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Milk

A DEMAND ANALYSIS FOR FLUID MILK IN ONTARIO

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and Extension Education

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University of Guelph

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Errors of omission or commission remain the responsibility of the authors.

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I. INTRODUCTION

Since 1965, the Ontario Milk Marketing Board (OMMB) has been authorized by the Milk Act of 1965 to establish producer prices for fluid milk in Ontario. In 1966 uniform prices were established across both Southern and Northern Ontario with, in recognition of higher production costs, a higher price in the latter region. From January 1966 to January 1973 producer prices in Southern Ontario increased from $5.29 to $7.40 per cwt. with a corresponding increase from $6.32 (July 1966) to $7.97 per cwt. in Northern Ontario (Table 1).

TABLE 1: Producer Prices of Fluid Milk in Ontario

	January 1966 to January 1973	
	Southern Ontario $ per cwt.	Northern Ontario $ per cwt.
January 1966	5.29	5.39-6.07
July 1966	5.75	6.32
May 1967	6.10	6.67
March 1968	6.15	6.72
September 1968	6.65	7.22
February 1971	6.85	7.42
September 1971	7.05	7.62
January 1973	7.40	7.97

The major purpose of this study is to assess the responsiveness of fluid milk consumption in Ontario to price changes at the farm level. Estimates of other demand characteristics for fluid milk such as seasonality, consumer incomes, prices of competition products and family characteristics are also provided in this study.

The usual procedure for analysing demand characteristics of a commodity is to apply regression analysis to time-series data. This approach is used in this study. However, time-series data consist of observations on the values of economic variables at different points in time or during different intervals of time. Due to the nature of available time-series data, some important characteristics such as effects of distribution of income, family size and composition on consumption cannot be detected. In an effort to circumvent some of these problems, a cross-section analysis is also used. As the primary reference of cross-section data is static, the temporal effects on consumption must be ignored in a cross-section analysis. Because both time-series and cross-section analysis have certain inherent disadvantages, attempts have been made to supplement one method with the other by combining cross-section and time-series data.

II. CHARACTERISTICS OF DEMAND FOR FLUID MILK FROM TIME-SERIES DATA

II.1 The Model and Data

During the period 1966 to 1971, per capita monthly consumption of fluid milk in Southern Ontario averaged 22.11 pounds while the comparative amount was 17.25 pounds in Northern Ontario (the areas of Kenora, Rainy River, Thunder Bay and Northern District)[1/]. As there is a substantial difference in consumption between regions, the regional demand characteristics for milk will be investigated independently.

Economic theory of demand is developed from the premise that an individual consumer is confronted by a

---

1/ These figures were estimated from [5].

set of commodities and limited income, and faces the problem of choosing among the available alternatives so as to maximize total satisfaction from consumption. Following this tradition and because the price of fluid milk is predetermined by the OMMB, the quantity of milk consumed is therefore treated as a dependent variable which is defined as a function of the price of fluid milk, consumer's disposable income, and price of competitive commodities.

A consumer research study of "Consumption and Opinions of Fluid Milk: 1969" indicated that orange juice was the most important alternative to milk among several commonly used beverages [2, Chart #17]. It is assumed that orange juice can be considered as representative of the competitive commodities of milk in this study.

In addition, it is hypothesized that consumers have been reinforced in milk purchases and habitual behavior is a significant behavioral characteristic in the market. In other words, the current purchase decision is partially affected by the previous purchase behavior. Thus, the variable of lagged consumption of milk is introduced into the model.[1/]

It is also anticipated that demand shifts systematically within the year due to different consumer behavioral responses toward milk. A set of eleven dummy variables is used for measuring the seasonal variations around the annual milk consumption.

According to the above discussion, the preliminary relationship used to represent monthly demand for

---

1/ A distributed lag model provides the framework for incorporating previous behavior in an estimated demand relation. A detailed discussion is given by Nerlove [4].

milk is specified as:

$$Q_{it} = f(P_{it}, Y_t, O_t, S_t, Q_{i,t-1}, U_{it})$$

and it is expressed linearly for estimation as:

$$Q_{it} = a_{io} + a_{i1}P_{it} + a_{i2}Y_t + a_{i3}O_t + \sum_{j=4}^{14} a_{ij}S_{tj}$$

$$+ a_{i16}Q_{i,t-1} + U_{it} \qquad \ldots(1)$$

where: i = 1, 2 and 3 representing Southern Ontario, and Ontario as a whole;

t = 1, 2...,60 representing the period January 1966 to December 1971;

j = 1, 2...,11 representing the months January to November;

Q_{it} = regional monthly per capita consumption of fluid milk;

P_{it} = regional monthly price of fluid milk;

Y_t = monthly per capita disposable income in Ontario;

O_t = monthly average price of orange juice in Canada;

S_{tj} = a set of eleven dummy variables representing January to November used to measure seasonal variation in consumption of fluid milk. The dummy variable for December is defined as $S_{15} = \sum_{j=4}^{14} S_j$;

$Q_{i,t-1}$ = regional monthly per capita consumption of fluid milk in the previous month; and

U_{it} = residual errors associated with the individual estimating equation which are assumed to be randomly distributed over months.

The definitions of these variables and their anticipated impact on consumption of fluid milk are briefly discussed as follows:

Quantity Consumed Data for quantities consumed used in this study are those reported to be purchases of fluid milk by dairies in the Monthly Dairy Report [5]. Those quantities indicate the total purchases of standard fluid milk (3.25 to 3.99% butterfat), special fluid milk (4 to 9.99% butterfat), partly skimmed milk (1.5 to 3.24% butterfat) and skim milk (under 1.5% butterfat). In order to isolate the influence of population on consumption, the quantities consumed were converted into a per capita basis by dividing regional total consumption by regional population.[1/] As the monthly purchases of fluid milk are affected by calendar composition, the reported data were adjusted for variation in calendar composition between months within the year. The method of adjustment is illustrated in Appendix A.

Prices of Fluid Milk Since 1966, fluid milk has been priced by a uniform price established by the OMMB with an adjustment for butterfat differential.[2/] The data for

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1/ Monthly population in Ontario was estimated from Statistics Canada data [7]. Regional population was estimated by the assumption that 90 percent of population in Ontario was located in the Southern Ontario and 10 percent in the Northern Ontario.

2/ For example, in January 1966, a uniform $5.29 per hundredweight price was established for 3.4 percent milk with a 5 cents per one-tenth percentage point adjustment for butterfat differential [3, p. 21].

fluid milk price used are those represented as the market prices paid by dairies reported in the Monthly Dairy Report [5]. Those prices represent the price of fluid milk, 3.5% butterfat, at the farm level plus the transportation costs of shipping raw milk from farms to dairy plants. The demands for raw materials and marketing services are derived from the demand for the final product and marketing services mix at the consumer level. Hence the estimated demand characteristics are those of the "derived" demand for raw milk. Since a retail or consumer level demand analysis was not attempted the "derived" demand estimates do not give explicit recognition to changes in marketing charges and in the product and marketing services mix which affect the "derived" demand and occur independent of price charges at the farm level.

In demand analysis, the rationale for using deflated or undeflated price series has often been discussed [12, p. 11]. However, "theorists have been unable to agree as to whether analyses should be based on deflated or undeflated price and income series" [11, p. 287]. In the preliminary empirical studies, both deflated[1/] and undeflated price series were used. Based on a purely empirical observation and judging by general criteria used in evaluating regression analysis, undeflated prices gave better results than deflated prices (see Appendix C). Thus, the undeflated price data set was chosen in this study. Economic theory postulates an inverse relationship between quantity demanded and its price, i.e., $a_{i1} < 0$.

Disposable Income Per capita monthly disposable income in Ontario was estimated by the mean of interpolation

---

1/ The fluid milk prices were deflated by the Toronto Consumer Price Index [9] in terms of 1971 constant dollars.

from the quarterly data published by the Statistics Canada [10]. Economic theory suggests that disposable income is one of the important factors affecting the quantity of a commodity consumed. In general, a commodity is classified as a necessity good if its expenditure elasticity with respect to income lies between 0 and 1. It is postulated that fluid milk is a necessity good and that income elasticity for milk is positive, i.e., $1 > a_{i2} > 0$. Preliminary tests of these hypotheses (using deflated and undeflated income series) were rejected (see Appendix D). This aspect will be further pursued in the cross-section analysis.

Price of Orange Juice As the information on provincial average price of orange juice is not available, the national average price series [9] is used in this study. When two commodities are substitutes for each other, the cross elasticity between them will be positive, i.e., $a_{i3} > 0$. However, the empirical results of the preliminary analyses (using deflated and undeflated prices) indicate that the price of orange juice did not influence milk consumption.[1/] Therefore, this variable was excluded from the model in the final analysis.

Seasonality of Milk Consumption In general, the quantities consumed of some agricultural products vary systematically throughout the year. It is anticipated that fluid milk consumption is highly seasonal. A set of 11 binary variables was used to represent January to November and the 12th dummy variable was specified as $S_{15} = \sum_{j=4}^{14} S_j$. This procedure forces the sum of monthly variation in milk consumption to be zero and measures deviations around the annual average level. The specification of the dummy variable for this procedure is given

---

1/ For some seasons within the year but not the year around, per capita milk consumption may be influenced by price of orange juice.

in Appendix B. If milk consumption is highly seasonal, there must exist a significant deviation for some seasons or months, i.e. some of a_{ij}, j=4, 5...,14 are non-zero.

Lagged Quantity Consumed The general form of distributed lag model derived by Nerlove from Koyck's assumption [4, pp. 18-20] is given as:

$$Q_t = a + b_i \sum_{i=1}^{n} Z_{it} + cQ_{t-1}$$

where Q_t and Q_{t-1} represent quantities consumed in current and previous periods, respectively. Z_{it} represents n independent variables specified in the model. According to Nerlove, the adjustment coefficient, d, can be computed from the relationship d = 1-c. The degree of the impact of previous purchase behavior on current purchase decision can be measured by the magnitude of the adjustment coefficient. If d = 1, it implies that the previous purchase behavior will be repeated by consumers in current period. On the other hand, if d = 0, the implication is that current purchase decision is independent from the previous behavior. Between these two extremes, habitual behavior is a significant behavioral characteristic in the market. It is anticipated that consumers, to some extent, have been reinforced in milk consumption. This hypothesis can be tested by the significance of the regression coefficient on the lagged quantity consumed. Specifically, it is expected that $0 < a_{i16} < 1$.

II.2 Results and Implications

The combination of two different time-series on quantities of milk consumed (data adjusted for variation in calendar composition by the USDA and the OMMB weekly sales index) and two different prices and income series (undeflated and deflated by the CPI) makes four possible data sets for analysis. Based on those data sets the consumption function for milk specified as in equation

(1) was estimated by the technique of step-wise regression analysis. The preliminary empirical results indicate that the postulated hypotheses of positive income effect on milk consumption, positive cross elasticity between milk and orange juice and a positive adjustment coefficient were rejected (see Appendix C). Thus equation (1) was re-specified so that consumption of fluid milk is a function of seasonality and the price of fluid milk. According to the usual criteria applied in evaluating regression results, the combination of undeflated prices and the quantities adjusted by the OMMB weekly sales index provide the best results (see Appendix D). The empirical results obtained from the undeflated and the OMMB adjustment data set are given in Table 2.

Judging by (1) the statistical significance of the regression coefficients by the t-tests; (2) the significance of the coefficients of determination by the F-tests; (3) confirmation of the assumption of a serially independent error term by the Durbin-Watson statistic tests; and (4) non-existence of the problem of multicollinearity by examining the simple correlation coefficients between each pair of explanatory variables, the models perform reasonably well.

The results indicate that 71 percent of fluctuations in average per capita consumption of fluid milk in Southern Ontario can be explained by seasonality and price of fluid milk. While the comparative figures in Northern Ontario and Ontario as a whole were 31 percent and 66 percent, respectively. This may suggest that additional information would be required to accurately explain variations in milk consumption in Northern Ontario.

Based on the price-quantity relationships presented in Table 1, the price elasticity of demand for fluid milk at the farm level around the average level of consumption during the period 1966 to 1971 in Southern Ontario is estimated to be -0.20. The price elasticity

TABLE 2: Consumption Function for Fluid Milk in Ontario, 1966-71, Estimated from Time-Series Data

Variables	Units	Regression Coefficients South	North[a]	Ontario
Quantity consumed	lb/p.c.	Dependent Variable		
Constant	lb/p.c.	26.50	17.05	25.52
Price of fluid milk	$/cwt.	-0.68**	0.03	-0.60**
January	lb/p.c.	-0.12	-0.39*	-0.15
February	"	0.46**	0.01	0.41**
March	"	0.13	-0.02	0.11
April	"	0.14	-0.15	0.11
May	"	-0.20+	-0.05	-0.19+
June	"	-0.09	0.29*	-0.05
July	"	-0.89**	0.40*	-0.76**
August	"	-0.53**	0.33*	-0.43**
September	"	0.46	0.29+	0.44**
October	"	0.18+	-0.26+	0.13
November	"	0.29**	-0.13	0.25+
December	"	0.18	-0.26	0.13
Multiple R^2		0.71**	0.31**	0.66**
Standard error of estimate		0.34	0.40	0.34
Mean of dependent variable		22.11	17.25	21.61
Durbin-Watson statistic		1.92++	1.79++	1.95++

[a] Northern Ontario includes Kenora, Thunder Bay and Northern Districts.

** Significant at 1%; * significant at 5%; + significant at 20% probability level.

++ The residual errors are free from auto-correlation at 1% level of probability.

at the farm level for Ontario as a whole is -0.18. In Northern Ontario, there was no responsiveness of milk consumption to a change in price. Algebraically, price elasticity of demand can be defined as:

$$E = \frac{dQ}{dP} \cdot \frac{\bar{P}}{\bar{Q}}$$

where E = price elasticity of demand;

$\frac{dQ}{dP}$ = the inverse of the slope of the demand curve, i.e., the responsiveness of quantity consumed to a change in its price;

$\bar{P}$ = the average price of milk during the observation period; and

$\bar{Q}$ = the average quantity of milk consumed.

If the marketing charges for transportation, assembly, processing, distribution and other marketing services is a flat rate per unit regardless of the price paid by consumers or the quantity marketed, the farmers' demand curve would be parallel to the consumers' demand curve, and hence the slopes of the retail and farm demand curves would be the same.[1/] Since Q is the same at the farm and at retail (milk is a perishable commodity), the only difference between the elasticity of demand at farm and the demand at retail is the difference in the average

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1/ For the another extreme situation, if the total marketing charge per unit is a constant percentage of the retail price regardless of the quantity marketed, the demand curve for the farm market would have a slope less steep than that for consumer demand and the same price elasticity as consumer demand [11, p. 52].

price. Obviously the price at retail is greater than the price at farm. Therefore the price elasticity of demand at retail is greater than at the farm level. If the retail price of fluid milk is twice as high as the price of raw milk, the price elasticity of demand for fluid milk in Ontario at retail is approximately -0.36 to -0.40.

The results of the empirical studies also indicate that there are two decided seasonal patterns in per capita consumption of fluid milk in Southern and Northern Ontario. On the basis of the estimated regression coefficients associated with the months, three seasonal consumption patterns were derived as shown in Figure 1. Since about 90 percent of Ontario's population is located in the South, the seasonal pattern in Southern Ontario coincided with the provincial pattern. The common pattern indicated that per capita consumption in February, September and November is greater than the annual average level, in July and August it is substantially less than the annual average. Consumption in the other months is similar to the annual average.[1/] Such seasonal variations may be attributed to the systematic within-year variation in consumer preferences for milk. It is hypothesized that consumers consume more soft drinks or fruit juice in summer than in winter. Consequently, milk consumption in summer is less than the annual average.

In Northern Ontario, another decided pattern was detected. The magnitude of fluid milk consumption during the period February to May was the same as the

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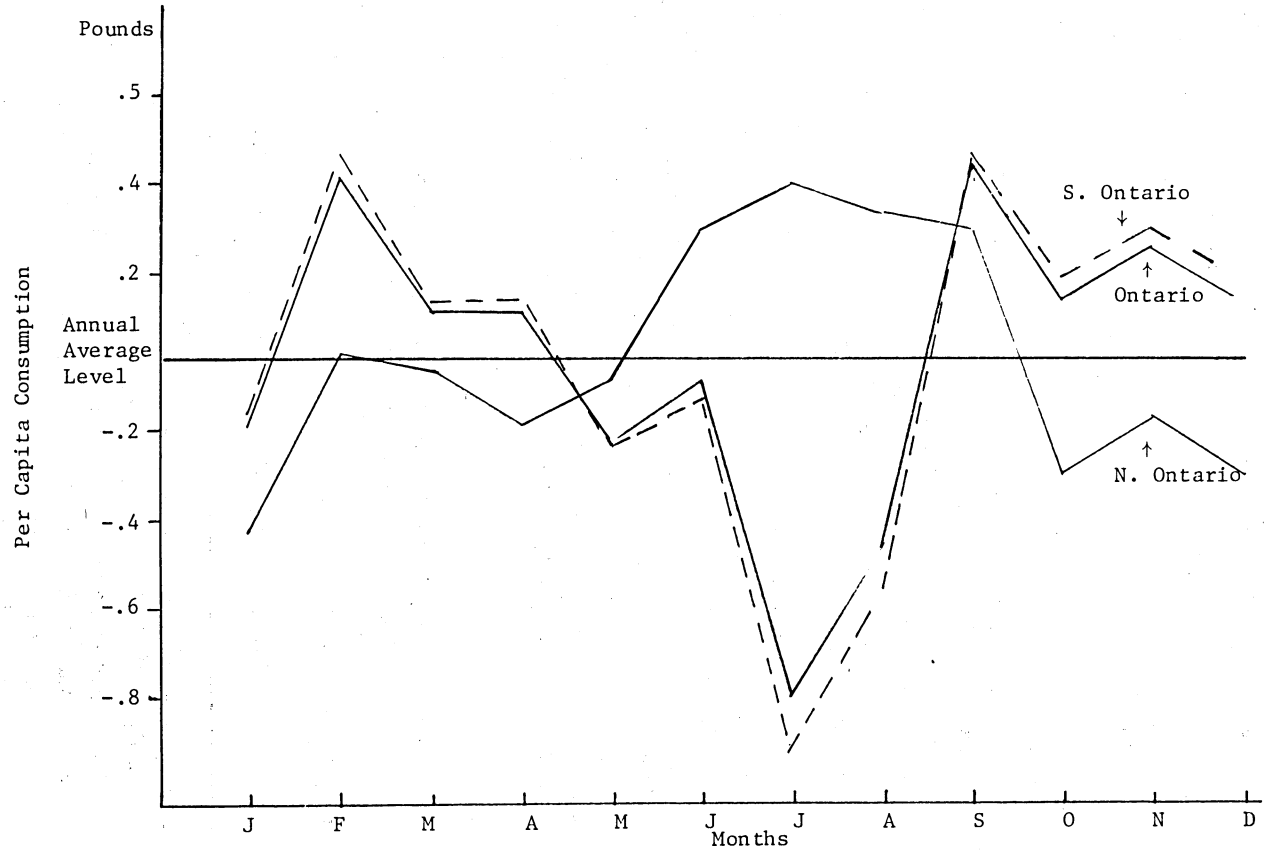
1/ Quantities of fluid milk consumed have been adjusted for variation in calendar composition. Each month had 30.4 days rather than the number of days given in the calendar.

FIGURE 1: Seasonal Variation in Per Capita Consumption of Fluid Milk in Southern Ontario, Northern Ontario and Ontario as a Whole, 1966-1971 Average



annual average level, during June to September, consumption of milk was greater than the annual average while during October to January milk consumption was below the average. The major contributor to such a pattern is probably the seasonal variation in number of visitors to Northern Ontario. (A further study regarding this aspect is required). Northern Ontario is one of the major recreation areas in Ontario. An increase in visitors to that area will increase total purchases of milk in summer. Since per capita consumption was estimated by dividing total purchase by the number of residents (excluded visitors), the estimated figures in summer must be biased[1/] upward. Thus the seasonal pattern in Northern Ontario should be interpreted as the combination of variations in consumer preferences for milk and in the number of visitors to Northern Ontario.

The shifts of monthly demand for fluid milk will vary the responsiveness of quantity consumed to a change in price. For example, a 10 percent increase in price in June in Southern Ontario will decrease per capita consumption by 2.1 percent, but the same price change will decrease consumption by 1.9 percent in September. The information with respect to the seasonality in consumption of fluid milk may be useful to a market regulatory body.

III. CHARACTERISTICS OF DEMAND FOR FLUID MILK FROM CROSS-SECTION DATA

III.1 The Model and Data

The cross-section data used in this study was

1/ Alternatively, demand functions can be estimated in terms of total rather than per capita basis. However, this alternative approach cannot eliminate the effect of population growth on per capita consumption. As the information on number of visitors to Northern Ontario is limited, this factor cannot be explicitly considered in the estimating demand functions.

provided by the Statistics Canada at the authors' request.[1/] The 1969 Family Food Expenditure Survey [8] conducted by the Statistics Canada sampled 10,022 households throughout Canada. These were classified into 7 family income groups and each group was re-classified into 13 family types. A family was defined as a group of persons living in the same dwelling and dependent on a common or pooled income for the major items of living expense [8, p. 16]. Family types were determined by different combinations of numbers of adults and children in a family. Family annual income referred to total income of all individuals in a household throughout calendar year 1969. Of the 91 possible classifications, 53 observations were used and 38 categories were excluded from this study (see Table 3). Thirty-seven of those excluded were ambiguous categories such as; a family having five or more children, not specified family types and not stated income groups. One family class (one-adult family) was also excluded because per capita annual income of that class was extremely higher than those of others.[2/]

Each observation consists of six variables. These are; family annual income, family type, weekly family and per capita expenditure on fresh milk, and weekly family and per capita consumption of fresh milk. Weekly family consumption figures were estimated from the quantities of milk consumed at home and consumed away from home. Per capita consumption of milk was estimated by dividing family consumption by family size. Weekly family and per capita expenditure on fresh milk figures were obtained in the same manner.

1/ The authors would like to acknowledge the cooperation and assistance provided by Mr. Champion and Ms. P. McLean, Family Expenditure Section, Prices Division of Statistics Canada.

2/ Average annual income of the sampled one-adult family was $36 thousand while the comparable figure for all sampled households was $2.6 thousand.

TABLE 3: Distribution of Sample Households for Cross-Section Data

Family Type \ Family Income	Under $2,000	$2,000-3,999	$4,000-5,999	$6,000-9,999	$10,000 14,999	$15,000 and over	Not Stated
1A	390	235	156	140	28		
1A/1+c							
2A	223	563	363	627	350	111	
2A/1c	33	113	190	421	132	22	
2A/2c	28	107	222	527	177	55	
2A/3c	15	52	150	326	126	37	
2A/4c	113	36	81	179	73	25	
2A/5+c							
3A	24	81	105	219	120	55	
3A/1c	9	31	56	131	77	21	
3A/2+c							
4A	6	36	25	74	75	48	
Other							

Source: Statistics Canada, Family Expenditure Section, "Family Food Expenditure in Canada, 1969", unpublished data.

"1A/1+c" is read "one adult and one or more children". Interpretation of the remaining Family Types is analogous. Blanks indicate ambiguous categories.

In the 1969 survey of family expenditure, a systematic random sampling technique was applied. The sampled households were distributed randomly throughout Canada and the sampling period. The regional and temporal effects on price differences among samples is alleviated. However, the implicit price derived by dividing family (or per capita) expenditures on fresh milk by family (or per capita) consumption varied from 26 to 33 cents per quart of milk. This variation in the implicit prices reflects sampling errors, differences in kinds of fresh milk purchased (such as homogenized milk, low fat milk, skim milk, chocolate milk), differences in type of outlet (such as home delivery, supermarket, jug milk store, small grocery store or corner store), and differences in types of containers (such as one quart bottle, one quart carton or multi-quart jug). Assuming that the sampling errors are subject to a normal distribution with a zero mean, the variation in the derived implicit prices would indicate the differences in butterfat content of milk consumed by a household and the differences in marketing services provided to consumers.

As the information on provincial cross-sectional fresh milk consumption was not available, the cross-sectional analysis is undertaken based upon the data of national basis. In this section, an attempt is made to estimate the different quantities of fresh milk which the consumers are willing to consume at various levels of income. In addition, the impacts of family characteristics and the implicit price on consumption of fresh milk will be examined as well. The modified Engel function to be estimated is specified as:

$$q_h = a_o + a_1 Y_h + a_2 Y^2_h + a_3 F_{1h} + a_4 F_{2h} + a_5 F_{3h} + a_6 P^*_h + U_h \quad \ldots (2)$$

where $h = 1, 2, \ldots, 53$ observations (sampled households);

q_h = national per capita household consumption of fresh milk;

Y_h = national per capita household disposable income;

F_{1h} = number of children between 0 and 4 years old in a household;

F_{2h} = number of children between 5 and 15 years old in a household;

F_{3h} = number of adults 16 and over in a household;

P^*_h = the implicit price level of fresh milk; and

U_h = unexplained variation assumed to be randomly distributed.

An Engel curve provides valuable information regarding consumption patterns for different individuals with respect to income. In general, as the consumer's income increases from very low level his consumption of food may increase considerably at first. However, as his income continues to increase, the increases in consumption may become less than proportional to the income increases. In other words, as the consumer's income increases, it is expected that per capita consumption of fresh milk will increase at a decreasing rate as income increased, i.e., $a_1 > 0$ and $a_2 < 0$.

A consumer research study of consumption of fluid milk reported that children consumed more milk than teenagers did and teenager's milk consumption was greater than that of an adult [2, p. 17]. Therefore, it is expected that $a_3 > a_4 > a_5$.

Finally, a negative relationship between quantities consumed and price is postulated, i.e., $a_6 < 0$. As the purchase price of milk is affected by the content of butterfat, type of outlet and types of containers, the negative price-quantity relationship may imply that the sampled households intended to maintain the consumption of butterfat constant by either consuming a large volume of low fat milk or consuming a small volume of high fat milk (the price of high fat milk is greater than that of low fat milk). It may also indicate that there is an inverse relationship between the costs of marketing services and quantities of milk purchased.

III.2 Results and Implications

The estimated results of equation (2) by ordinary least squares regression are summarized in Table 4. The results indicate that 66 percent of the fluctuations in per capita consumption of fresh milk in 1969 can be explained by the specified model. All of the postulated hypotheses were supported by statistical evidence.

The quadratic relationship between the quantities of fresh milk consumed and per capita disposable income was found for the 1969 sampled households. When the consumer's income increased per capita consumption of fresh milk increased at a decreasing rate. If all variables held constant at their means and per capita disposable income was $503 per month, a potential maximum amount of per capita monthly consumption could be 23.67 pounds.

The magnitude of regression coefficients of variables of the three age groups specified in equation (2) indicate that an additional child 0 to 4 years old to a family of 3.6 persons (the average family size of the sampled households) increases average per capita household

TABLE 4: Consumption Function for Fluid Milk in Canada in 1969 Estimated from Cross-Section Data

		Independent Variables Mean Values	Dependent Variables	
			Regression Coefficients	t-values
Quantity (q)	qt/month	7.288		
Constant	qt/month	-	21.495	-
Income (Y)	$/month	220	0.018	6.90**
Income (Y^2)	$1,000/month	89.219	-0.018	5.61**
Children 0-4(F_1)	person	0.375	1.112	1.46+
Children 5-15(F_2)	person	0.870	-0.134	1.30+
Adults (F_3)	person	2.359	-0.246	1.30+
Implicit Price (P^*_i)	cents/qt	29.6	-0.551	2.95**
Coefficient of Determination		0.664		
Standard Error of Estimate		1.186		
Durbin-Watson Statistic		1.594++		

** Significant at 1% probability level

+ Significant at 20% probability level

++ The residual errors are free from auto-correlation at 1% probability level.

milk consumption by 1.112 quarts. An additional child 5 to 15 years old decreases average per capita household consumption by 0.134 quarts while another adult results in a decrease of 0.246 quarts (see Table 4). Based on the above figures, it is estimated that an additional young child increases total family consumption by 1.634 quarts. The comparative effects of a teenager (5-15 year old) and an adult on family consumption were 1.127 and 0.507 quarts, respectively. These findings agreed with the conclusion given by other study [2, p. 17].

The negative coefficient of the implicit price variable supports the hypothesis that per capita consumption increased as price decreased. In general, the lower the butterfat is, the lower the price of milk will be. The negative relationship between quantity and price may imply that the sampled households maintain total consumption of butterfat constant by either consuming a large volume of low fat milk or consuming a small volume of high fat milk. It also implies that the demand for marketing services is inverse to the costs of those services.

IV. AN APPROACH TO COMBINING CROSS-SECTION AND TIME-SERIES DATA

IV.1 The Model and Data

In the cross-section analysis, among other things, a positive income effect on per capita consumption of fresh milk was estimated. If the income-consumption relationships for the period January 1966 to December 1971 can be drawn. If the distribution of income among regions is the same throughout the observation period, per capita consumption of fresh milk should increase over time because there has been a upward long-run trend in disposable income. However, no responsiveness of consumption of fresh milk to a change in disposable income was found

in the previous time-series analysis. This implies that changes in consumers' tastes and preferences offset the positive effects of the increase in income.[1/]

In the time-series analysis, if the model is specified as equation (3), intercorrelation between disposable income and a trend variable, representing factors which change systematically over time, prevents separation of these individual influences on demand. In an attempt to circumvent this problem of multicollinearity, the income effect on consumption was excluded from the time-series data by respecifying the model as equation (4).

$$Q_t = b_o + \sum_{i=1}^{11} b_i S_{it} + b_{12} p_t + b_{13} T_t + b_{14} Y_t + b_{15} Y_t^2 + U_t \quad \ldots (3)$$

$$(Q_t - b_{14} Y_t - b_{15} Y_t^2) = b_o + b_{i=1}^{11} b_i S_{it} + b_{12} P_t + b_{13} T_t + U_t \quad \ldots (4)$$

where $t = 1, 2, \ldots, 60$ representing the period January 1966 to December 1971;

$i = 1, 2, \ldots, 11$ representing the months January to November;

Q_t = per capita consumption of fresh milk;

S_{it} = a set of eleven dummy variables representing the seasonal variation in consumption;

P_t = average monthly price of fresh milk;

1/ A similar situation has been occurred in the U.S. [1, p. 32].

T_t = a time trend variable;

Y_t = per capita disposable income; and

U_t = residual errors.

Assuming that the economic relationship between income and quantity of milk consumed in Ontario during the period 1966 to 1971 should be the same as that of the 1969 sampled households in Canada, values of b_{14} and b_{15} in equation (4) can be replaced by a_1 and a_2 of equation (2). Afterward the data set specified in preliminary time-series analysis were applied to equation (4).

IV.2 Results and Implications

Results obtained from regression analysis on the basis of the adjusted data (excluding the income effects on consumption) are given in Table 5. The coefficients of determination increased from 0.71, 0.31, and 0.66 in the previous time-series analyses to 0.92, 0.79, and 0.92 for the consumption functions in Southern Ontario, Northern Ontario, and Ontario as a whole, respectively (see Tables 2 and 5). This improvement was attributable to taking the factors of disposable income and time trend into consideration.

Based on the revised time-series analysis, the income elasticities were estimated to be 0.35, 0.45, and 0.36 for Southern Ontario, Northern Ontario, and Ontario as a whole, respectively. These estimates were similar to Rojko's estimation of 0.3 or 0.4 but these were greater than Brandow's estimation of 0.16 [1, pp. 7-10]. The empirical results also indicated that there was a systematic decrease in the demand for fluid milk. This may be a reflection of changes in consumers' tastes and preferences.

TABLE 5: Consumption Function for Fluid Milk in Ontario, 1966-71 Estimated from the Adjusted Time-Series Data

Variables	Units	Regression Coefficients		
		South	North[a]	Ontario
Quantity consumed (Q)	lb/p.c.	Dependent Variable		
Constant	lb/p.c.	27.85	20.78	27.17
Income (Y)[b]	$/month	0.045**	0.045**	0.045**
Income (Y^2)[b]	$1000/month	-0.045**	-0.045**	-0.045**
Price of Milk (P)	$/cwt.	-0.69**	-0.34*	-0.67**
Time Trend (T)	month	-0.03**	-0.02**	-0.03**
January	lb/p.c.	-0.12	-0.38*	-0.15
February	"	0.46**	0.01	0.41**
March	"	0.13	-0.04	0.11
April	"	0.14	-0.18	0.10
May	"	-0.20+	-0.06	-0.19+
June	"	-0.09	0.25*	-0.05
July	"	-0.89**	0.38*	-0.76**
August	"	-0.53**	0.31*	-0.44**
September	"	0.46**	0.24+	0.44**
October	"	0.18+	-0.22+	0.14
November	"	0.29*	-0.08	0.25+
December	"	0.18	-0.21	0.12
Multiple R^2		0.92**	0.79**	0.92**
Standard error of Estimate		0.34	0.41	0.34
Mean of Dependent Variable		22.11	17.25	21.61
Durbin-Watson Statistic++		1.91	1.74	1.94

[a] Northern Ontario includes Kenora, Thunder Bay and Northern Districts.

[b] The regression coefficients on income were estimated in the cross-section analysis.

** Significant at 1%, * significant at 5%, and + significant at 20% probability level.

++ No auto-correlation problem in each equation was concluded.

The price elasticities derived from the revised results remain unchanged for Southern Ontario and Ontario as a whole. However, the price elasticity of demand for fresh milk in Northern Ontario was estimated to be -0.13 instead of zero in the previous analysis. As mentioned before, if the total marketing charge per unit was not a constant proportion of the retail price at various quantities marketed, the price elasticity of demand at retail must be greater than that at the farm level. In other words, the price elasticities at the retail markets in Southern Ontario, Northern Ontario and Ontario as a whole must be greater than -0.20, -0.18, and -0.13, respectively.

The patterns of seasonal variation in consumption of fresh milk were almost identical to the previous observations.

V. SUMMARY OF MAJOR RESULTS

A regression analysis applied to 1966-1971 data produced the following results:

1. Per capita consumption of fluid milk in Ontario during the observation period was unrelated to disposable income and price of orange juice (the representative of substitutes).
2. Habitual behavior was not a significant behavioral characteristic in the milk market. In other words, current decisions with respect to purchasing fluid milk were independent from previous purchase behavior.
3. The price elasticity of demand for milk at the farm level in Southern Ontario was -0.20 while the comparative figure for Ontario as a whole was -0.18. In Northern Ontario the responsiveness of milk consumption to a change in price was not significant.
4. In general, consumers consume more soft drinks or fruit juice in summer than in winter. Consequently, milk

consumption in summer is less than the annual average level.

5. An increase in visitors to Northern Ontario results in another decided seasonal pattern of milk consumption in that area. In summer, the average per capita consumption of milk was greater than the annual average.

Cross-section analysis of the 1969 Family Food Expenditure Survey data on consumption of fluid milk revealed the following:

6. As consumers' income increased, per capita consumption of fresh milk increased at a decreasing rate.

7. Young children consumed more milk than teenagers did and milk consumption of a teenager was greater than that of an adult.

8. There was a tendency for the sampled households to maintain a constant consumption of butterfat by either consuming a large volume of low fat milk or consuming a small volume of high fat milk.

9. Quantities of milk consumed are affected by the type of outlet of milk and types of containers. The amount of consumption and costs of marketing services are negatively correlated.

The empirical results of applying the time-series data adjusted for income effect on consumption of milk estimated from the cross-section analysis indicated the following:

10. The positive income effect on milk consumption was offset by the negative effects of changes in consumers' tastes and preferences.

11. The income elasticities for fluid milk in Southern Ontario, Northern Ontario, and Ontario as a whole were estimated to be 0.35, 0.45, and 0.36, respectively.

12. The revised price elasticities of demand for fluid milk at the farm level in Southern Ontario and Ontario as a whole were estimated to be the same magnitude of -0.20 while the comparative figure for Northern Ontario was -0.13.

13. As the situation of the total marketing charge per unit is a constant percentage of the retail price regardless of the quantity marketed is very improbable, the price elasticities at the retail level are likely to be higher than those at the farm level.

APPENDIX A

Adjusting Fluid Milk Sales Data for Calendar Composition

In general, the variation of monthly sales of a commodity originates from secular trend, seasonal variation, calendar composition, and irregular fluctuations. This study is intended to investigate the shifts in fluid milk sales between months within a year. Therefore, the seasonal variation must be accounted for. Techniques for estimating seasonal variation have been well developed.[1/] However, in order to detect an accurate seasonal pattern of sales, the effect of calendar composition bias from the data must be removed.

Basically, the calendar composition bias is due to fluid milk sales not being uniform throughout the week. For example, home deliveries are made only two or three times a week and sales to stores tend to rise toward the weekend. The within-week variation in sales and the differences in the number of each weekday occurs during the month result in a substantial difference in sales from year to year for the same month. In addition, the calendar composition involved in the data is due to the difference in the numbers of the days within a month.

Daily sales of fluid milk in the U.S. and in Canada have been estimated by the USDA and the OMMB respectively. The USDA study developed a "31-30 day difference method"[2/] to establish the weights of sales for each day of the week. A time series data of milk

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1/ See F. L. Thomsen and R. J. Foote, [11, Ch. 17].

2/ See A. Schlenker and P. Christ, [6].

sold during the period January 1961 to December 1969 was seasonally adjusted and the effect of secular trend in the series was minimized by dividing the seasonally adjusted data by the corresponding 12-month moving average. The sales on a certain day, Saturday for example, is then estimated by (1) averaging the monthly sales for all 31-day months beginning on Saturday, (2) averaging the monthly sales for all 30-day months beginning on Sunday, and (3) estimating the sales on Saturday by calculating the difference between 31-day average and 30-day average. By the same procedure, the sales on each day within the week are estimated. Finally, the daily sales index for one week is equal to 7.0. As shown in Table 6, the fluid milk sales in the U.S. are low on Sunday, high on Monday, taper off on Tuesday and Wednesday, and then increase through Saturday. By the same method, on the basis of the information on the OMMB sales to processors, the daily sales index is estimated by the OMMB (See Table 6).

The Canadian pattern of fluid milk sales within the week is similar to the U.S. pattern. However, day-to-day variation in Canada is greater than that in the U.S.

Given the estimated daily sales index, in order to eliminate the calendar composition bias, the actual sales data can be adjusted by the following formula:

Adjusted Monthly Sales = (Actual Monthly Sales/Mix Days) X 30.4 Days

where the "mix days" for a certain month is the sum of the products of each day's sales index and the number of the day within the month. The "mix days" is equivalent to the total standardized selling days within the month. Therefore, the average sales for a standardized day can be estimated by dividing the actual monthly sales by the mix days. Assuming that 365 days were evenly distributed among months, the adjusted (eliminating the calendar composition bias) monthly sales would be equal to the product of the average dairy sales multiplies 30.4 days (365 days/12).

TABLE 6: Daily Sales Index for Fluid Milk in the U.S. and in Canada

Day	USDA Index[a]	OMMB Index[b]
Sunday	0.072	0.024
Monday	1.184	1.033
Tuesday	1.055	1.490
Wednesday	1.025	0.340
Thursday	1.030	1.363
Friday	1.295	1.099
Saturday	1.339	1.651
Total	7.000	7.000

[a] USDA index is estimated by Schlenker and Christ [6].

[b] OMMB index is given by the Ontario Milk Marketing Board.

As shown in Table 7, the information on per capita consumption of fluid milk in Southern Ontario, Northern Ontario, and Ontario as a whole was obtained by dividing the unadjusted sales reported in the Monthly Dairy Report [5] by regional population. On the basis of OMMB index and USDA index, two different sets of mix days were calculated, namely "Mix Day 1" and "Mix Day 2", respectively. Furthermore, applying the data on actual sales to the above mentioned adjusting formula, two series of adjusted monthly per capita consumption of fluid milk were calculated.

TABLE 7: PER CAPITA CONSUMPTION OF FLUID MILK IN ONTARIO, 1966-71 UNADJUSTED AND ADJUSTED FOR VARIATION IN CALENDAR COMPOSITION

Year	Month	Mix Day1	Mix Day2	Southern Ontario			Northern Ontario			Ontario as a whole		
				Unadjusted	Adjusted1	Adjusted2	Unadjusted	Adjusted1	Adjusted2	Unadjusted	Adjusted1	Adjusted2
				Pounds/Per Capita/Per Month								
1966	1	30.71	30.59	22.55	22.34	22.42	16.37	16.21	16.27	21.91	21.70	21.78
1966	2	28.00	28.00	21.24	23.07	23.07	15.77	17.13	17.13	20.68	22.46	22.46
1966	3	31.19	31.11	23.60	23.01	23.07	17.73	17.29	17.33	22.99	22.42	22.48
1966	4	30.75	30.63	22.85	22.60	22.69	16,88	16.70	16.76	22.23	21.99	22.07
1966	5	30.55	30.31	23.00	22.90	23.08	17.45	17.38	17.51	22.42	22.32	22.50
1966	6	29.70	30.05	22.53	23.07	22.80	17.32	17.74	17.53	21.99	22.52	22.25
1966	7	30.86	31.26	22.41	22.09	21.80	17.87	17.61	17.39	21.94	21.62	21.35
1966	8	32.11	31.66	22.35	21.17	21.47	17.24	16.33	16.56	21.82	20.67	20.96
1966	9	29.06	29.26	22.47	23.52	23.36	16.96	17.75	17.63	21.90	22.92	22.77
1966	10	31.19	31.11	22.32	21.76	21.82	16.81	16.39	16.44	21.75	21.21	21.27
1966	11	30.75	30.63	22.08	21.84	21.92	16.40	16.22	16.28	21.50	21.27	21.35
1966	12	30.55	30.31	23.27	23.17	23.35	17.96	17.88	18.02	22.72	22.62	22.80
Annual	Ave	365.42	364.94	270.67	270.55	270.87	204.76	204.63	204.86	263.85	263.73	264.04
1967	1	30.55	30.31	22.77	22.67	22.85	17.43	17.36	17.49	22.22	22.13	22.30
1967	2	28.00	28.00	21.32	23.16	23.16	16.13	17.52	17.52	20.78	22.57	22.57
1967	3	30.80	31.35	22.95	22.66	22.27	17.57	17.35	17.05	22.39	22.11	21.72
1967	4	29.67	29.41	22.52	23.08	23.29	17.34	17.77	17.93	21.98	22.53	22.73
1967	5	30.86	31.26	22.86	22.53	22.24	17.79	17.53	17.31	22.34	22.02	21.73
1967	6	30.46	30.32	22.98	22.95	23.05	17.78	17.75	17.83	22.45	22.42	22.52
1967	7	30.71	30.59	21.62	21.41	21.49	17.36	17.20	17.26	21.18	20.98	21.06
1967	8	31.19	31.11	22.39	21.83	21.89	17.84	17.40	17.44	21.92	21.37	21.43
1967	9	30.75	30.63	22.87	22.62	22.71	17.84	17.65	17.71	22.34	22.13	22.16
1967	10	30.55	30.31	22.73	22.63	22.81	17.50	17.43	17.56	22.19	22.10	22.27
1967	11	29.70	30.05	22.23	22.76	22.50	17.07	17.48	17.28	21.69	22.21	21.95
1967	12	30.77	30.71	22.73	22.47	22.52	17.20	17.00	17.04	22.15	21.89	21.94
Annual	Ave	364.02	364.07	269.97	270.79	270.77	208.85	209.43	209.42	263.63	264.42	264.41
1968	1	30.86	21.26	22.39	22.07	21.78	17.52	17.27	17.05	21.88	21.36	21.28
1968	2	29.36	29.03	22.07	22.86	23.12	16.57	17.16	17.36	21.50	22.27	22.53
1968	3	30.77	30.71	22.74	22.48	22.53	17.38	17.18	17.22	22.18	21.92	21.97
1968	4	30.52	30.24	22.36	22.28	22.49	17.16	17.10	17.26	21.82	21.74	21.95
1968	5	30.80	31.35	22.16	21.88	21.50	17.50	17.28	16.98	21.67	21.40	21.02
1968	6	29.67	29.41	21.17	21.70	21.89	16.81	17.23	17.38	20.72	21.24	21.45
1968	7	30.86	31.26	21.38	21.07	20.80	18.03	17.77	17.54	21.03	20.73	20.46
1968	8	32.11	31.66	22.89	21.68	21.99	18.57	17.59	17.84	22.45	21.26	21.57
1968	9	29.06	29.26	21.38	22.38	22.23	16.39	17.16	17.04	20.86	21.94	21.89
1968	10	31.19	31.11	22.68	22.12	22.17	17.36	16.93	16.97	22.13	21.58	21.64
1968	11	30.75	30.63	22.41	22.17	22.25	17.16	16.97	17.04	21.86	21.62	21.70
1968	12	30.55	30.31	21.85	21.76	21.93	16.89	16.82	16.95	21.23	21.24	21.40
Annual	Ave	366.52	366.24	265.48	264.44	264.69	207.34	206.46	206.63	259.43	258.41	258.65

continued

TABLE 7: PER CAPITA CONSUMPTION OF FLUID MILK IN ONTARIO, 1966-71 UNADJUSTED AND ADJUSTED FOR VARIATION IN CALENDAR COMPOSITION (concluded)

Year	Month	Mix Day1	Mix Day2	Southern Ontario			Northern Ontario			Ontario as a Whole		
				Unadjusted	Adjusted1	Adjusted2	Unadjusted	Adjusted1	Adjusted2	Unadjusted	Adjusted1	Adjusted2
				Pounds/Per Capita/Per Month								
1969	1	30.80	31.35	22.27	21.99	21.61	17.25	17.03	16.74	21.75	21.48	21.10
1969	2	28.00	28.00	20.56	22.33	22.33	16.01	17.39	17.39	20.09	21.82	21.82
1969	3	30.71	30.59	22.32	22.11	22.19	17.19	17.03	17.09	21.79	21.58	21.66
1969	4	29.83	30.08	21.49	21.91	21.73	16.84	17.17	17.03	21.01	21.42	21.23
1969	5	32.11	31.66	22.79	21.59	21.89	17.92	16.97	17.21	22.29	21.11	21.41
1969	6	29.06	29.26	20.80	21.77	21.63	16.91	17.70	17.58	20.40	21.35	21.21
1969	7	31.19	31.11	21.36	20.83	20.88	17.70	17.26	17.31	20.98	20.46	20.51
1969	8	30.77	30.71	22.20	21.94	21.99	18.14	17.93	17.97	21.78	21.53	21.57
1969	9	30.52	30.24	22.41	22.33	22.54	17.25	17.19	17.35	21.87	21.79	22.00
1969	10	30.80	31.35	22.72	22.44	22.04	16.99	16.73	16.48	22.13	21.85	21.47
1969	11	29.67	29.41	21.72	22.26	22.46	16.42	16.83	16.98	21.17	21.70	21.89
1969	12	30.86	31.26	22.38	22.06	21.77	17.32	17.07	16.85	21.85	21.53	21.2[illegible]
Annual	Ave	364.34	365.02	263.02	263.56	263.08	205.94	206.35	205.98	257.11	257.44	257.[illegible]
1970	1	32.11	31.66	22.95	21.74	22.05	17.27	16.36	16.59	22.36	21.18	21.48
1970	2	28.00	28.00	20.53	22.30	22.30	15.76	17.12	17.12	20.04	21.77	21.77
1970	3	30.55	30.31	21.81	21.72	21.89	17.39	17.32	17.45	21.35	21.26	21.42
1970	4	29.70	30.05	21.60	22.12	21.86	16.58	16.98	16.78	21.08	21.59	21.33
1970	5	30.77	30.71	21.60	21.35	21.40	17.10	16.90	16.94	21.14	20.89	20.94
1970	6	30.52	30.24	21.55	21.47	21.68	17.41	17.35	17.51	21.12	21.05	21.24
1970	7	30.80	31.35	21.42	21.15	20.78	18.35	18.12	17.80	21.10	20.84	20.47
1970	8	30.71	30.59	21.84	21.63	21.71	18.34	18.17	18.23	21.48	21.28	21.35
1970	9	29.83	30.08	21.69	22.12	21.93	17.20	17.54	17.39	21.22	21.64	21.46
1970	10	32.11	31.66	23.34	22.11	22.42	18.13	17.17	17.42	22.83	21.60	21.93
1970	11	29.06	29.26	21.33	22.33	22.18	17.22	18.03	17.90	20.90	21.38	21.73
1970	12	31.19	31.11	22.25	21.70	21.75	17.32	16.89	16.93	21.74	21.20	21.26
Annual	Ave	365.36	365.03	261.91	261.73	261.95	208.07	207.93	208.07	256.33	256.16	256.3[illegible]
1971	1	30.77	30.71	21.89	21.64	21.68	17.10	16.90	16.94	21.39	21.14	21.19
1971	2	28.00	28.00	20.32	22.07	22.07	15.86	17.23	17.23	19.85	21.56	21.56
1971	3	30.86	31.26	22.16	21.84	21.56	17.44	17.19	16.97	21.67	21.36	21.08
1971	4	30.46	30.32	21.92	21.89	21.99	16.87	16.84	16.92	21.40	21.37	21.48
1971	5	30.71	30.59	21.76	21.55	21.63	17.30	17.14	17.20	21.29	21.09	21.17
1971	6	29.83	30.08	21.02	21.43	21.26	17.14	17.48	17.33	20.62	21.03	20.85
1971	7	32.11	31.66	22.10	20.93	21.23	18.92	17.92	18.17	21.77	20.62	20.91
1971	8	30.55	30.31	21.55	21.46	21.63	18.14	18.06	18.20	21.20	21.11	21.27
1971	9	29.70	30.05	21.60	22.12	21.86	17.07	17.48	17.28	21.13	21.64	21.36
1971	10	30.77	30.71	22.30	22.04	22.09	17.48	17.28	17.32	21.80	21.55	21.59
1971	11	30.52	30.24	22.41	22.33	22.54	17.31	17.25	17.41	21.88	21.80	22.01
1971	12	30.80	31.35	22.13	21.85	21.47	16.50	16.29	16.01	21.55	21.28	20.91
Annual	Ave	365.10	365.29	261.16	261.16	261.01	207.13	207.06	206.98	255.55	255.54	255.40

Source: Monthly Dairy Report [5]
Mix Day1 = Estimated on the basis of Canadian Daily Weights for Adjustment; Mix Day2 = Based on the US Weights
Adjusted Consumption = Actual Consumption/Mix Days * 30.4 Days

APPENDIX B

Measurement of Seasonal Variation in Time-Series Data

The moving average and dummy variable approaches are commonly used for measuring seasonal variation in monthly data. In general, a monthly time-series data is a composite of secular trend, seasonal variation, cyclical movements, calendar composition and irregular fluctuations. The basic concept of the moving average approach is one way of isolating the seasonal variation in data by excluding the elements of secular trend, cyclical movements, calendar composition and irregular fluctuation from the time-series data.

Alternatively, zero-one dummy variables can be used in a regression analysis to measure seasonal shifts in demand schedule within the year. One way of the specification of the dummy variable matrix for this purpose is illustrated in Table 8.

A seasonal index for consumption obtained from a moving average approach measures the combined effect of all relevant economic factors on seasonal variation in consumption.[1/] On the other hand, in the dummy variable approach the index is measured by the coefficients of dummy variables from regression analysis. Those coefficients are obtained by removing the impact of all explanatory variables used in the regression on consumption. In this study, the seasonal index obtained from the dummy variable approach represent the consumer's purchase pattern and excludes the impact of price variation on purchases.

1/ The authors are willing to provide an IBM program for calculating seasonal index upon request.

TABLE 8: The Specification of Seasonal Variation by Dummy Variables

Months	S_4	S_5	S_6	S_7	S_8	S_9	S_{10}	S_{11}	S_{12}	S_{13}	S_{14}
January	1										
February	0	1									
March	0	0	1								
April	0	0	0	1							
May	0	0	0	0	1						
June	0	0	0	0	0	1					
July	0	0	0	0	0	0	1				
August	0	0	0	0	0	0	0	1			
September	0	0	0	0	0	0	0	0	1		
October	0	0	0	0	0	0	0	0	0	1	
November	0	0	0	0	0	0	0	0	0	0	1
December	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1

The differences between any two indexes measured by those two approaches indicate the amount of seasonal variation attributable to price variations in the estimating relations. Under OMMB fluid milk pricing arrangements, the magnitude of variation in monthly average prices has been limited. Therefore, as shown in the following diagram, any pair of the seasonal indexes are almost the same.

FIGURE 2: Seasonal Variation in Per Capita Consumption of Fluid Milk in Southern Ontario by Moving Average and Dummy Variable Approaches, 1966-1971 Average

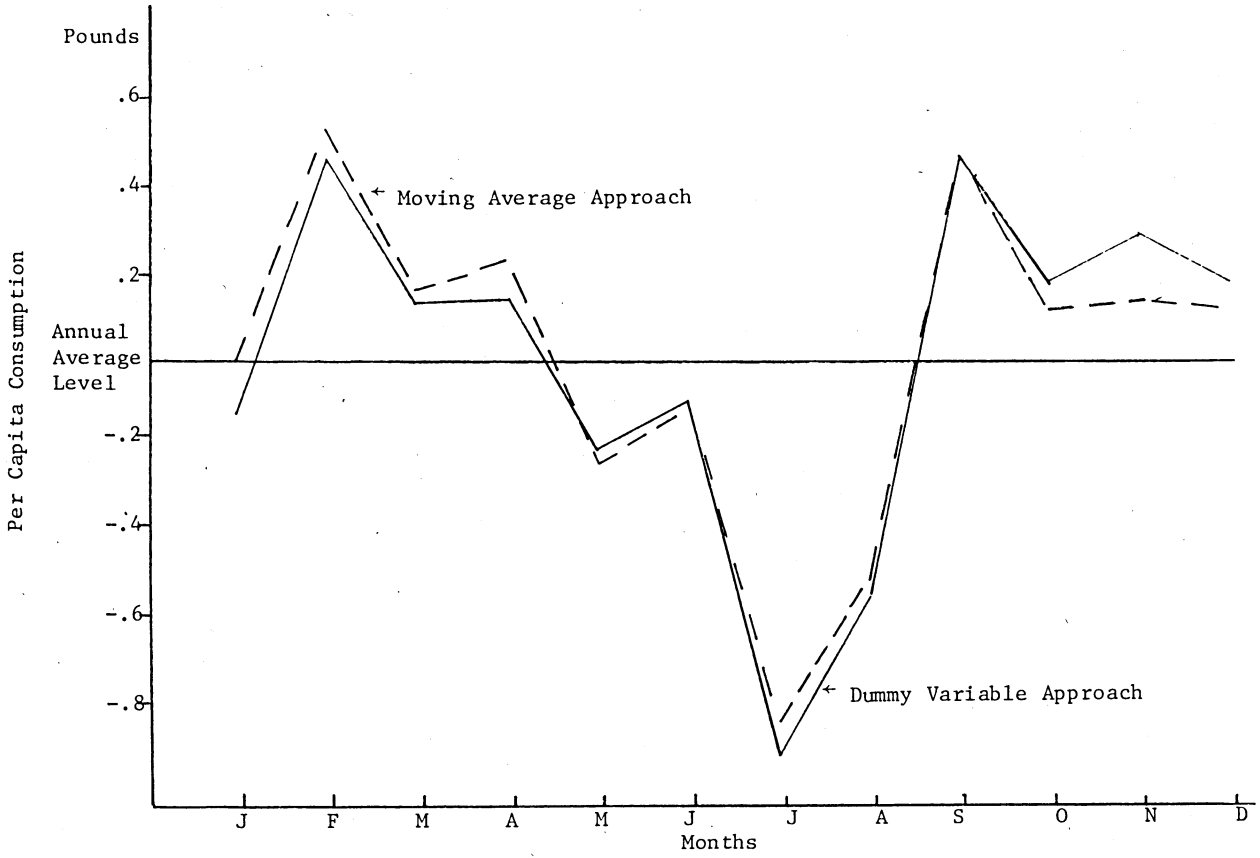


FIGURE 3: Seasonal Variation in Per Capita Consumption of Fluid Milk in Northern Ontario by Moving Average and Dummy Variable Approaches, 1966-1971 Average

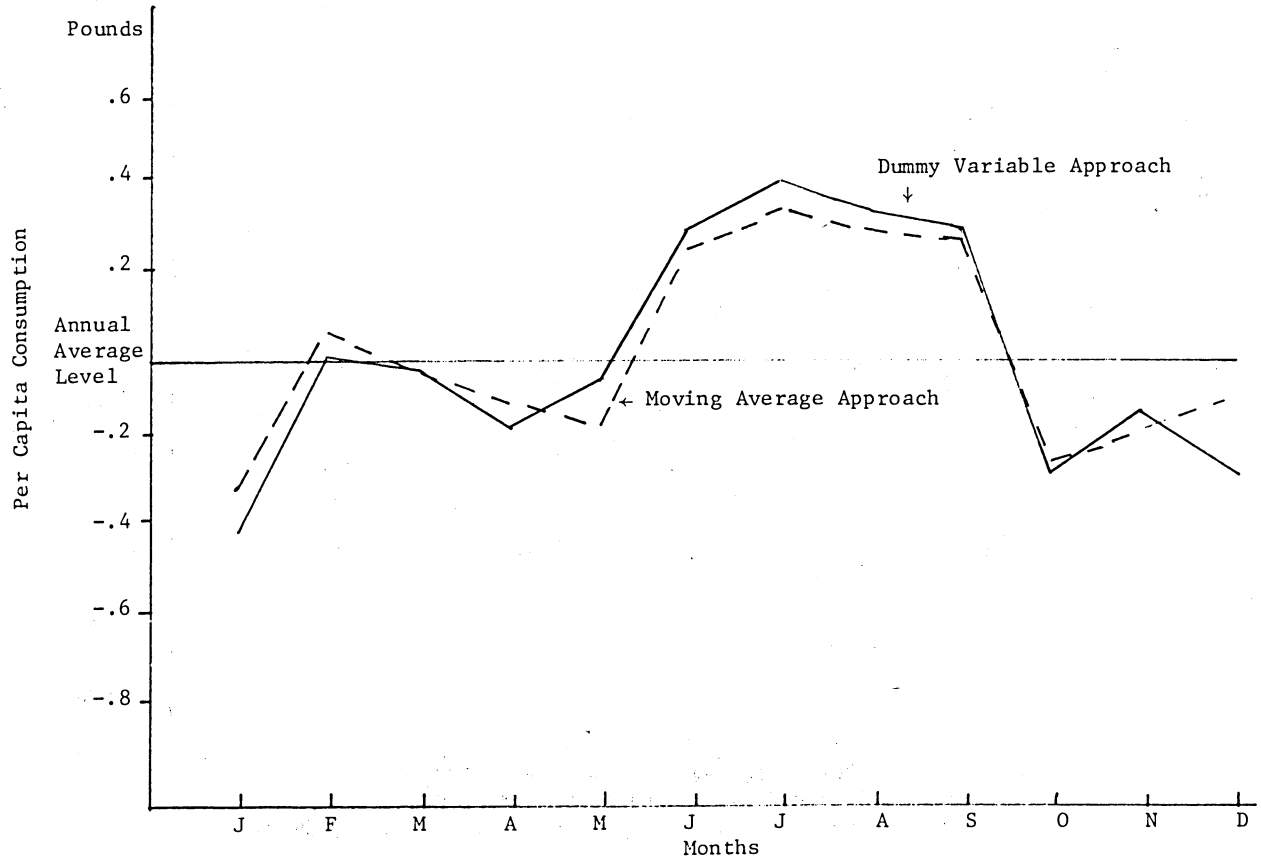
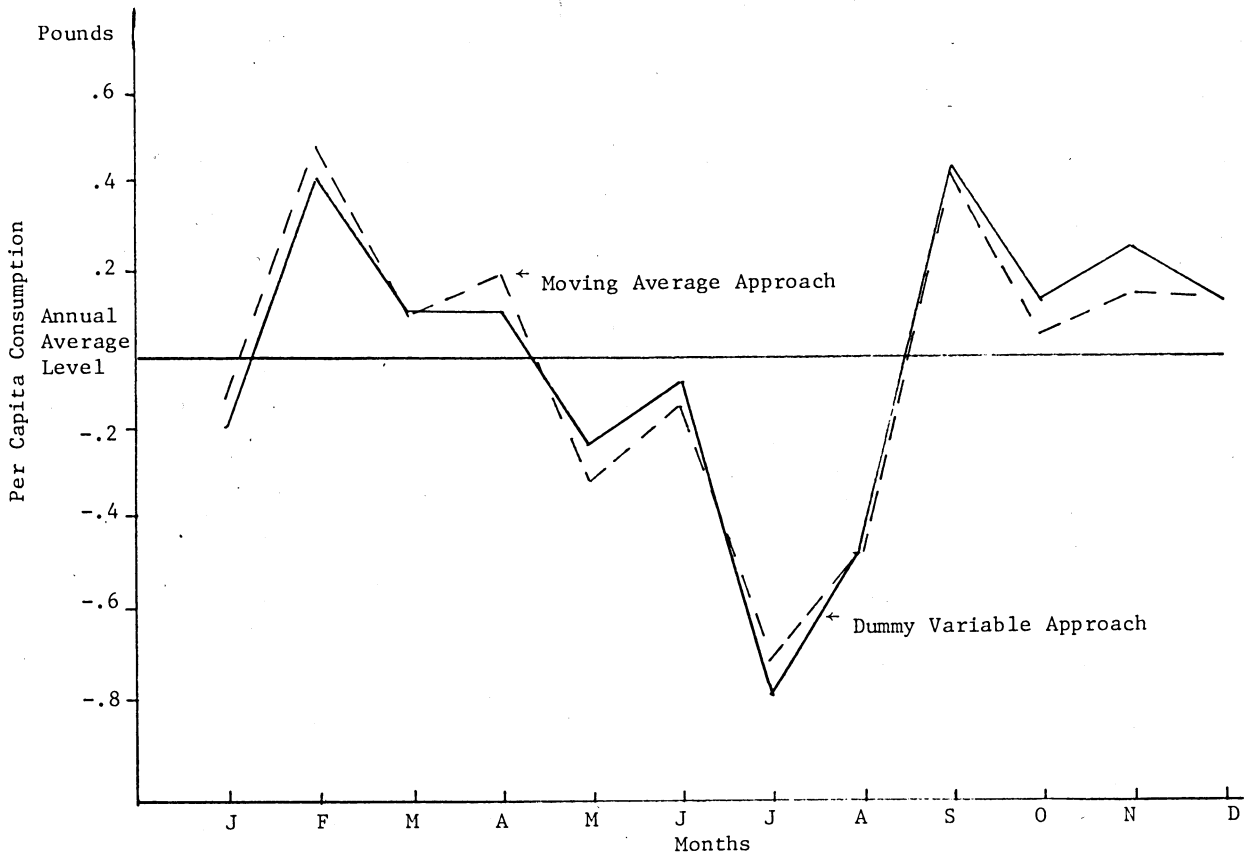


FIGURE 4: Seasonal Variation in Per Capita Consumption of Fluid Milk in Ontario by Moving Average and Dummy Variable Approaches, 1966-1971 Average



APPENDIX C

Selection of Data Set Used for Time-Series Analysis

In the preliminary empirical studies, two sets of quantities of fluid milk consumed (data were adjusted for eliminating the biases arising from the variations in calendar composition by the OMMB and the USDA weekly sales index) and two sets of prices and income series (undeflated and deflated by the CPI) were used. According to the following judgement, the data set of quantities adjusted by the OMMB index and undeflated prices and income series was chosen.

OMMB data vs. USDA data

In general, the criteria employed for evaluating the regression results are: (1) the statistical significance of regression coefficient, (2) the magnitude of coefficient of determination or the magnitude of standard error of estimate, (3) the problem of autocorrelation, and (4) the problem of multicollinearity. On the basis of the above criteria, the results obtained from the data sets of OMMBUNDEF and USDAUNDEF were almost identical. Similarly, no significant difference was found between the results obtained from the data sets of OMMBDEF and USDADEF (see Table 9). These findings may suggest that both the OMMB and the USDA data sets are equally applicable for this study from the statistical standpoint. However, no basis has been found with confidence to assume that it is desirable to apply the U.S. market information for investigating the characteristics of demand for fluid milk in Ontario. Therefore, it is concluded that the OMMB data set is superior to the USDA data set for the purpose of this study.

TABLE 9: Preliminary Results of Regression Analyses of Consumption Function for Fluid Milk in Southern Ontario, 1966-71, Obtained From Various Data Sets

Variables	Units	OMMBUNDEF Coeff.	OMMBUNDEF S.E.	OMMBDEF Coeff.	OMMBDEF S.E.	USDAUNDEF Coeff.	USDAUNDEF S.E.	USDADEF Coeff.	USDADEF S.E.
Quantity Consumed	lb/p.c.								
Constant	lb/p.c.	25.47	-	27.49	-	29.18	-	31.96	-
Price of Fluid Milk	$/cwt.	-0.57**	0.21	-0.76**	0.32	-0.66**	0.24	-0.89**	0.36
Disposable Income	$100/p.c.	-0.05	0.24	-1.02**	0.27	-0.07	0.26	-1.21**	0.29
Lagged Consumption	lb/p.c.	0.01	0.02	0.01	0.13	-0.01	0.13	-0.01	0.13
Price of Orange Juice	¢/6 oz.	-0.24	0.24	-0.41++	0.31	-0.25	0.26	-0.45++	0.36
January	lb/p.c.	-0.12	0.13	-0.10	0.14	-0.13	0.15	-0.11	0.15
February	"	0.45**	0.13	0.48**	0.14	0.48**	0.15	0.51**	0.15
March	"	0.10	0.15	0.09	0.15	0.11	0.16	0.11	0.17
April	"	0.13	0.14	0.11	0.14	0.17	0.15	0.14	0.15
May	"	-0.21++	0.14	-0.23++	0.14	-0.20	0.15	-0.22++	0.15
June	"	-0.08	0.14	-0.09	0.14	-0.12	0.15	-0.14	0.17
July	"	-0.88**	0.13	-0.91**	0.14	-0.98**	0.15	-1.02**	0.15
August	"	-0.47*	0.18	-0.46*	0.18	-0.44*	0.19	-0.44*	0.20
September	"	0.49**	0.15	0.50**	0.15	0.37*	0.15	0.36*	0.16
October	"	0.15	0.15	0.15	0.16	0.25++	0.16	0.27++	0.16
November	"	0.28*	0.14	0.29*	0.14	0.33*	0.15	0.35*	0.16
December	"	0.16	-	0.17	-	0.16	-	0.19	-
Coefficient of Determination		0.716		0.699		0.686		0.666	
Standard error of Estimate		0.345		0.355		0.378		0.390	
Mean of Dependent Variable		22.11		22.11		22.11		22.11	
Durbin-Watson Statistic		2.099+		2.124+		2.048+		2.064+	

**Significant at 1%, * significant at 5%, ++ significant at 20%, + no auto-correlation indicated.
OMMBUNDEF: Quantity consumed were adjusted by the OMMB weekly sales index and price and income series were not deflated.
DEF stands for deflated data and USDA stands for the USDA weekly sales index.

Undeflated data vs. Deflated data

In general, marked increases in the general price level are attributed to inflation. The process designed to account for the influence of inflation on prices of commodities in price analyses is called deflation. Price analysts frequently deflate the data set by dividing the original price series by the Consumer Price Index or the General Wholesale Price Index. Shepherd indicated that no standard technique of deflation is applicable to all problems "but this process is effective and accurate only if the relation between the price of the good and the deflator is 1 to 1" [9, p. 121]. The price of fluid milk in Ontario is determined by the OMMB. The changes in prices are mainly affected by the price policy of the OMMB rather than affected directly by inflation. In this case, the assumption of the one-to-one relationship between the price of milk and the CPI may not be valid. This implies that it is inappropriate to use the CPI as a deflator. According to the empirical studies, some unexpected results were found from the deflated data set. As shown in Table 9, the estimated regression coefficients of the variables of disposable income and price of orange juice associated with the OMMBDEF (deflated) data set were negative. These findings conflicted with the postulated hypotheses of positive income elasticity for fluid milk and positive cross elasticity between fluid milk and orange juice. On the other hand, these weaknesses were not found in the undeflated data set. Therefore, the undeflated data set was used in this study.

APPENDIX D

Comparisons of Empirical Results of Preliminary Time-Series Analyses Obtained by Stepwise Sequences

Statistical theory dictates that the more variations in the independent variable explained in a regression equation, the higher the magnitude of the coefficient of determination associated with the equation will be. The stepwise regression approach is one way of computing a sequence of multiple regression equations in a stepwise manner. By this way, the influence of an individual factor on the fluctuations in the dependent variable can be detected. As shown in Table 10, five steps have been used to estimate the consumption function for fluid milk in Southern Ontario. In step I, the regression equation was specified as that the quantity of milk consumed was a function of the seasonal variation in consumers preferences toward milk alone. The result of the coefficient of determination indicated that 37 percent of fluctuations in per capita consumption of fluid milk can be explained by seasonal variation in consumption. In step II, an additional variable of price of fluid milk was introduced into the equation and resulted in an increase in the coefficient of determination by 33 percent. This implied that 33 percent of fluctuations in milk consumption was contributable to changes in price. In steps III, IV, and V, variables of disposable income, lagged consumption fluid milk, and price of orange juice were added sequentially. The increase in the magnitude of the coefficient of determination was negligible in each step. The aggregated effects of those three variables on fluctuations in milk consumption was less than one percent. In addition, the regression coefficients associated with these variables were statistically equal to zeros. It is inferred that per capita consumption of fluid milk was not affected by disposable income, lagged consumption,

TABLE 10: Preliminary Results of Consumption Function For Fluid Milk in Southern Ontario, 1966-71, Estimated by a Stepwise Regression Analysis

Variables	Units	Step I Coeff.	Step I S.E.	Step II Coeff.	Step II S.E.	Step III Coeff.	Step III S.E.	Step IV Coeff.	Step IV S.E.	Step V Coeff.	Step V S.E.
Quantity Consumed	lb/p.c.					Dependent Variable					
Constant	lb/p.c.	22.12		26.50		26.24		24.32		25.47	
Price of Fluid Milk	$/cwt.	-		-0.68**	0.08	-0.58**	0.22	-0.56**	0.22	-0.57**	0.22
Disposable Income	$100/p.c.	-		-		-0.11	0.22	-0.08	0.23	-0.05	0.23
Lagged Consumption	lb/p.c.	-		-		-		0.01	0.02	0.01	0.02
Price of Orange Juice	¢/6 oz.	-		-		-		-		-0.25	0.24
January	lb/p.c.	-0.05	0.20	-0.12	0.13	-0.12	0.13	-0.13	0.14	-0.12	0.14
February	"	0.55**	0.20	0.46**	0.13	0.46**	0.13	0.46**	0.14	0.45**	0.14
March	"	0.14	0.20	0.13	0.13	0.13	0.13	0.09	0.15	0.10	0.15
April	"	0.23	0.20	0.14	0.13	0.14	0.13	0.13	0.14	0.13	0.14
May	"	-0.16	0.20	-0.20++	0.13	-0.20++	0.13	-0.21++	0.14	-0.21++	0.14
June	"	-0.06	0.20	-0.09	0.13	-0.09	0.13	-0.07	0.14	-0.08	0.14
July	"	-0.95**	0.20	-0.89**	0.13	-0.89**	0.14	-0.88**	0.14	-0.88**	0.14
August	"	-0.34++	0.20	-0.53**	0.13	-0.52**	0.13	-0.45**	0.15	-0.47**	0.15
September	"	0.32++	0.20	0.46**	0.13	0.46**	0.14	0.50**	0.15	0.49**	0.15
October	"	0.11	0.20	0.18++	0.13	0.17++	0.14	0.13	0.14	0.15	0.14
November	"	0.19	0.20	0.29**	0.13	0.28*	0.14	0.27*	0.14	0.28*	0.14
December	"		-	0.18	-	0.19	-	0.16	-	0.16	-
Coefficient of Determination		0.374		0.708		0.709		0.710		0.716	
Standard Error of Estimate		0.515		0.341		0.343		0.345		0.345	
Mean of Dependent Variable		22.11		22.11		22.11		22.11		22.11	
Durbin-Watson Statistic		1.156+		1.922+		1.930+		2.098+		2.099+	

** Significant at 1%, * significant at 5%, ++ significant at 20%, + no auto-correlation indicated.

Step I = Q=f (Seasonality)
Step II = Q=f (S, Price of Milk)
Step III = Q=f (S, PM, Disposable Income)
Step IV = Q=f (S, PM, DI, Lagged Consumption)
Step V = Q=f (S, PM, DI, LC, Price of Orange Juice)

and price of orange juice and thus these three variables were excluded from the model.

Similarly, the stepwise regression approach was applied to estimate the consumption functions for fluid milk in Northern Ontario and Ontario as a whole. The results also indicated that there were no casual relationships existed among those variables. The empirical results were not reported.

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