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Abstract

Advertising is a marketing tool used to a significant degree by the Ontario Milk Marketing Board. In this research the effectiveness of the advertising campaign is evaluated using a time-series demand system model of the cold non-alcoholic beverage market in Ontario.

The results of the analysis suggest that increasing advertising expenditure on fluid milk would increase fluid milk revenue net of advertising costs to the dairy industry. Fluid milk demand is little affected by advertising of other goods in the market but does affect the demand for other beverages.

THE OMMB'S FLUID MILK ADVERTISING

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Advertising fluid milk for the purpose of increasing sales and demand for fluid milk in Ontario has been one of the main tools in the Ontario Milk Marketing Board's (OMMB) market expansion program.

Sales of fluid milk in Ontario increased slowly in the early 1970s, and this was often attributed to advertising as price was virtually constant in real terms. But in the late 1970s and early 1980s fluid milk sales fell in Ontario, at the same time advertising expenditures on fluid milk soared to over 4 million dollars, from about a quarter million dollars in the early 1970s.

Most of the advertising was aimed at capturing an increased share of the market for cold non-alcoholic beverages. It was hoped that young adults and teenagers, supposedly consuming more of the other beverages than fluid milk, would be influenced by advertising into consuming fluid milk. This was probably based on the fact that while sales for fluid milk were declining total sales for the market were increasing and the share of fluid milk was decreasing.

Realizing that marketers of other products had increased their advertising expenditure, the OMMB also increased its level of advertising in the 1980s.

The effectiveness of any marketing strategy, such as advertising, should be evaluated ex post before decisions about future resource allocation are made. The difficulty lies in the determination of the appropriate scope and method for measuring effectiveness. In this research an econometric time-series approach to measuring advertising effectiveness within the context of the market for cold non-alcoholic beverages is reported. The objectives of the research are to determine the consumption response of fluid milk, to fluid milk advertising while taking into account responses to price, prices and advertising of other related goods and income.

Previous Research

With the significant increase in the use of generic advertising as a marketing tool, there has also been an increase in the literature on evaluating the effectiveness of advertising. One major stream of this literature has been concerned with the introduction of advertising into the estimation of demand functions for a variety of commodities (Kinnucan 1983, Thompson and Eiler, 1977). Per capita consumption of the advertised commodity is estimated as a function of price, income, prices of substitutes and complements. Very little attention has been paid in the literature to the impact of advertising one commodity on the consumption of other commodities.

A number of studies have specified a model in the following form:

$$Q_i = f(P_i, Y, A_i)$$

where:

$i = 1, 2, 3, \ldots n,$

Q = quantity demanded,

P = price of the commodity and of substitutes and, or complements,

Y = disposable income, and

A = advertising variable for the commodity.

With the exception of a study by Amuah (1985), all previous studies reviewed used a single equation approach, even in multi-commodity models. The demand equation was specified directly and estimated using either the linear or log linear functional forms. Amuah used a demand system model derived from a flexible utility function.

In the demand for fluid milk, the factors that were found important included prices, income, advertising, demography and seasonal changes (Kinnucan, 1981, 1982; Kinnucan and Forker, 1982). Advertising by competing products was not considered in any of the studies for fluid milk, though it has been found to be an important factor in advertising butter and margarine (Amuah, 1985; Strak and Gill, 1983).

Kinnucan (1981, 1982) found population age a significant factor in the demand for fluid milk. Population age was defined as the average age of the population in the area covered in the study. Another demographic factor that was found to be important was the race of the consumer (Kinnucan and Forker, 1982). Race was defined as the percentage of the population that was non-white.

In most studies of fluid milk demand, seasonal changes were handled by dummy variables and harmonic variables (Kinnucan, 1981, 1982; and Kinnucan and Forker, 1982) or by deseasonalizing the data (Strak and Gill, 1983).

A number of previous studies (Clarke, 1976) reported that the impact of advertising on consumer demand was distributed over time. Researchers have approached the problem of lagged effects in advertising using a variety of methods, with distributed lag models the most common method. Lag structures of various sorts have been specified, depending on data periodicity, constraints imposed by estimation techniques and the subjective decision of the researcher.

Nerlove and Waugh (1961) modeled lagged effects by introducing a stock of goodwill variable, defined as a weighted average of past and current advertising expenditures. The stock of goodwill was taken as an approximation of the geometric lag model, and a number of recent studies followed this approach. While it is intuitively appealing and simple to estimate, it can not determine the exact duration of any lagged effects if any.

Others have used the direct lag approach (Palda, 1964; and Clarke and McCann, 1973), where lagged values of advertising are included as independent variables. The major problem with the direct lag approach lies in specifying the number of lags and the multicollinearity among the lagged advertising variables (Clarke, 1976).

Other models that have been used to measure lagged effects in advertising include the autoregressive current effect model where dynamic elements of advertising response are confined to the disturbances (Vanhonacker, 1984). Others have used the partial adjustment model (Weiss and Windal, 1980).

The best known lag structure associated with the sales-advertising relationship is the Koyck (1954) specification which assumes the largest response to take place in the initial period, then decline geometrically with time (Palda, 1964). However, this specification has been found to be consistent only with data with large periodicity, either annual or quarterly data (Bass and Clarke, 1972).

Lagged effects in advertising fluid milk were studied by Strak and Gill (1983) and Thompson and Eiler (1975; 1977). Their analysis made use of monthly data, and they found a polynomial distributed lag model to be the best in characterizing the sales-advertising relationship in fluid milk with the largest response occurring between the first three to five months after advertising.

In general, advertising increases consumer demand by either shifting the demand or increasing the elasticity of the demand curve. But as the literature suggests, neither is a guaranteed effect of advertising. Thus, one has to conduct empirical analyses to see if advertising increases the demand and/or demand elasticity. Given the lack of a priori knowledge on the price elasticity of demand for fluid milk, a model that does not a priori constrain the various elasticities (price, expenditure and advertising) can provide objective answers to advertising's effect on demand elasticities.

To account for the effects of advertising non milk products in the market for cold non-alcoholic beverages, a demand system approach is used in this study. Given the previous empirical evidence, a geometric model is used to characterize the structure of advertising lagged effects.

Model Specification

Traditional consumer theory assumes that consumers allocate a fixed income across all commodities which generate utility. The concept of weak separability allows for the disaggregation of this unwieldy problem into components made up of commodities for which the marginal rate of substitution is independent of quantities of other commodities consumed. Consumption of a particular group of commodities can then be determined in a two stage process. In the first stage the income allocated to a particular group of commodities is determined through the allocation of total income across utilities generated by a number of similarly aggregated groups of commodities (i.e., food, clothing, etc.). In the second stage the income allocated to the group of commodities is distributed across the individual commodities in the group. Both stages are determined by a simultaneous utility maximization procedure. Green (1971) has shown that the conditions necessary for a consistent two stage budgeting process (consistent in that quantities determined are the same through the two stage procedure as those that would have been determined in a single stage procedure) are a linear homogeneous utility function at the second stage, and an equivalence between the aggregate price index and the ratio of individual prices to individual marginal utilities.

The problem addressed in this research is the determination of consumption of beverages in the cold non-alcoholic market in Ontario. Weak separability between these beverages and all other commodities is a maintained hypothesis. As the major concern is the consumption of individual goods in the market (milk, soft drinks, apple juice, tomato juice, orange juice, with the beverages determined partially by hypothesized close economic relationships and partially by pragmatic data considerations) the emphasis is placed on the economic characteristics of the second stage of the decision problem with the first stage being specified in a more ad hoc fashion.

The econometric time-series studies of advertising discussed in the previous section all included advertising as an explanatory variable in demand equations. Implicit in this specification is the inclusion of advertising variables (normally expenditure) as arguments in the underlying utility function. The inclusion of advertising in utility functions can be justified if advertising is interpreted as a taste change parameter operating directly on utility but not generating utility.. A similar specification is used on the supply side when time is included directly in a profit or production function as a technology changing parameter. Some researchers believe that it is possible for advertising to contribute directly to utility (i.e. bandwagon effects, Fisher and McGowan, 1979) while others believe that the inclusion of advertising in a utility function is a 'misrepresentation' of the role advertising plays in affecting consumer purchases (Kotowitz and Mathewson, 1979). This research does not attempt to resolve these debates and continues to use the inclusion of advertising in the utility function as a taste change parameter in both stages of the model.

The first stage of the demand model used in this research is specified directly as a loglinear equation. The dependent variable in the equation is total real expenditure on cold non-alcoholic beverages in Ontario. This definition of the dependent variable avoids the obvious problems that would be generated with the use of a quantity variable (i.e. can you add apples and oranges or apple juice and milk?). The first stage equation written in its general form can be expressed as:

$$\sum_i P_i X_i = TEXP = f(P, Y, A, Z, TEXP_{t-1}) ,$$ with i = 1, 2, ... n number of individual commodities

P_i = real price of individual beverage i

X_i = quantity consumed of beverage i

P = quantity weighted average price of all beverages

Y = real per capita disposable in income

A = real aggregate expenditure on advertising of all beverages

Z = matrix of seasonal (quarterly) dummies

$TEXP_{t-1}$ = lagged dependent variable .

All nominal dollar variables are deflated by the general consumer price index for Canada.

A priori the sign of the coefficient on P can not be determined; it could be either negative (implying price elastic demand for cold non-alcoholic beverages) or positive but less than one (implying price inelastic demand for cold non-alcoholic beverages). A coefficient positive and greater than one would imply an upward sloping demand curve, a phenomenon not consistent with consumer theory. A priori the expected signs of coefficients on Y and A are both positive. The presence of lagged dependent variables allows for geometrically declining lags on prices and advertising.

The second stage of the demand system is derived from a translog indirect utility function defined across normalized prices (P_i/TEXP) of individual beverages and advertising expenditures associated with individual beverages. The translog indirect utility function can provide a local second order approximation to any arbitrary indirect utility function. This property is common to a set of functions which have come to be known as flexible functional forms. Other members of the set include the generalized Cobb-Douglas, the generalized Leontief, the generalized square root quadratic and the generalized Box-Cox. These functions are considered flexible in that they place no a priori restrictions on the full set of elasticities (price, income, substitution) at a base point (Caves and Christensen, 1980).

The global properties of the different functional forms remain largely unknown except for empirical evidence from specific sets of data. In a variety of studies comparing functional forms and in explicit tests of the acceptability of certain functional forms (eg. Wales, 1977, Appelbaum, 1979, Goddard, 1984, Amuah, 1985) frequently the translog functional form could not be rejected. Using this criteria the translog functional form was selected for this research.

A translog indirect utility function, in terms of prices and total expenditure is specified as:

$$\ln V = \alpha_0 + \sum_{i=1}^{n} \alpha_i \ln P_i^* + 1/2 \sum_{i=1}^{n} \sum_{j=1}^{n} \beta_{ij} \ln P_i^* \ln P_j^* \text{ , } i = 1,2 \ldots n$$

where

$$P_i^* = P_i/TEXP \quad \text{and} \quad \beta_{ij} = \beta_{ji} \text{ .}$$

Using the logarithmic form of Roy's identity, expenditure shares for the ith commodity, can be derived as:

$$\frac{P_i X_i}{TEXP} = - \frac{\partial \ln V}{\partial \ln P_i} \Big/ \frac{\partial \ln V}{\partial \ln TEXP} \text{ ,} \qquad i = 1, 2 \ldots n \text{ .}$$

For the translog indirect utility function these are expressed as:

$$\frac{P_i X_i}{TEXP} = W_i = \frac{\alpha_i + \sum_j \beta_{ij} \ln P_j^*}{\sum_i \alpha_i + \sum_i \sum_j \beta_{ij} \ln P_j^*} \qquad i = 1, 2 \ldots n \text{ .}$$

This basic translog model (as derived by Christensen and Manser, 1977) does not include either advertising or any dynamic (lagged) effects. The addition of advertising expenditures on all goods in the group results in an indirect utility function of the following form:

$$\ln V = \alpha_0 + \sum_i \alpha_i \ln P_i^* + \sum_j g_i \ln A_i + 1/2 \sum_i \sum_j \beta_{ij} \ln P_i^* \ln P_j^*$$

$$+ 1/2 \sum_i \sum_j m_{ij} \ln A_i \ln A_j + 1/2 \sum_i C_{ij} \ln P_i^* \ln A_j \text{ ,}$$

$$i, j = 1, 2 \ldots n \text{ .}$$

Expenditure shares can be derived from this model as:

$$W_i = \frac{\alpha_i + \sum_j \beta_{ij} \ln P_j^* + \sum_j C_{ij} \ln A_j}{\sum_i \alpha_i + \sum_i \sum_j \beta_{ij} \ln P_j^* + \sum_i \sum_j C_{ij} \ln A_j}, \quad i, j = 1, 2 \ldots n .$$

The impact of habit formation has been incorporated into an indirect translog utility function (Manser, 1976) by specifying that certain of the parameters depend upon past consumption. The α_i, in the current specification, can be assumed to depend linearly on consumption in the immediately preceding period:

$$\alpha_i = a_i + d_i X_{i_{t-1}}, \qquad i = 1, 2 \ldots n$$

Expenditure share equations can then be derived as:

$$W_i = \frac{a_i + d_i X_{i_{t-1}} + \sum_j \beta_{ij} \ln P_j^* + \sum_j C_{ij} \ln A_j}{\sum_i a_i + \sum_i d_i X_{i_{t-1}} + \sum_i \sum_j \beta_{ij} \ln P_j^* + \sum_i \sum_j C_{ij} \ln A_j},$$

$$i, j = 1, 2 \ldots n .$$

A system of expenditure share equations such as those proposed above must, by definition, sum to one. Thus, only n-1 of the equations are independent and can be estimated. Since expenditure share equations are homogeneous of degree zero in prices and total expenditure a normalization of parameters is necessary. The normalization, used by Manser and in this study is that $\sum_i a_i = -1$. In estimation additive error terms are assumed for the budget share equations. The error terms are assumed to have a joint normal distribution with mean zero and constant covariance.

THE DATA

Quarterly data collected from the first quarter of 1971 (1971:1) to the fourth quarter of 1984 (1984:4) was used in this study.

The commodities considered in the market for cold non-alcoholic beverages were fluid milk, soft drinks, fruit and vegetable juices. However, data on prices and disappearance were not available for fruit juices other than apple, orange and tomato juice.[1] As a result, the data described here includes information on fluid milk, soft drinks, tomato juice, apple juice and orange juice.

Data for advertising expenditures was obtained from monthly data on media advertising expenditures by commodity compiled by the Elliot Research and Media Measurement Corporation in Toronto. These media expenditures were made up of advertising expenditures on radio, television and daily newspapers in Ontario. The only other medium where advertising expenditures for these commodities could have been generated was consumer magazines. But this information was very infrequent and minimal, and was available only at a national level. A figure for Ontario on advertising in consumer magazines was obtained by pro-rating the national data on a per caput basis, and this figure was added to the expenditures on radio, television and daily newspapers as described above to arrive at a figure representing total expenditures on advertising for each commodity in Ontario.

Advertising expenditures for fluid milk were advertising expenditures by the OMMB. Advertising expenditures for soft drinks were generated by summing those for Canada Dry, Crush Canada, Royal Crown, Seven-Up, Pepsi, Dr. Pepper, Coca Cola, Minute Maid and Schweppes. Advertising expendi-

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1 Data is available from the authors on request.

tures for orange juice included those by McCain, Florida Citrus Association, Tang, General Foods, Jb Foods, SunPac, Old South, Sun Squeeze and Minute Maid. Advertising expenditures for apple juice included those by Jb Foods, Brights Foods, Campbell Soup Ltd., McCain, FBI Foods, Tang, SunPac, Canada Dry and Cobi Foods. Advertising expenditures for tomato juice included those by Heinz, Campbell Soup Ltd., E.D. Smith, Motts and Brights Foods. Advertising expenditures by store brands for all commodities in this study were not available.

Data on quantity consumed of fluid milk was obtained from monthly data compiled by Statistics Canada while data for soft drinks, apple juice, orange juice and tomato juice were generated in the following manner:

disappearance = (production + imports + inventory at beginning of period) - (exports + inventory at end of period).

Data on exports and imports was available only on a national basis and was obtained from monthly data compiled by Statistics Canada. A figure for Ontario was obtained by pro-rating this data on a per caput basis.

Production data for soft drinks were available only at a national level and were obtained from monthly data compiled by Statistics Canada. A figure for Ontario was obtained by pro-rating the national figure on a per caput basis. Production data for apple and tomato juices were available for Ontario, and this was obtained from monthly data compiled by Statistics Canada. There was no production data on orange juice as all the orange juice consumed in Canada was imported.

Inventory data for soft drinks was obtained by dividing monthly data on the value of inventory compiled by Statistics Canada by the industry selling price computed from monthly data on the industry selling price index compiled by Statistics Canada. The constructed figure was on a national level, and a figure for Ontario was obtained by pro-rating this information on a per caput basis. Inventory data for apple and tomato juice were available for Ontario, and this was obtained from monthly data compiled by Statistics Canada. There was no inventory data available for orange juice, at a national or a provincial level.

Data on disposable income for Ontario was obtained from annual data compiled by Statistics Canada. To get quarterly data, the annual data was divided by four (4) on the assumption that consumers received a fixed annual income, evenly distributed throughout the year.

Data on retail prices for the commodities were provided by Statistics Canada upon request. This data represent retail prices for each commodity in the major cities (Ottawa, Toronto, Hamilton, London, Sudbury and Thunder Bay) in Ontario. Analysis of the price data showed a very strong correlation between commodity prices among these major cities permitting the use of data from one of these cities as a proxy. However, this data was not available for all quarters in the analysis. As a result, price data was generated from monthly price indices (PI) for the commodities used in this study at a national level. An analysis of PI for all the commodities used in the study where data was available for the Ontario cities mentioned above and the national figures showed a strong correlation between national and Ontario city price movements. This information was used to construct missing quarterly retail prices for the various commodities.

Population data for Ontario was obtained from quarterly data compiled by Statistics Canada.

ESTIMATION PROCEDURE

Estimation of the aggregate demand function employed the Ordinary Least Square (OLS) technique. Statistical inference for the aggregate demand equation is based on the t and F statistics criteria.

The stochastic specification discussed previously was used to estimate the budget share equations generated from the indirect translog utility function. Under this specification, only four of the five budget share equations were needed for a complete econometric model of demand. The omitted equation was the budget share equation for apple juice. Estimation was carried out by the maximum likelihood estimation method. Statistical inference was based on the likelihood ratio criterion.

All computations were done with the computer package TSP version 4.0B.

ANALYSIS OF RESULTS

Results from both the first and second stage of the two stage maximization process are presented and discussed in this section.

To estimate the aggregate expenditure function and the system of expenditure share equations, the data described earlier was transformed into per caput data by dividing each series by Ontario's population. Expenditures on each commodity were obtained by multiplying the per caput quantity data by deflated retail prices. Total expenditure on cold non-alcoholic beverages was obtained by adding up consumer expenditure on each of the five commodities in this group.

For the aggregate expenditure function, the price index was an endogenous quantity weighted average price for cold non-alcoholic beverages. Aggregate advertising expenditure was obtained by adding up the per capita advertising expenditure on each commodity.

For the expenditure share equations, the ratios of prices to total expenditure and advertising expenditure levels were scaled to equal 1.0 in 1978:1. It has been demonstrated, that the elasticities and the fitted w_i's are invariant to such rescaling (Christensen and Manser, 1977).

Preliminary analysis of the aggregate model showed little seasonal variation. Several specifications of the aggregate model in the linear and log-linear forms were estimated. On the basis of tests statistics and theoretical consideration, the dynamic specification with price, disposable income, advertising expenditure and habit formation in its log-linear form was found to be the best model.

The results as given in Table 1.1 show a significant positive response of total expenditure on cold non-alcoholic beverages to price at a level of significance of 1%. A priori this could have been expected since demand for foods are generally considered to be inelastic. Thus, an increase in price will cause consumers to allocate more of their income to expenditure on cold non-alcoholic beverages with very little change in the quantity of the beverages consumed. The results confirm the a priori expectation of positive response to income changes. However, this impact of disposable income on total expenditure on cold non-alcoholic beverages is insignificant at the 1% level (and significant only at the 20% level).

Advertising, in general, is expected to increase consumers' consumption of the advertised product. But this can only happen if advertising can shift the demand schedule to the right or increase the demand elasticity, and if supply of the product is not perfectly inelastic. The positive response of total expenditure on cold non-alcoholic beverages to advertising is significant at the 1% level of significance.

The results show that habit formation is a significant factor in determining expenditure on cold non-alcoholic beverages; or, in fact, that there is some persistence buying on the part of consumers.

The overall results from the aggregate model suggests that price, advertising and habit formation are significant (on the basis of "t" statistics) at the 1% level of significance. All the variables taken together significantly influence total expenditure on cold non-alcoholic beverages at the 1% level. The tabulated F statistic at the 1% level of significance is 3.72 which is smaller than the calculated F statistic of 97.258. As indicated by the coefficient of determination (R^2), approximately 90% of the variation in total expenditure for cold non-alcoholic beverages can be explained by the variables in the model. To validate the results given in Table 1.1, the potential presence of autocorrelation has to be tested for. The relevant test for autocorrelation in the presence of a lagged dependent variable is the h statistic (Pindyck and Rubinfeld, 1981). Since Durbin (1970) has shown that the h statistic is approximately normally distributed with unit variance, the test for first order autocorrelation can be done directly using the standard normal distribution. The calculated h statistic is 1.913. At the 1% level of significance, the critical value of the normal distribution is 2.326. Since the calculated h statistic is less than 2.326, the null hypothesis of no autocorrelation is accepted. The model was also estimated with an autocorrelation adjustment and the rho parameter was not statistically different from zero.

Various specifications of the second stage of the model were tested to determine the importance of each of the chosen variables in the model. The basic translog budget share system (basic translog model) includes only prices and total expenditure. To test for the significance of including advertising in the model, the basic translog model was reestimated with advertising expenditure also included as an explanatory variable. The restricted model was the basic translog model while the unrestricted model includes price and advertising. Likelihood ratio test statistics were used to see if the restriction of not including advertising expenditure levels could be accepted. Tests for the inclusion of habit formation were also conducted in the same manner. The unrestricted model was the specification with price and habit formation in the case of habit formation. The restricted model was the basic translog model.

The other specification that was tested was that with price, advertising and habit formation. The restricted model for the specification with price, habit formation and advertising was the specification with price and habit formation. The results from the testing procedure described above are presented in Table 1.2.

Comparing the chi-square critical values with the test statistics all restricted model specifications were rejected (ie. models without advertising or lagged variables).

To test the validity of the assumption of symmetry ($\beta_{ij} = \beta_{ji}$) imposed on the accepted specifications, the values of Rx were compared to the critical values of the chi-square as given in Table 1.3. On the basis of the likelihood ratio test, symmetry was accepted in all the accepted specifications.

The model specification with prices (expenditure), advertising and habit formation with symmetry imposed on the price coefficients was selected as the optimal model for the second stage of the demand system. To thoroughly investigate the dynamic nature of the optimal model the demand system was simulated with each of a single period shock in the price of milk and in advertising expenditure on milk. The single period shocks were a 10% increase in the level of each of the exogenous variables in the third quarter of 1971. The results for a particular endogenous variable are tabulated in Table 1.4. From the results in the table the exogenous single period shocks produce results that decline geometrically until they disappear.

Economic theory requires that the indirect utility function specified in the study be monotonically decreasing in P/TEXP and be strictly quasi convex (Caves and Christensen, 1980).

The quasi convexity requirement on V is equivalent to the requirement that the matrix of elasticities of substitution be negative semidefinite. Monotonicity requires that $\partial V/\partial P_i$ be strictly less than zero. This essentially means that the expenditure shares, w1,w2,...,wn, be strictly positive (Caves and Christensen, 1980).

The matrices of substitution elasticities for the optimal model selected were tested and found to be negative definite. All expenditure shares are positive, satisfying monotonicity. Thus, both the monotonicity and quasi convexity requirements are satisfied.

Uncompensated price and expenditure elasticities are reported in Table 1.5 for a variety of different sample points. All own price elasticities exhibit the expected negative response. An uncommonly high number of cross price elasticities have negative signs suggesting gross complementarity. For example, in almost every period all beverages are gross complements for fluid milk and for soft drinks. The only clear gross substitution effect in the whole matrix is that between orange juice and apple juice. The own price elasticities of demand are smallest for orange juice with fluid milk running second. The largest own price elasticity of demand (in absolute value terms) is for soft drinks. The largest expenditure elasticity is for soft drinks with orange juice coming second. The fluid milk expenditure elasticity is consistently the third largest and is significantly larger than those for either tomato or apple juice.

Allen elasticities of substitution are reported in Table 1.6. These elasticities show that all goods appear to be net substitutes with the exception of the relationship between orange juice and both fluid milk and tomato juice.

Advertising expenditure own and cross price elasticities of demand are reported in Table 1.6. With the exception of the tomato juice advertising elasticity all own-advertising elasticities are positive. All own elasticities appear to be in the same range of magnitude. The cross advertising elasticities do not have comparable signs to the price elasticities. One might, for example, expect that the advertising of a gross complement might increase the demand for a good. In the results presented often the opposite occurs. For example, advertising soft drinks, apple juice and tomato juice decrease the demand for fluid milk while advertising orange juice increases the demand for fluid milk. Overall the own and cross advertising effects of tomato and orange juices advertising effects seem to be the smallest (column) while those for fluid milk are the largest. The demand for fluid milk seems the least affected by advertising of other commodities (row) in absolute value terms.

In order to thoroughly investigate the properties of the two stage demand model estimated it was decided to simulate the complete model under a variety of scenarios of interest to the OMMB. The policy scenarios examined were a 10% increase in the price of fluid milk, a 10 and 50% increase and 10% decrease in advertising expenditure for fluid milk, a 10% increase in per capita disposable income. While disposable income levels in Ontario are beyond the control of the OMMB it was thought useful to simulate this option to shed some light on future possibilities for the milk market in Ontario. The model was simulated over the entire sample period and values of endogenous variables at their mean from the various different simulations are reported in Table 1.7.

The results with respect to advertising expenditure are quite positive for the industry. For example, with a 10% increase in advertising expenditure on fluid milk there is an increase in total expenditure on beverages, an increase in milk demand and an increase in net revenue to the milk industry (revenue net of advertising costs). The other advertising simulations give comparable results. This implies that there are positive returns to increasing advertising expenditures by the OMMB.

Both increasing price and an exogenous increase in disposable income lead to increased revenues for the milk industry in Ontario. This is due, in a large part, to the very inelastic nature of demand for beverages as well as demands for individual beverages estimated in this study.

Conclusions

The research in this paper attempted to determine the effectiveness of fluid milk advertising in Ontario within the context of a model for cold non-alcoholic beverages. The model measured both the impact of fluid milk advertising on fluid milk consumption and consumption of other beverages and the impact of other beverage advertising on consumption of all beverages.

Own advertising elasticities both at the aggregate and disaggregated levels were positive. Cross advertising effects varied in sign from commodity to commodity. Model simulations suggested that it would be possible for the OMMB to increase revenue net of advertising costs to the milk industry by increasing advertising expenditure. This suggests that while current advertising expenditure levels are generating positive payoffs the industry has not yet reached optimal advertising expenditure levels.

The research reported in this paper rests on a number of critical assumptions i.e. that advertising expenditures can be incorporated directly into utility functions as taste change parameters. One assumption that has not been explicitly referred to is the rather limiting assumption that a dollar of advertising returns the same result regardless of in which medium the advertising occurs. With current time series techniques and data availability it is difficult to relax this assumption. Future research efforts should be aimed at fine tuning the analysis so that it might be possible to provide the industry with more detailed information about different advertising strategies.

Table 1.1: Results from the Aggregate Expenditure Model

(Dependent variable: log of total expenditure on cold non-alcoholic beverages, n = 55)

Variable	Coefficient	t-Statistic
Constant	11.908	6.498
Log weighted average price	0.798*	3.718
Log income	0.125	0.922
Log total advertising	0.075*	3.623
Lagged dependent variable	0.363*	3.759
R^2	0.89	
$\bar{R}^2$	0.88	
DW Statistic	2.120	
h Statistic	1.913**	
F Statistic	97.258***	

* Coefficient significant at 1% level.
** h statistic significant at the 1% level.
*** F statistic significant at 1% level; tabulated F statistics is 3.72.

Table 1.2 Results of Likelihood Ratio Test for Model Specification

Model Specification	lnL Lr	Lu	Rx	df	cv 1%	5%
1. P + A*	633.258	666.632	66.748	25	44.34	37.66
2. P + HF*	633.258	646.374	26.232	5	15.09	11.07
3. P + A + HF*	646.374	672.048	51.348	25	44.34	37.66

* specification accepted at 1% and 5% level,
** specification accepted at 5% levels,
(P) prices, (A) advertising, (HF) habit formation,
(cv) critical value of chi-square,
(Rx) test statistics,
(df) degree of freedom,
(Lr) likelihood function from restricted model,
(Lu) likelihood function from unrestricted model, and
(ln) logarithms.

Table 1.3: Test for Symmetry Given Model Specification

Model	Specification	lnL Lr	Lu	Rx	df	cv 1%	5%
1.	P only*	633.258	635.724	4.932	10	23.19	18.31
2.	P + A*	666.632	673.517	13.770	10	23.19	18.31
3.	P + HF**	646.374	655.930	19.112	10	23.19	18.31
4.	P + A + HF*	672.048	679.379	14.662	10	23.19	18.31

* Symmetry accepted at 1% and 5% level;
** Symmetry accepted at 1% level;
(P) price, (A) advertising, (HF) habit formation,
(Lr) likelihood function of the restricted model,
(Lu) likelihood function of the unrestricted model,
(lnL) maximum value of the log of likelihood function,
(df) degrees of freedom,
(Rx) test statistics, and
(cv) critical values of chi-square.

Table 1.4: Absolute Differences in the Quantity of MIlk Consumed with 10% Increases in the Price of Milk and Advertising on Milk, 1971-3

Quarter	Δ in Price of Milk	Δ in Advertising of Milk
	litres per caput	
1971-3	3.87	.57
1971-4	.89	.14
1972-1	.42	.04
1972-2	.11	.01
1972-3	.05	.00
1972-4	.02	.00
1973-1	.01	.00
1973-2	.00	
1973-3		

Table 1.5: Price and Expenditure Elasticities

	FM	SD	TJ	OJ	AJ	Y
1974:4						
FM	-0.483	-0.091	-0.042	-0.097	-0.038	0.751
SD	-0.734	-0.957	-0.096	-0.007	-0.210	2.005
TJ	0.002	0.204	-0.522	-0.067	-0.032	0.415
OJ	-1.068	0.197	-0.259	-0.207	0.263	1.074
AJ	-0.003	-0.035	-0.036	0.132	-0.506	0.449
1978:4						
FM	-0.555	0.088	-0.036	-0.085	-0.033	0.799
SD	-0.577	-0.946	-0.076	-0.004	-0.167	1.771
TJ	-0.012	0.158	-0.563	-0.064	-0.030	0.512
OJ	-0.742	0.196	-0.184	-0.425	0.191	0.964
AJ	-0.006	-0.032	-0.032	0.113	-0.574	0.536
1982:4						
FM	-0.593	-0.080	-0.033	-0.078	-0.031	0.814
SD	-0.586	-0.973	-0.077	-0.006	-0.167	1.809
TJ	0.004	0.162	-0.636	-0.051	-0.024	0.544
OJ	-0.668	0.181	-0.166	-0.481	0.173	0.961
AJ	0.002	-0.017	-0.027	0.100	-0.628	0.569
1984:4						
FM	-0.276	-0.080	-0.036	-0.085	-0.033	0.785
SD	-0.640	-0.964	-0.082	-0.006	-0.183	1.878
TJ	0.001	0.176	-0.583	-0.059	-0.028	0.493
OJ	-0.823	0.189	-0.202	-0.374	0.208	1.002
AJ	-0.005	0.036	-0.032	0.115	-0.566	0.524

(FM) Fluid Milk; (SD) Soft Drink; (TJ) Tomato Juice; (OJ) Orange Juice; and (Y) Expenditure.

Table 1.6: Elasticities of Substitution

	FM	SD	TJ	OJ	AJ
1974:4					
FM	-0.314				
SD	0.386	-1.827			
TJ	0.419	1.233	-3.755		
OJ	-1.281	1.862	-0.996	-3.256	
AJ	0.443	0.307	0.158	3.199	-3.637
1978:4					
FM	-0.457				
SD	0.464	-1.804			
TJ	0.484	1.109	-4.353		
OJ	-0.714	1.704	-0.629	-6.585	
AJ	0.523	0.394	0.262	2.540	-4.188
1982:4					
FM	-0.524				
SD	0.488	-2.175			
TJ	0.554	1.207	-4.439		
OJ	-0.546	1.703	-0.343	-7.450	
AJ	0.575	0.500	0.357	2.540	-4.188
1984:4					
FM	-0.433				
SD	0.462	-2.002			
TJ	0.494	1.202	-4.192		
OJ	-0.819	1.762	-0.624	-6.081	
AJ	0.514	0.379	0.266	2.707	-4.108

(FM) Fluid Milk; (SD) Soft Drink; (TJ) Tomato Juice; (OJ) Orange Juice; and (AJ) Apple Juice.

Table 1.7: Advertising Elasticities

	FM	SD	TJ	OJ	AJ
1974:4					
FM	0.008	-0.005	-0.005	0.001	-0.004
SD	-0.019	0.005	0.019	-0.019	0.003
TJ	0.075	0.026	-0.008	0.021	-0.010
OJ	-0.086	-0.004	0.007	0.007	0.044
AJ	0.032	-0.016	-0.015	0.009	0.002
1978:4					
FM	0.002	-0.005	-0.004	0.002	-0.001
SD	-0.006	0.005	0.007	-0.017	-0.003
TJ	0.054	0.022	0.004	0.022	-0.001
OJ	-0.036	0.000	-0.017	0.001	0.016
AJ	-0.031	-0.015	-0.010	0.008	0.004
1982:4					
FM	0.003	-0.004	-0.001	0.002	-0.001
SD	-0.019	0.003	0.018	-0.014	0.005
TJ	0.060	0.020	-0.009	0.016	-0.010
OJ	-0.030	0.001	0.017	0.001	0.013
AJ	-0.019	-0.012	-0.015	0.006	-0.001
1984:4					
FM	0.006	-0.004	-0.004	0.001	-0.003
SD	-0.018	0.004	0.017	-0.016	0.003
TJ	0.064	0.023	-0.007	0.019	-0.010
OJ	-0.051	-0.001	-0.008	0.003	0.024
AJ	-0.030	-0.015	-0.011	0.008	0.003

(FM) Fluid Milk; (SD) Soft Drinks; (TJ) Tomato Juice; (OJ) Orange Juice; and (AJ) Apple Juice.

Table 1.8: Mean Absolute changes in Total Expenditure, Demand Revenues due to Changes in Fluid Milk Price, Fluid Milk Advertising and Disposable Income Over the Period 1971:2 to 1984:4

	10% increase in Price	10% increase in Income	10% increase in Advertising	50% increase in Advertising	10% decrease in Advertising
TEXP($)	2.681	0.909	0.110	0.494	-0.114
QM(l)	0.395	0.471	0.104	0.683	-0.100
QSD(l)	0.432	0.504	0.050	0.107	-0.052
QT(l)	0.094	0.030	0.066	0.300	-0.069
QO(l)	-0.352	0.081	-0.046	-0.304	0.042
QA(l)	0.075	0.024	-0.032	-0.117	0.033
MTR($000)	20 642	3 148	661	4 186	-641
MNR($000)	20 641	3 147	609	3 925	-588
AM($)	-	-	51 530	257 651	-51 530
PM($)	0.079	-	-	-	-
Y($)	-	233.70	-	-	-

(TEXP) total expenditure on cold non-alcoholic beverages;
(QM) fluid milk demand;
(QSD) soft drink demand;
(QT) tomato juice demand;
(QO) orange juice demand;
(QA) apple juice demand;
(MTR) total revenue for fluid milk;
(MNR) net revenue for fluid milk;
(AM) advertising expenditure on fluid milk;
(PM) price of fluid milk; and
(Y) is disposable income.

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