0.005	-0.078*	-0.002	0.033

*Notes: **, * represents estimates that are significant at the 5% level or less and 10% level, respectively.*
Standard errors are in parenthesis.