Apples - Prices

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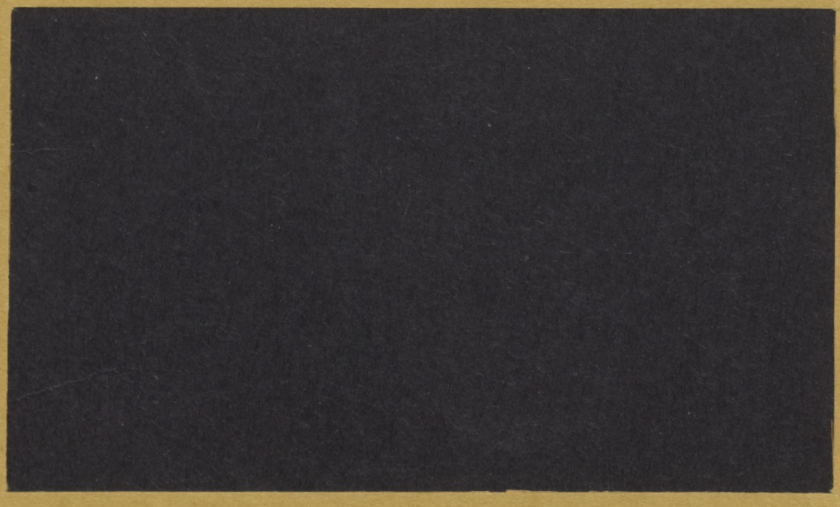

AN ECONOMETRIC ANALYSIS OF APPLE PRICES IN CANADA, WITH SPECIAL REFERENCE TO ONTARIO

by

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The authors alone remain responsible for any errors in the final report.

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1.0 THE CANADIAN APPLE MARKET

In 1972 apples generated 12.3 million dollars of income for Ontario apple producers, accounting for 30 percent of the total income derived from fruit crops.

Canadian apple production during 1967/68 - 1970/71 was 31.5 percent larger than production during 1957/58 - 1960/61. This increase in production has been absorbed mainly by the processing industry and to a lesser extent by fresh consumption. In 1967/68 - 1970/71, 42.9 percent of the apple crop was utilized in fresh consumption while 35.1 percent was processed and 13.3 percent exported.

Fresh consumption was the largest user of Canadian apples during the 1960's but the share of apples utilized in processing has increased at the expense of exports and fresh consumption (Table 1).

During the last decade apple production in Ontario has increased more rapidly than in Canada as a whole. Likewise the consumption of apples

TABLE 1: Outlets of Canadian Grown Apples in the Four Year Periods 1957/58 - 1960/61 and 1967/68 - 1970/71

(Yearly Averages Over Four Year Period, in 1000 lb)

Periods	Production	Fresh Consumption	Processing	Exports	Waste 1/
1957/58 - 1960/61	709,504	334,337	204,626	110,656	59,885
% of Production	100%	47.1%	28.8%	15.6%	8.5%
1967/68 - 1970/71	933,332	399,978	327,960	124,512	80,882
% of Production	100%	42.9%	35.1%	13.3%	8.7%

1/ Waste is assumed to be 10 percent of production minus exports.

in all uses has increased substantially in Ontario.

Per capita consumption of fresh apples in Canada has been rather static, averaging 22.8 pounds in 1957/58 - 1960/61 and 22.2 pounds in 1967/68 - 1970/71. Consequently, most of the increase in fresh apple consumption has been due to a 20.4 percent increase in population.

Per capita fresh apple consumption in Ontario increased from about 18.6 pounds per person in 1957/58 - 1960/61 to 22.3 pounds in 1967/68 - 1970/71.

Processing of apples became increasingly important in Canada and Ontario during the 1960's (Tables 1 and 2). Apples are processed into a great many products but the greatest growth has occurred in apple sauce and apple juice.

Apple exports as a percent of production declined during the 1960's. Since 1968 exports to overseas countries, in particular the United Kingdom, have dropped substantially while exports to the United States have remained constant. The United States is now the single most important importer of Canadian apples.

2.0 OBJECTIVES

This paper presents the results of an econometric analysis of the apple markets in Ontario, Canada, and North America. The objective of the paper is to provide quantitative information about price formation that can be used in developing marketing policies for apples.

Quantitative analysis of the Canadian apple market is scarce. Burns [1] provides a description of the Canadian apple industry and Kulshrestha [4]

TABLE 2: The Canadian and the Ontario Apple Markets During Two Four Year Periods

(In 1000 Lb)

Periods	Production		Imports 1/	Total Supply	Fresh Consumption	Processing	Exports 2/	Waste
	Index	In 1000 Lb.						
CANADA								
1957/58 - 1960/61	100	709,504	53,199	762,703	384,876	204,626	110,656	62,545
% of Total Supply		93%	7.0%	100%	50.5%	26.8%	14.5%	8.2%
1967/68 - 1970/71	131.5	933,332	68,140	1,001,472	464,711	327,960	124,512	82,289
% of Total Supply		93.2%	6.8%	100%	46.4%	32.7%	12.4%	8.4%
ONTARIO								
1957/58 - 1960/61	100	183,426	26,876	210,302	109,726	73,333	8,418	18,825
% of Total Supply		87.2%	12.8%	100%	52.2%	34.8%	4.0%	9.0%
1967/68 - 1970/71	155.6	285,486	32,618	318,104	164,435	100,572	25,728	27,369
% of Total Supply		89.7%	10.3%	100%	51.7%	31.6%	8.1%	8.6%

Figures derived from non published data of the Ontario Department of Agriculture.

1/ Movements from other provinces inclusive, in the case of Ontario.

2/ Movements to other provinces inclusive, in the case of Ontario.

estimated the demand for apples in his study of the demand for fruits and vegetables. In general neither of these studies provide the detailed information regarding price formulation that is needed to analyze Canadian apple marketing policy.[1/]

In order to remedy this situation four different but interrelated aspects of apple price formulation are investigated in this study. They are:

1. Price differences due to market outlet. Canadian apples have three primary outlets, fresh consumption, processing and export. Prices in each of the markets will differ since they are affected by different demand factors. Therefore the demand for each use is estimated separately.

2. Geographic price differences. The Ontario apple market is an open market vis a vis the other Canadian provinces. Consequently, changes in production and demand in the other provinces have an important effect on the prices received by Ontario apple producers. Similarly the Canadian market operates within the scope of a broader North American apple market. Substantial quantities of apples are imported and exported from the United States each year. For this reason it is necessary to consider price making forces in the geographically separated markets.

3. Price relationships at different market levels. An important dimension in agricultural price policy is the relationship among retail,

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1/ Estimates of future apple demand by Burns [1] and Kulshrestha [4] are inconsistent. Burns predicted that annual per capita apple consumption would increase to 46 pounds by 1980. This figure was based on an estimated increase in the consumption of processed apples of 5.5 pounds and a 0.5 pound increase in the consumption of fresh apples.

Kulshrestha predicted a 48 percent increase in per capita consumption of fresh apples and a modest 14.8 percent increase in consumption of processed apples by 1980. Developments until 1971 appear to support Burns' predictions.

wholesale, and producer prices. In particular it is important to know how changes in price at the producer level work through the market to change price and utilization at the retail level.

4. Price changes over time. Agricultural price policy is primarily aimed at keeping annual average prices at profitable levels. Nevertheless marketing policy can have a substantial effect on short run or monthly price relationships. For this reason it is important to have a quantitative understanding of price formulation for both annual and monthly prices.

2.1 Outline of Report

In section 3 three models of annual price behavior are formulated and estimated. Section 4 presents the results of estimating two monthly models of apple price formulation. Section 5 makes use of household expenditure survey data to estimate the income elasticity of all fresh and processed fruit. In section 6 the results of the study are summarized.

3.0 ANALYSIS OF ANNUAL APPLE PRICES

In analyzing annual market prices for apples three economic models are formulated and estimated. The three models vary according to the degree of aggregation and geographic coverage.

All of the equations are assumed to be linear in logarithums and consequently elasticities can be read directly from the coefficient estimates. Supply is assumed to be predetermined for the crop year and all of the structural equations are overidentified. All three models are estimated using two stage least squares and data from 1950 through 1970.

3.1 Model 1: Apple Prices in Canada and Ontario

Model 1 contains the following endogenous variables: the farm price of Canadian apples, the farm price of processed Canadian apples, the retail price of apples, the pounds per capita of apples processed in Canada, net apple exports from Canada, the consumption of fresh apples in Canada, the farm price of apples in Ontario, and the processing per capita of apples in Ontario.[2/]

In general the results of estimating the eight equations in model 1 are unsatisfactory. A large number of the coefficient estimates are not statistically different from zero. In particular estimates of the farm price of apples and per capita fresh consumption of apples, in Canada are unsatisfactory. Since these equations are crucial in the prediction of future prices, model 1 is reformulated.

3.2 Model 2: A Simplified Model of the Canadian Apple Market

Model 2 is a reformulation of model 1 with the basic change being that Ontario is not considered explicitly. Therefore, model 2 represents a higher level of aggregation than does model 1. Model 2 attempts to explain prices and utilizations within the entire Canadian apple market. The market is closed with the exception of a single export (net) equation. Model 2 contains 5 endogenous variables and ten predetermined variables.

Table 3 presents the equations estimated and the variable definitions. Variables considered endogenous are separated from predetermined variables by a semi-colon.

2/ Separate export and import functions were tried initially. In general they didn't perform as well as the single net export equation.

TABLE 3: Model 2, A Simplified Model of the Canadian Apple Market

1. Average annual farm price of apples in Canada

$$PC_t = f_1(QPRC_t, QEC_t, CCC_t; QPC_t, QPUS_t, Y_t)$$

2. Per capita processing of apples in Canada

$$QPRC_t = f_2(PC_t; Y_t, QPRC_{t-1})$$

3. Average annual retail price of apples in Canada

$$PRC_t = f_3(PC_t; W_t, PRC_{t-1}, PFC_t)$$

4. Per capita net exports of apples from Canada

$$QEC_t = f_4(QPC_t, QPUS_t, D_t)$$

5. Per capita citrus consumption in Canada

$$CCC_t = f_5(PRC_t; PO_t, Y_t, T)$$

IDENTIFICATION OF VARIABLES

Endogenous Variables :

PC_t = annual grower price of apples in Canada, deflated by the Canadian price index for all farm products, in cents per pound [2, 8].

$QPRC_t$ = annual processing of apples in Canada, in pounds per capita [2, 7].

PRC_t = annual retail price of apples in Canada, deflated by the consumer price index for all items in Canada, in cents per pound [8].

QEC_t = annual Canadian net apple exports (exports minus imports), in pounds per capita [2, 7].

CCC_t = per capita Canadian citrus consumption in pounds [7, 10].

TABLE 3 continued

Predetermined Variables:

QPC_t = annual production of apples in Canada in pounds per capita [2, 7].

$QPUS_t$ = annual production of apples in the United States in pounds per capita [12, 13].

Y_t = annual per capita disposable income in Canada, deflated by the consumer price index for all items, in dollars [7, 8].

QPC_{t-1} = QPC_t lagged one year.

W_t = annual weekly wages in trade in Canada, deflated by the consumer price index for all items, in dollars [7, 8].

PRC_{t-1} = PRC_t lagged one year.

PFC_t = retail price index of all fruits in Canada [8].

D_t = zero one dummy variable equal to one for 1968/69 and following years and zero for all others.

PO_t = annual retail price of oranges, deflated by the consumer price index for all items, in cents per pound [8].

T = trend, 1950/51 = 1, 1951/52 = 2, etc.

3.3 Model 2: Structural Equations

In equation (1) the farm price of apples is expected to vary inversely with the production of apples (Table 3). With the production of apples held constant increases in the per capita processing or exporting of apples should stimulate apple prices. If citrus fruits compete with apples we would expect an increase in citrus consumption to decrease the price of apples. If apples are a normal good we would expect increasing per capita income to increase apple prices.

Equation (2) explains the quantity of apples used in processing as

a function of the farm price of apples, disposable income, and lagged production. We expect a negative relationship between processing and farm price and a positive relationship with income. Processing firms are inclined to maximize the use of their processing capacity. Therefore they may purchase apples not only on the basis of apple prices but also on the basis of their processing capacity. Unfortunately data is not available on plant processing capacity so apples processed in the past year is introduced as a proxy for plant capacity.

Equation (3) explains the retail price of apples as a function of the farm price, wage rates, the price of fruit, and the retail price lagged one year. The retail price of apples depends on the farm price of apples and the marketing margin. The marketing margin is measured by introducing a proxy variable, wage rates. The retail price index of all fruits takes account of a potential relationship between the retail price of apples and the retail price of a broad range of fresh fruits. If other fruits substitute for apples we would expect this variable to have a positive coefficient. The retail price of apples lagged one year is included to take account of the relative stability in retail prices.

The net export of apples from Canada is explained using equation (4). The major factor explaining the export of Canadian apples is the competitive relationship between the United States and Canada. When Canadian production increases holding United States production constant we would expect net exports from Canada to increase. Likewise when United States production increases holding Canadian production constant, net exports will decrease. Since apple exports to the United Kingdom decreased substantially

after 1968/69, a zero one dummy variable has been introduced to take account of this phenomena.

Equation (5) explains the per capita consumption of citrus fruit in Canada. This equation is included because we hypothesize that apple prices and citrus consumption are interdependent. Citrus consumption is assumed to depend negatively on the price of oranges and positively with the retail price of apples and income. Time is included in equation (5) to take account of the trend in per capita consumption.

3.4 Model 2: Empirical Results

Table 4 presents the results of estimating model 2 of the Canadian apple market. Student "t" values are given in parenthesis below the estimated coefficients. The value of the coefficient of determination (R^2) and the Durbin-Watson (D-W) statistic are reported.[3/] Since all of the equations are linear in logarithums the coefficient estimates represent elasticities or flexibilities.

The flexibility coefficient of Canadian grower price (equation 1) with respect to per capita Canadian production of apples is -2.19. This implies that an increase in Canadian apple production cet. par. results in a large decrease in prices causing a decline in the total farm value of apples. It should be kept in mind that the cet. par. condition is not realistic since an increase in production may cause an increase in the value of other variables

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3/ The R^2 from a two stage estimating procedure has a different interpretation than R^2 in the ordinary least squares case. For a discussion of this problem see [11]. Likewise the Durbin-Watson statistic is biased towards two when a lagged dependent variable is included in the equation [5].

TABLE 4: Estimates of the Structural Equations of Model 2: The Canadian Apple Market

Equation 1, Annual average farm price of apples in Canada

$$PC_t = 11.51 + \underset{(.60)}{.347}\ QPRC_t + \underset{(1.03)}{.156}\ QEC_t - \underset{(-1.45)}{.856}\ CCC_t - \underset{(-2.86)}{2.19}\ QPC_t$$

$$- \underset{(-.85)}{.716}\ QPUS_t + \underset{(.28)}{.278}\ Y_t$$

$R^2 = .67$ D. W. = 2.12

Equation 2, Per capita processing of apples in Canada

$$QPRC_t = -6.79 - \underset{(-2.28)}{.47}\ PC_t + \underset{(5.16)}{1.34}\ Y_t - \underset{(-.50)}{.008}\ QPRC_{t-1}$$

$R^2 = .64$ D. W. = 1.57

Equation 3, Average annual retail price of apples in Canada

$$PRC_t = 2.08 + \underset{(2.18)}{.150}\ PC_t - \underset{(-1.71)}{.657}\ W_t - \underset{(-2.50)}{.017}\ PRC_{t-1} + \underset{(2.33)}{.733}\ PFC_t$$

$R^2 = .84$ D. W. = 1.84

Equation 4, Per capita net exports of apples from Canada

$$QEC_t = -.66 + \underset{(2.91)}{2.80}\ QPC_t - \underset{(-1.55)}{2.51}\ QPUS_t - \underset{(-3.36)}{1.06}\ D_t$$

$R^2 = .57$ D. W. = 1.49

Equation 5, Per capita citrus consumption in Canada

$$CCC_t = 15.80 - \underset{(-.46)}{.176}\ PRC_t - \underset{(-3.28)}{.89}\ PO_t - \underset{(-3.20)}{1.19}\ Y_t + \underset{(1.59)}{.147}\ T$$

$R^2 = .78$ D. W. = 1.63

in the equation. This is particularly true for processing and net exports which may have a positive effect on price.

The production of apples in Canada is the only variable in equation (1) with a statistically significant coefficient at the 5 percent level.

Equation (2) indicates that the income elasticity of demand for processed apples is 1.34. In the past twenty years the increase in income, possibly in conjunction with changes in consumption habits, has stimulated the demand for processed apples. The direct price elasticity of -.47 indicates that the demand for apples, to be processed, is rather price inelastic.

All of the coefficients in equation (3) are statistically significant at the 5 percent level of significance, although the coefficient on wage rates has the wrong sign. According to equation (3) a one percent change in the farm price of apples results in a 0.15 percent change in the retail price. The limited effect of changes in grower price on retail price is a consequence of large fixed marketing margins. We have no good argument for the small negative, but statistically significant influence of lagged retail prices.

Net Canadian exports of apples increase by 2.8 percent with a one percent increase in production (equation 4). In view of the importance of Canadian apple exports to the United States we would have expected United States production to have a strong negative influence on Canadian exports. Equation 4 confirms the negative relationship but the coefficient on United States production is not statistically significant.

In equation (5) the demand for citrus fruit is found to be more price elastic than expected with an estimated elasticity of (-.89). There is a

weak positive trend in citrus consumption, which is statistically insignificant, and a statistically significant negative influence of disposable income on citrus consumption. The coefficient on apple price has the wrong sign but is not statistically significant.

The estimates of model 2 provide insight into the structural characteristics of the Canadian apple market, but appear less useful for predictive purposes. The statistical fit (R^2) for the structural equation and the reduced form equation, explaining grower price in Canada, equals .67.[4/] While the R^2 does not provide an exact measure of fit in the structural equations, the low value in the reduced form makes it doubtful if the estimated model can provide reliable predictions of the farm price of apples. Because of the crucial position of equation (1) in explaining grower prices in Canada an alternative model is developed.

3.5 Model 3: The North American Apple Market

There is considerable apple trade between Canada and the United States. During 1967/68 to 1970/71 average annual exports to the United States were 52,740,000 pounds and imports 82,460,000 pounds. The free trade in apples between the United States and Canada suggests a dependence among these apple markets. In model 2 this dependence was taken into account by an export equation. An alternative approach is to treat the Canadian and United States apple markets as one market. It is on this basis that model 3 is formulated.

4/ The reduced form equations for each model in the report were estimated. Due to space limitations they are not reproduced in the text.

Model 3 contains eight endogenous variables and thirteen predetermined variables. The equations to be estimated are presented in Table 5 along with the variable definitions.

3.6 Model 3: Structural Equations

Model 3 differs from model 2 in that the first three equations explain average apple prices and the quantity to be processed in North America (Table 5). In the remaining equations the price of apples in various market segments, East North America, Canada, and Ontario are determined.

Equation (1) expresses the annual farm price of apples in North America as a function of production, quantity of apples processed and exported, disposable income, and the quantity of oranges produced. It is hypothesized that the production of apples and the production of oranges will have a negative influence on apple price. It is assumed that changes in disposable income, and changes in the number of apples processed and exported will have a positive influence on price.

The processing of apples (equation 2) will increase as a consequence of decreasing apple prices and increasing disposable income. Quantity lagged one year is a proxy variable introduced to take account of the possible influence of available processing capacity.

The price of processing apples (equation 3) is expected to fall when the quantity of apples processed increases and when the average grower price declines.

North American apple production and consumption areas are located in the Eastern and Western sections of North America.

TABLE 5: Model 3, The North American Apple Market

1. Annual average grower price of apples in North America

$$PNA_t = f_1(QPR_t;\ QP_t,\ QE_t,\ Y_t,\ QO_t)$$

2. Per capita processing of apples in North America

$$QPR_t = f_2(PPR_t;\ Y_t,\ QPR_{t-1})$$

3. Annual average price of processing apples in North America

$$PPR_t = f_3(QPR_t,\ PNA_t;)$$

4. Annual average price of apples in East North America

$$PENA_t = f_4(PNA_t;\ QENA_t/QP_t)$$

5. Annual average grower price of apples in Canada

$$PC_t = f_5(PNA_t;\ QC_t/QP_t,\ YC_t,\ QEC_t)$$

6. Annual average retail price of apples in Canada

$$PCR_t = f_6(PC_t;\ YC_t,\ PCR_{t-1})$$

7. Annual average grower price of apples in Ontario

$$PO_t = f_7(PC_t,\ QPRO_t;\ QOA_t/QENA_t,\ YC_t)$$

8. Per capita processing of apples in Ontario

$$QPRO_t = f_8(PPR_t;\ QPO_t,\ SO_t,\ YC_t)$$

VARIABLE IDENTIFICATION

Endogenous Variables:

PNA_t = annual grower price in North America (Canada and United States) deflated by price index of all farm products, in cents per pound [2, 8, 12, 13].

TABLE 5 continued

QPR_t = quantity of apples processed in North America in pounds per capita [2, 7, 12, 13].

PPR_t = annual price of processing apples deflated by the price index of all farm products, in cents per pound [2, 6, 8, 12, 13].

$PENA_t$ = annual grower price of apples in East North America (Canada minus, British Columbia, Alberta, Saskatchewan, and Manitoba) plus Eastern United States (New York, Pennsylvania, Virginia and Michigan) deflated by the price index of all farm products, in cents per pound [2, 8, 12, 13].

PC_t = annual grower price of apples in Canada, deflated by the price index of all farm products, in cents per pound [2, 8].

PCR_t = annual retail price of apples in Canada, deflated by the consumer price index of all items in Canada, in cents per pound [8].

PO_t = annual grower price of apples in Ontario, deflated by the price index of all farm products, in cents per pound [2, 6, 8].

$QPRO_t$ = apples processed in Ontario in pounds per capita [6, 7].

Predetermined Variables:

QP_t = annual production of apples in North America in pounds per capita [2, 7, 12, 13].

QE_t = annual net exports of apples in North America, in pounds per capita [2, 7, 12, 13].

Y_t = annual disposable income in North America deflated by consumer price index all items in dollars per capita [7, 8, 13].

QO_t = annual production of oranges in the United States, in boxes per capita [12, 13].

QPR_{t-1} = QPR_t lagged one year.

$QENA_t/QP_t$ = ratio of annual apple production in East North America in pounds per capita to apple production in North America in pounds per capita [2, 7, 12, 13].

TABLE 5 continued

QC_t/QP_t	=	ratio of annual apple production in Canada per capita to apple production North America per capita in pounds per capita [2, 7, 12, 13].
YC_t	=	annual disposable income in Canada, deflated by the consumer price index of all items, in dollars per capita [7, 8].
PCR_{t-1}	=	PCR_t lagged one year.
QEC_t	=	annual Canadian exports of apples (exclusive of those to the United States), in pounds per capita [2, 7].
$QOA_t/QENA_t$	=	ratio of annual apple production in Ontario in pounds per capita to apple production in East North America in pounds per capita [2, 6, 7, 12, 13].
QPO_t	=	annual production of apples in Ontario in pounds per capita [6, 7].
SO_t	=	stocks of processed apples in Ontario (in fresh equivalent, at the end of season, June 30), in pounds per capita [6, 7].

It is important to know if these centers have their own market characteristics. Thus an attempt has been made to determine if the East North American market is a specific segment of the North American market with respect to price formulation.

The East North American price (equation 4) is specified as a function of: (1) the North American price, which takes account of the interrelationship with the North American market, and (2) the ratio of East North American production to total North American production, which takes account of the specificity of the East North American market.

The Canadian apple price is expected to be closely related to the North American apple price although there are factors that cause the Canadian

price to deviate from the North American average. Consequently, in equation (5) the Canadian price of apples is expressed as a function of: (1) the ratio of Canadian production to North American production, which should move inversely with Canadian apple prices; (2) Canadian exports (exclusive of the United States) which should strengthen Canadian prices; and, (3) Canadian disposable income, whose effect on Canadian price may differ from the effect of disposable North American income on average North American price.

Retail prices in Canada (equation 6) depend most heavily on the farm price but also depend on disposable income and price in the past period. The price lagged one year is included to take account of retailers preferences for stable prices.

The Ontario apple market is a segment of the Canadian market and consequently Ontario farm prices are strongly correlated with Canadian grower prices (equation 7). Other factors expected to affect the Ontario price of apples are: (1) the ratio of Ontario production to East North American production, which should move inversely with Ontario farm price; (2) the quantity of apples processed which is expected to have a positive influence on price; and, (3) changes in disposable income that shift the demand function.

The quantity of apples processed in Ontario (equation 8) depends on the price of apples moving into processing in North America. It is also assumed that an increase in Ontario apple production will stimulate processing because of the great importance of processing in Ontario. Disposable income should be related in a positive and end of year stocks in a negative manner with the quantity of apples processed.

3.7 Model 3: Empirical Results

The results of estimating the equations in Table 5 are given in Table 6. Again all of the equations are estimated using two stage least squares, data from 1950-1970 and double log demand functions.

As in the model of the Canadian market it appears that the price flexibility of grower price with respect to total production is, in absolute value, substantially larger than one. The price flexibility coefficient from equation (1) of -3.44 indicates a decrease in grower price of 3.4 percent for every one percent increase in production. Again it should be pointed out that the cet. par. condition is not realistic in so far as the quantities moving into processing and export markets increase with production. The coefficient on net exports has the wrong sign and is statistically insignificant. The quantity of apples moving into processing has an important positive effect on grower price but it does not seem likely that the effect of increased processing, as a consequence of increased production, compensates for the negative influence of increased production on price. This opinion is supported by a flexibility coefficient on farm price with respect to production of -1.7 in the reduced form equation. Therefore it seems reasonable to conclude that in the North American apple market an increase in apple production results in a decrease in the total farm value of an apple crop. The cross price flexibility of grower price with respect to orange production is -.22 supporting the hypothesis there is a competitive relationship between the two products.

The demand for processing apples (equation 2) has a substantial income elasticity of 1.15 and a small price elasticity of -0.26.

TABLE 6: Estimates of the Structural Equations of Model 3: The North American Apple Market

Equation 1, Annual average grower price of apples in North America

$$PNA_t = \underset{}{11.35} + \underset{(4.05)}{1.32}\ QPR_t - \underset{(-6.69)}{3.44}\ QP_t - \underset{(-1.17)}{.047}\ QE_t - \underset{(-.67)}{.175}\ Y_t - \underset{(-1.71)}{.223}\ QO_t$$

$R^2 = .91$ D.W. = 1.42

Equation 2, Per capita processing of apples in North America

$$QPR_t = \underset{}{-5.79} - \underset{(-1.76)}{.265}\ PPR_t + \underset{(3.58)}{1.15}\ Y_t - \underset{(-.57)}{.155}\ QPR_{t-1}$$

$R^2 = .65$ D.W. = 1.47

Equation 3, Annual average price of processing apples in North America

$$PPR_t = \underset{}{-1.20} + \underset{(.17)}{.028}\ QPR_t + \underset{(9.89)}{1.36}\ PNA_t$$

$R^2 = .86$ D.W. = 1.56

Equation 4, Annual average price of apples in East North America

$$PENA_t = \underset{}{.098} + \underset{(12.59)}{.985}\ PNA_t - \underset{(-2.71)}{.414}\ QENA_t/QP_t$$

$R^2 = .91$ D.W. = 1.48

Equation 5, Annual average grower price of apples in Canada

$$PC_t = \underset{}{-2.21} + \underset{(5.47)}{1.02}\ PNA_t - \underset{(-3.77)}{1.17}\ QC_t/QP_t + \underset{(.73)}{.037}\ QEC_t + \underset{(1.11)}{.296}\ YC_t$$

$R^2 = .80$ D.W. = 1.47

Equation 6, Annual average retail price of apples in Canada

$$PCR_t = \underset{}{1.10} + \underset{(6.86)}{.266}\ PC_t + \underset{(.83)}{.075}\ YC_t + \underset{(2.55)}{.312}\ PCR_{t-1}$$

$R^2 = .87$ D.W. = 2.73

TABLE 6 continued

Equation 7, Annual average grower price of apples in Ontario

$$PO_t = -1.06 + \underset{(5.56)}{1.04}\ PC_t - \underset{(-1.14)}{.245}\ QPRO_t - \underset{(-.89)}{.38}\ QOA_t/QENA_t + \underset{(.33)}{.136}\ YC_t$$

$R^2 = .80$ D.W. = 1.44

Equation 8, Per capita processing of apples in Canada

$$QPRO_t = -1.95 - \underset{(-.46)}{.034}\ PPR_t + \underset{(9.47)}{.585}\ QPO_t + \underset{(2.57)}{.124}\ SO_t + \underset{(.39)}{.083}\ YC_t$$

$R^2 = .94$ D.W. = 2.36

The price of processing apples depends mainly on the average farm price (equation 3). The elasticity coefficient of the price of processing apples with respect to the grower price is 1.36. This coefficient indicates that the price of processing apples fluctuates more, in percentage terms, than average grower prices. The sign on the quantity of apples processed is opposite to that expected but its coefficient is very close to zero.

The average farm price of apples in East North America follows a pattern similar to that for the average North American price (equation 4). However the farm price of apples in East North America deviates in a negative direction when the ratio of apple production in East North America rises relative to total production in North America.

Canadian grower prices of apples are only slightly more volatile than are average North American prices (equation 5). When Canadian production increases relative to North American production prices in Canada fall. A one percent increase in the ratio of Canadian to North American production

results in a 1.17 percent decrease in the price of Canadian apples. Although the coefficients on net exports from Canada and disposable income have the expected signs their coefficients, in equation 5, are not statistically different from zero.

The retail price of apples in Canada changed by 0.27 percent with each one percent change in Canadian grower price. This value is higher than that found in model 2 of 0.15 percent but both estimates indicate that changes in grower price work through to the retail level only to a limited extent (equation 6).

A one percent change in the grower price of apples in Canada appears to cause a 1.04 percent change in the Ontario farm price (equation 7). The other variables introduced in equation 7 to explain changes in the farm price of Ontario apples are not statistically significant at the five percent level, and one of the coefficients (quantity of apples processed) has the wrong sign.

The quantity of apples processed in Ontario (equation 8) depends to a large extent on the quantity of apples produced in Ontario. There is no evidence that increasing end of season stocks diminishes the demand for processed apples since, contrary to expectations, the variable has a positive sign.

3.8 Model 3: Conclusions

The statistical fit of the structural equations in terms of R^2 are reasonably good except for the equation relating to the quantity of apples processed (equation 5). The estimated reduced form equations also seemed to predict past behavior satisfactorily. In particular the equation relating to grower price gives a good fit, something not accomplished in models one and two. Thus it seems some of the necessary conditions for making good

predictions are fulfilled by the North American model. Whether the model can in fact predict future prices depends on the stability of the parameters estimated and the availability of reliable forecasts of the predetermined variables. Experimental use of the model is necessary to evaluate its predictive ability.

4.0 MONTHLY MODELS OF CANADIAN AND ONTARIO APPLE PRICES: INTRODUCTION

Whether a farmer realizes a satisfactory average annual price depends to some extent on apple price variations during the crop year. For this reason a short run pricing policy is needed. In this section of the report an attempt has been made to develop and estimate a model that will explain monthly apple prices. Unfortunately a lack of data has put severe constraints on the analysis. The analysis is limited to the consideration of monthly retail prices for Canadian apples during December through April. Two models of monthly price formulation are presented in sections 4.1 and 4.2.

4.1 Model 4: A Single Equation Model of Monthly Apple Price Formulation

In this model the retail price of apples in Canada is expressed as a function of the quantity of apples moved into the market, disposable income and the price of oranges. In functional form:

$$P_t = f(Q_t, PO_t, Y_t) \qquad (1)$$

where,

P_t = monthly retail price of apples in Canada, deflated by the consumer price index for all products, in cents per pound [8].

Q_t = monthly apple movements in the Canadian market in pounds per capita [2, 7].

PO_t = monthly retail price of oranges in Canada deflated by the consumer price index for all products, in cents per pound [8].

Y_t = annual per capita disposable income in Canada deflated by the consumer price index for all products, in dollars [7, 8].

Movements of apples into the market contain apples both for fresh consumption and for processing. The analysis would have been strengthened if these quantities had been introduced separately but data problems prevented this. The error involved is probably not great since from January to April the use of apples in processing is small.

No data is available on monthly disposable income, consequently annual disposable income is used as a proxy variable. The constant value of income in different months of the same year does not seem a serious drawback since consumption of apples probably adapts only gradually to a new level of income.

Equation (1) is estimated using ordinary least squares and data from 1950 to 1970. The demand function is linear in actual values.

The results of estimating equation (1) for December, January, February, March, and April are given in Table 7.

The R^2 for all of the equations are quite low. The estimated equations do show that disposable income has a positive effect on monthly prices over time. The influence of monthly market supply on retail prices is statistically significant in February, March, and April with estimated price flexibilities of -.33, -.53, and -.47 respectively. These coefficients are much smaller, in absolute value, than the estimated flexibility coefficients at the producer level, as measured in models 2 and 3. The small flexibility again reflects the effects of a large marketing margin and the fact that retail

TABLE 7: Estimates of the Monthly Retail Prices of Apples in Canada: Model 4

Period	Dep. Variables	Constant	Explanatory Variables			R^2	D.W.
			Q_t	PO_t	Y_t		
December	P_t	0.03667	-0.005245 (-0.38)	0.177501 (4.08)	0.0000018 (0.69)	0.775	1.22
January	P_t	0.1224	-0.009590 (-1.37)	-0.00409 (-0.09)	0.0000034 (2.61)	0.554	1.86
February	P_t	0.1426	-0.016945 (-2.86)	-0.00871 (-0.29)	0.0000037 (3.15)	0.661	1.65
March	P_t	0.1705	-0.03049 (-3.34)	0.006707 (0.22)	0.0000039 (3.20)	0.706	1.68
April	P_t	0.1204	-0.039026 (-3.05)	0.021387 (0.70)	0.0000071 (3.55)	0.684	1.48

prices are sticky.

The price of oranges has a statistically significant effect on apple prices only in December.

4.2 Model 5: A Two Equation Model of Monthly Apple Price Formulation

This model differs from the previous one in that the quantity of apples marketed each month is taken as an endogenous variable and explained, rather than treated as an exogenous variable.

The two equation model of monthly price behavior can be represented as

$$P_t = f(Q_t;\ PO_t,\ Y_t,\ D_t,\ P_{t-1}) \qquad (2)$$

$$Q_t = g(P_t;\ S_t,\ D_{ti}) \qquad (3)$$

where,

P_t = monthly retail price of apples in Canada deflated by the consumer price index of all products in cents per pound [8].

Q_t = monthly movements of apples in the Canadian market in pounds per capita [2, 7].

PO_t = monthly retail price of oranges in Canada deflated by the consumer price index of all products in cents per pound [8].

Y_t = annual per capita disposable income deflated by the consumer price index in Canada for all items, in dollars [7, 8].

P_{t-1} = P_t lagged one year.

S_t = stocks of apples at the beginning of the month in 1,000 pounds [2].

D_{ti} = zero one dummy variable to take account of seasonal shifts in apple prices,
when i=1, D_{t1} = one for January, zero for other months.
i=2, D_{t2} = one for February, zero for other months.
i=3, D_{t3} = one for March, zero for other months.

In view of the interdependence between movements into the market and retail price two stage least squares is used to estimate simultaneously equations 2 and 3. Model 5 is estimated using 1950-1970 data linear in actual values. The equations are estimated for three different time periods: (1) January, February, March and April; (2) January and February; and, (3) March and April. In each case dummy variables have been introduced to take account of any seasonality in prices.

Equation (2) differs from equation (1) in that the price of apples in the previous month and seasonal dummy variables have been added. In equation (3) it is expected that apple movements into the market are large when stocks at the beginning of the month are high and when retail prices are high.

The results of estimating equations (2) and (3) for the different time periods are contained in Table 8.

The general fit of the estimated equations for the March-April time period are good, but the results for the January-February period are less satisfactory.

4.3 Model 5: Structural Equations

Equations 2.1, 2.2 and 2.3 explain the retail price of apples for different time periods. A close tie between retail prices in consecutive months is apparent given the strong positive influence of lagged retail prices. Price flexibility coefficients for each month are: January (-.32); February (-.29); March (-.17) and April (-.11). The latter two coefficients are not statistically significant at the 5 percent level. The low absolute values of the flexibility coefficients demonstrate the rigidity of retail prices with respect to changes in market supply. The price flexibility coefficients tend to be smaller, in absolute value, as the season progresses.

The coefficient on the retail price of oranges is statistically significant only during the March-April time period although it has the correct sign in the other equations.

Equations 2.1, 2.2, and 2.3 indicate that monthly retail prices are positively related to disposable income over time.

Equations 3.1, 3.2, and 3.3 explain the movement of apples into the market. Size of stocks have, as expected, a positive influence on apple movements. The negative sign of the price variable in the supply equation is difficult to understand. Obviously, some factors that affect the supply of apples in the short run have been overlooked. The flexibility coefficients

TABLE 8: Estimates of the Monthly Retail Price of Apples in Canada: Model 5

Time Periods	Equation Number	Dep. Variables	Constant	Explanatory Variables							R^2	D.W.
				Q_t	P_{t-1}	PO_t	Y_t	D_1	D_2	D_3		
Jan.-April	2.1	P_t	0.009383	-0.01745 (-3.22)	+0.41426 (7.06)	0.012692 (1.01)	+0.0000027 (3.81)	-0.00462 (1.56)	-0.00329 (-0.91)	-0.00791 (-1.22)	0.72	1.91
Jan.-Feb.	2.2	P_t	0.10541	-0.01458 (-2.85)	+0.29031 (4.59)	+0.003685 (0.18)	0.00000273 (3.43)	-0.002748 (-0.90)			0.60	1.89
March April	2.3	P_t	0.017581	-0.00960 (-1.06)	+0.93489 (8.46)	+0.018986 (2.95)	0.00000095 (+0.88)			-0.002885 (-0.51)	0.96	1.83
				P_t	S_t	D_1	D_2	D_3				
Jan.-April	3.1	Q_t	2.83255	-9.17423 (-2.75)	0.00000576 (+8.74)	-0.25186 (-2.25)	0.44055 (3.04)	0.15331 (0.81)			0.76	1.73
Jan.-Feb.	3.2	Q_t	3.75742	-15.55596 (-2.60)	0.00000569 (6.38)	0.267613 (1.97)					0.55	1.92
March April	3.3	Q_t	3.03185	-8.36592 (-3.18)	0.00000665 (7.32)			-0.24833 (-2.65)			0.80	1.39

estimated in model 5 are similar to those obtained by Edman in the United States [3].

5.0 CROSS SECTION ANALYSIS OF THE DEMAND FOR FRESH AND PROCESSED FRUITS

In this section the demand for fresh and processed fruit is analyzed using data from the 1969 family food expenditure survey [9].[5/] Since apples are an important commodity in both the fresh and processed fruit expenditure categories the expenditure elasticities of these commodity groups are of some interest.

The demand for fresh and processed fruit is estimated using linear demand curves and both ordinary and weighted least squares.

The equations estimated and the variable definitions are given below and the results in Table 9.

$$y_1 = \alpha_o + \alpha_1 X_1 + \alpha_2 X_2 + \mu_1 \quad , E(\mu_1) = 0, \quad E(\mu_1 \mu_1') = \sigma_1^2 G$$

and

$$y_1^* = \alpha_o \sqrt{Z} + \alpha_1 X_1^* + \alpha_2 X_2^* + V_1, \quad E(V_1) = 0, \quad E(V_1 V_1') = \sigma_1^2 I$$

and similarly for y_2, where

y_{1i} = average weekly expenditure per person on processed fruits in income class i, in dollars [9].

y_{2i} = average weekly expenditure per person on fresh fruits in income class i, in dollars [9].

X_{1i} = average weekly total expenditure per person in income class i, in dollars [9].

5/ Sixty-three percent of the 1969 expenditure on fresh fruit was for apples.

TABLE 9: Estimates of the Income Elasticity of Fresh and Processed Fruit

Dep. Var.	Constant	Independent Variables					D.W.	R^2	ε
		X_1	X_2	$\sqrt{Z}$	X_1^*	X_2^*			
Y_t	.1914	0.00001307	-0.04823229				2.45	0.74	0.17
		(4.31)	(-3.87)						
Y_2	0.3675	0.00003206	-0.08404				2.79	0.87	0.20
		(7.30)	(-4.06)						
Y_1^*				0.1886	0.00001340	-0.04652	2.42	0.89	0.16
				(21.07)	(3.89)	(-4.08)			
Y_2^*				0.3716	0.00003111	-0.08540	2.82	0.95	0.18
				(2.92)	(6.58)	(-5.27)			

X_{2i} = number of children between 10 and 15 years of age, per family, in income class i [9].

Z_i = number of families in income class i [9].

$y_1^*{}_i = y_{1i}\sqrt{Z_i}$

$y_2^*{}_i = y_{2i}\sqrt{Z_i}$

$X_1^*{}_i = X_{1i}\sqrt{Z_i}$

$X_2^*{}_i = X_{2i}\sqrt{Z_i}$

ε = expenditure elasticity.

The results of the ordinary and weighted least squares regressions are quite similar. The expenditure elasticity of processed fruit is .20 and .18 for fresh fruit. The low expenditure elasticity for all fruit would suggest a low income elasticity for apples as well.

6.0 STUDY CONCLUSIONS

(1) The apple market in Canada is rather static. Annual domestic fresh apple consumption amounted to 22.8 pounds per person in 1957/58 - 1960/61 and 22.2 pounds per person in 1967/68 - 1970/71. With an income elasticity of demand for apples to be processed of 1.35 the processing of apples has increased substantially. Exports increased during the period 1950-1966 but have declined since 1968 because of a loss of exports to the United Kingdom.

(2) Canadian and United States apple markets are closely related at the grower level. Models treating both markets as one integrated market give a better explanation of Canadian and Ontario apple prices than models

of the Canadian apple market alone, even when the models contain an export equation.

(3) The possibility of estimating annual apple prices in Canada and Ontario simultaneously with the grower price in North America seems promising. The usefulness of this method depends on the stability of the parameters estimated and the availability of good forecasts of the predetermined variables, in particular production.

(4) The model of monthly price relationships estimated in section 4.2 may be useful in predicting monthly retail prices for the months January through April. More work needs to be done to determine the factors that effect the monthly marketings of apples.

(5) Price flexibilities with respect to total production are high in the North American apple market, -1.7 in the reduced form equation and -3.4 in the structural equation. These numbers show that on the average an increase in production lends to a decrease in the farm value of the North American apple crop.

(6) Grower prices in the different segments of the North American apple market are closely related. Average grower prices in East North America and West North America will deviate somewhat according to relative changes in the size of the apple crop in both areas.

(7) Neither oranges nor other fresh fruits appeared to be strong substitutes for apples in Canada

(8) A one percent change in the grower price of apples in Canada results in a 0.15 to 0.27 percent change in the retail price of apples.

(9) The expenditure elasticities of .20 and .18 for fresh fruit and processed fruit indicate a modest increase in the expenditure for fresh and processed apples in the future.

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