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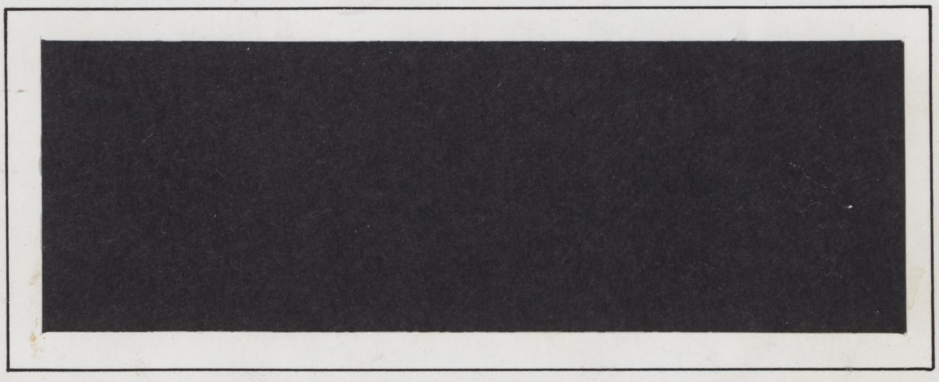

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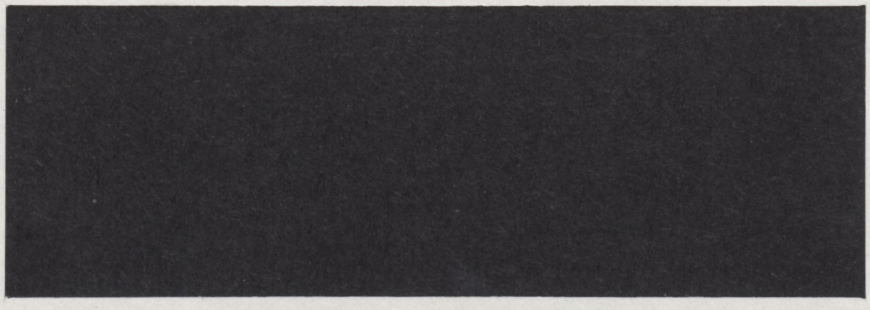

APPLE FORECASTING MODEL

(Working Paper No. 5/86)

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APPLE FORECASTING MODEL

INTRODUCTION

The Apple Forecasting Model will provide, for both fresh apples and apple juice, estimates and forecasts of production, domestic disappearance, import and export prices, wholesale prices, retail prices, and trade. Because of the yearly characteristic of fresh apple production and the fact that disappearance data are provided as annual series, the Apple model will be estimated on an annual basis.

There are a number of significant differences in varieties of apples, their qualities and end-use. This physical heterogeneity implies major differences in price and demand responses at the marketplace. The model will be estimated "conjointly" for fresh apples, and apple juice. However, there is no disaggregation by varieties (primarily for data consideration).

Although technological changes (particularly through the introduction of new varieties of apples and new planting techniques) have been very rapid in some regions of Canada, the quantitative information is still inadequate for testing the impact of such structural changes on the global output of fresh apples.

The expansion of the production and consumption of processed apples (e.g. apple juice) in Canada has been considerable. As a result, accurate estimates and reliable forecasts of the output response for such a by-product are fundamentally necessary. Moreover, the assessment of the relationships between the markets for fresh and processed apples is vital for domestic policy concerning the apple sector.

Accordingly the Apple Forecasting model will facilitate greater understanding of current and future development in the Canadian apple industry, by providing estimates of the direct effect of specific factors. The model will also monitor and simulate the flow of fresh apples to the processed apple sector.

The study is divided into seven sections: 1) a brief presentation of the Canadian apple industry, 2) an overview of theoretical motivation and model structure, 3) the equations specification, 4) a review of data considerations, 5) the analysis of the estimation results, 6) the validation procedure, and 7) an assessment of the current version plus identification of future development.

It is necessary to mention that the study reflects the framework of "applied research". Practical considerations retain major attention. Thus, no detailed theoretical analysis is foreseen. Concurrently, the absence of a previous simulation model of the Canadian apple industry precludes any comparative evaluation of the Apple model.

1. CHARACTERISTICS OF THE CANADIAN APPLE SECTOR

Industry Setting

The development of the Canadian apple industry has been described in detail elsewhere, for example by E. Campbell (1983). These studies indicate significant structural changes in production and in the pattern of consumption. In all major producing regions, apple tree area has declined; thus the increases in production are primarily attributed to higher yields per hectare as a result of higher density plantings, high yielding varieties and the expanding use of inputs.

Apples are produced on a "commercial level" in British Columbia, Ontario, Quebec, New Brunswick and Nova Scotia. While Ontario has the biggest share of the total national area (36.45 percent in 1981); it is British Columbia that produces more fresh apples in Canada, nearly half (47.2 percent) the total domestic production (Table 1).

A favourable climate, plus the fact that British Columbia orchardists have been planting more apple trees per hectare (as compared with the other producers) explain this comparitive advantage. Moreover, there have been major changes in the varieties of apples grown in British Columbia. In 1931, such varieties as Spitzenburg, Wagener, Duchess and Wealthy constituted the bulk of production. In 1961, Duchess and Wealty were still produced, but new varieties like Spartan, Newtowns and Winesaps were introduced. Finally, by 1981 Red and Golden Delicious as well as Tydeman's Red became the leading apple varieties.

These changes have significant implications for the apple industry of British Columbia since the end-uses of each variety may vary. For example, Red and Golden Delicious (the leading varieties) are oriented towards the fresh market; conversly Winesaps and Newtowns are basically used by the processing industry.

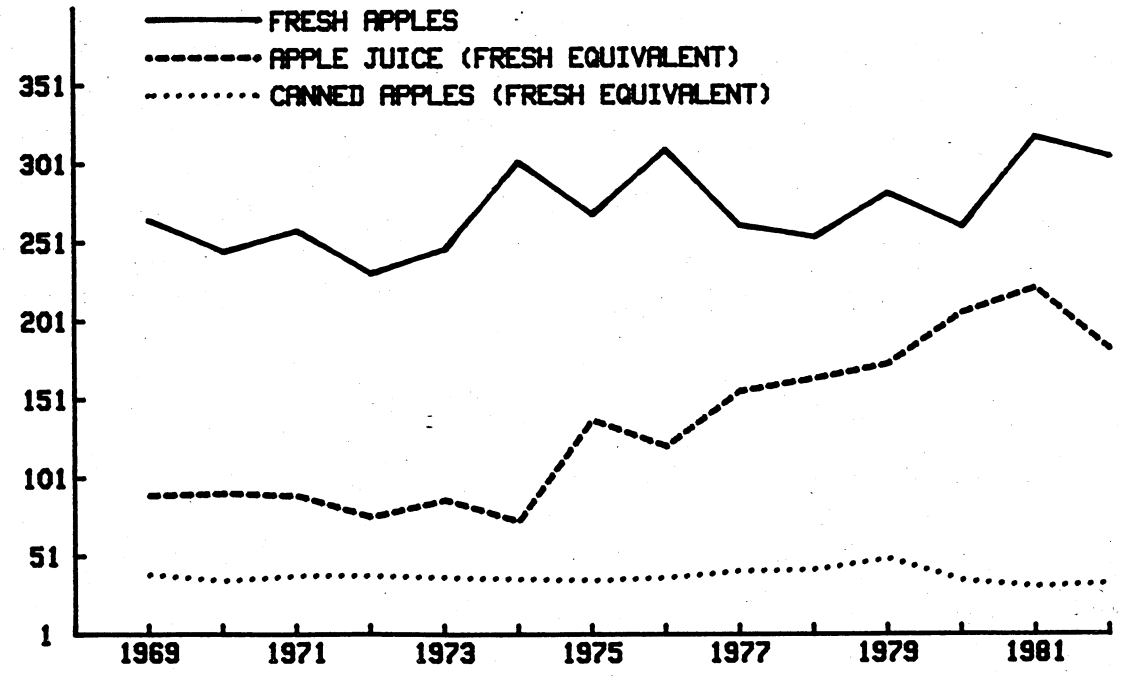
Ontario is the second biggest producer, with 27.7 percent of the total Canadian production of apples. Most of the apples are grown in the Southern part of the province, where the climate is warmer. Although Ontario retains the largest area devoted to apple production, it has also experienced the most significant decline, nearly 13 thousand hectares were removed from apple production between 1971 and 1981.

Among the major varieties of apple grown in Ontario are McIntosh, Red Declicious, Winesaps and Northern Spy. In her recent study of Canada's Apple industry, E. Campbell indicates that several other varieties (Idared, Spartan, Empire) also show promise of increasing their importance to the industry. Spartan (like McIntosh and Red Delicious) is a fresh market apple, while Idared and Empire have potential as dual purpose varieties.

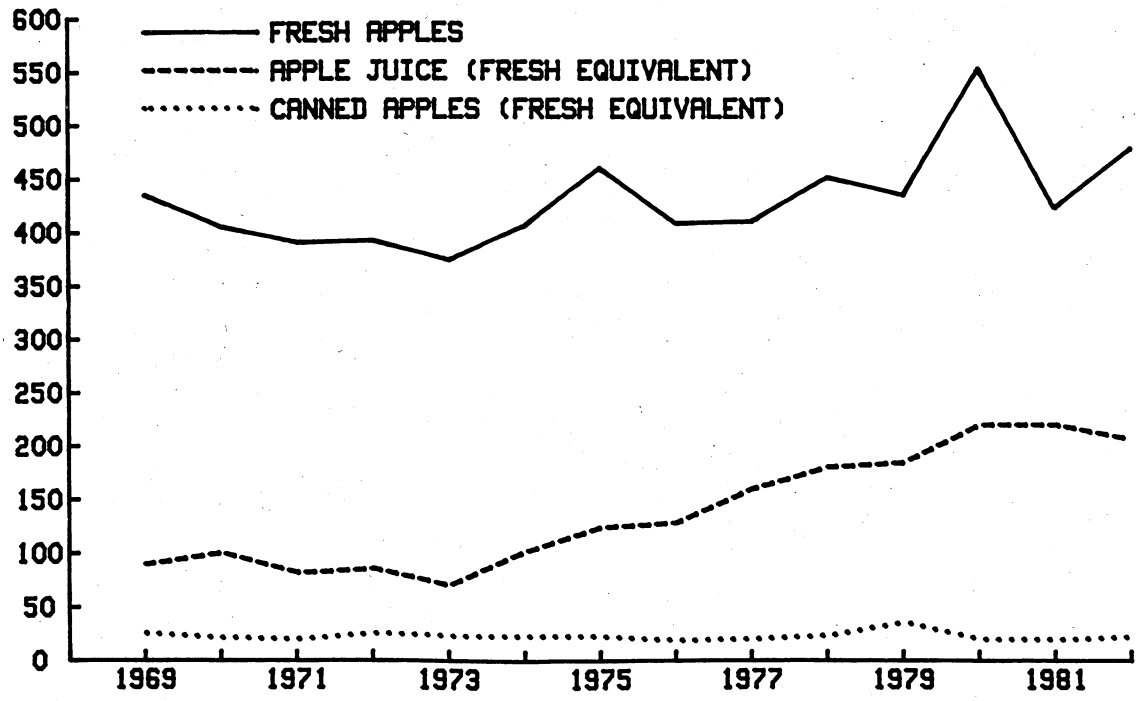
The other apple producing areas in Canada have also demonstrated major adjustments in terms of production. But it is in Quebec where the changes are the most significant. Production dropped from 34.6 percent of total Canadian output in 1965 to 21.4 percent in 1980. Following the 1980/81 winter freeze, total Quebec production of fresh apples represented only 10.9 percent of domestic production. The total area has declined steadily, with approximately 1.0 thousand hectares deleted from apple production during the period 1971 and 1981. However, a replanting program resulting from severe freeze in the winter of 1980-81 will bring a big increase in the Quebec apple production.

These changes in the pattern of production have some specific meaning in the orientation of the Canadian apple industry. The shift in varieties grown will influence the relative share of fresh versus processing markets, as well as the characteristics of net trade in fresh apples. Concurrently, the replacement of standard rootstocks by semi-dwarf and dwarf trees should improve global yield and therefore the competitiveness of the Canadian apple industry.

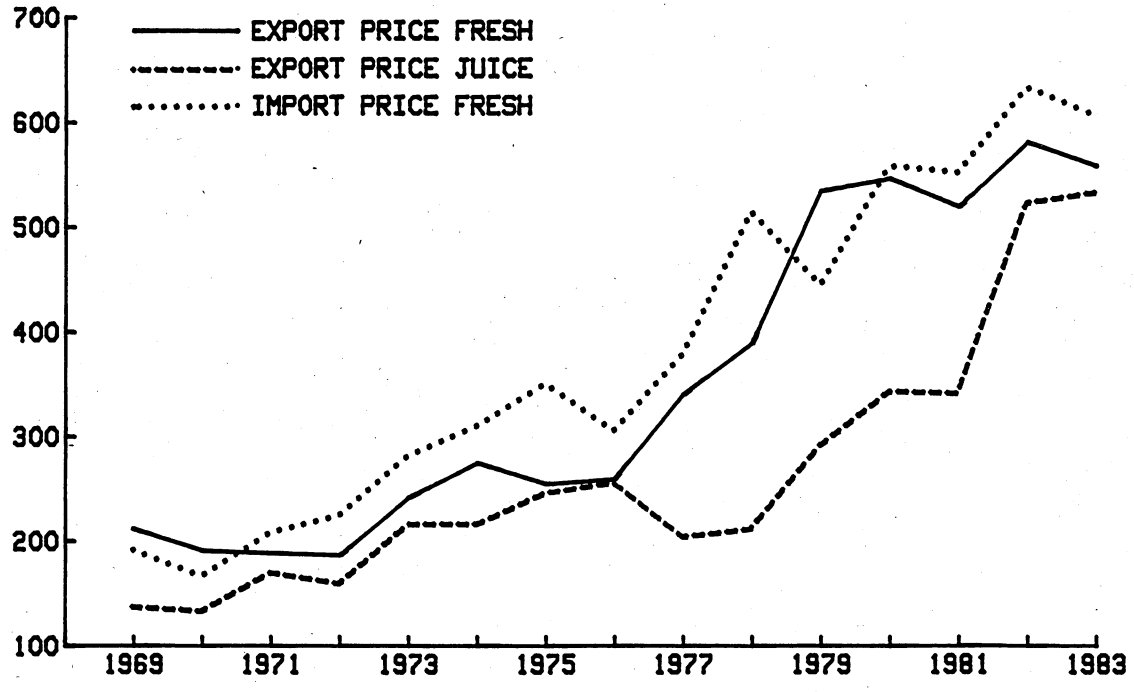
TOTAL DISAPPEARANCE OF FRESH APPLES, CANNED APPLES, APPLE JUICE 1969-1982



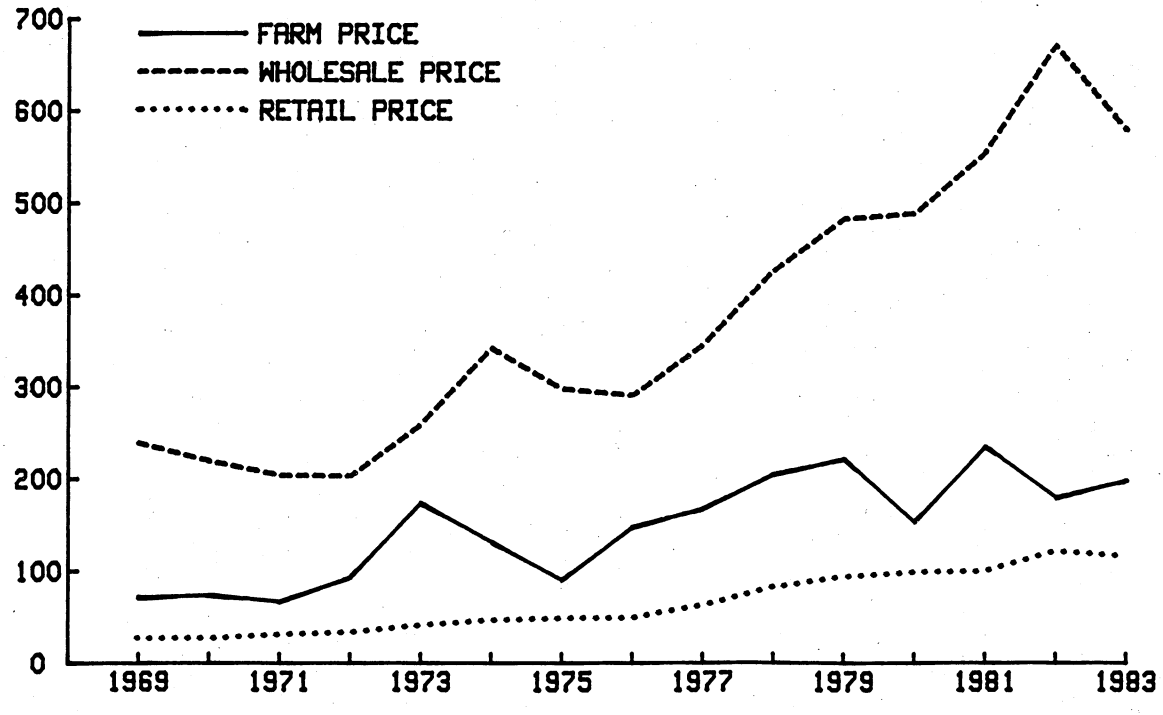
MARKETED PRODUCTION OF FRESH APPLES, CANNED APPLES, APPLE JUICE



EXPORT PRICES FOR FRESH APPLES AND APPLE JUICE, IMPORT PRICES FOR FRESH APPLES, 1969-1983 (DOLLAR/TONNE)



FARM AND WHOLESALE PRICES ($/TONNE), RETAIL PRICE (1981=100) FARM PRICE INCLUDES A.S.B. PAYMENTS, 1969-1983



Foreign competition (particularly green apples) remains a critical element, as new varieties produced abroad, like Granny Smith, gained substantially in the domestic market for fresh apples. In terms of the total marketed production, imports represented approximately 20 percent (Table 3).

Changes in consumer's taste, the fact that imported fresh apples are used for processing, seasonal characteristics of supply (nearly 40 percent of the imports in 1980 occurred during the months of May, June and July), type and quality of products, marketing practices, and lower cost of production explain the relative importance of fresh apple imports in Canada. Structural linkages between the U.S. and Canadian markets may also account for the high degree of penetration of imported fresh apples into Canada.

A fresh apple is one of the most common fruits in Canada (Appendix III - Table 2). Apples represent more than 20 percent of all fruits consumed by Canadians. Relatively mild price competition between the major fruits (apples, bananas and oranges) plus the existence of a substantial Canadian apple industry (and therefore a significant supply) are major factors for the prevalence of apples in the Canadian fresh fruit market. The total disappearance of fresh apples has increased (but not uniformly) over the period 1967/68 to 1981/82 and is expected to continue to expand in the future.

Canned apple consumption remains relatively low (less than 40 thousand tonnes per year) and very stable, contrary to the consumption of apple juice which has increased remarkably since 1975 (Figure 1). Although the total disappearance of apple juice has significantly expanded, its relative share of the Canadian market for fruit juice had shrunk. In 1965 apple juice represented 21 percent of total juice consumption while orange juice accounted for 31 percent. By 1980, apple juice consumption constituted only 19 percent while orange juice represented over 50 percent of total juice consumption.

TABLE 1. MARKETED PRODUCTION OF APPLES (FRESH AND PROCESSED), BY PROVINCE, ('000 TONNES)

YEAR	ATLANTIC PROVINCES	QUEBEC	ONTARIO	BRITISH COLUMBIA	CANADA
1967	78.93	101.81	118.40	137.50	436.64
1968	62.90	109.30	123.15	105.55	400.90
1969	64.01	104.14	139.06	123.03	423.24
1970	59.63	85.12	128.66	132.10	405.51
1971	56.87	119.20	128.80	86.28	391.14
1972	43.34	114.04	125.27	110.16	392.81
1973	47.63	89.42	92.05	145.59	374.69
1974	47.63	125.22	124.49	109.00	406.34
1975	55.44	108.59	130.18	166.21	460.42
1976	48.20	72.26	115.99	172.72	409.17
1977	46.67	94.19	127.86	142.70	411.42
1978	57.15	101.67	142.68	150.44	451.94
1980	52.49	118.52	171.34	210.24	552.59
1981	59.44	45.30	115.58	202.06	422.38
1982	65.06	78.11	159.04	175.42	477.63
1983	59.63	65.08	165.19	194.95	484.85

SOURCE: Statistics Canada, "Reference Handbook Fruits", September 1983.

Statistics Canada, "Fruit and Vegetable Production", (#22-003), converted from thousand pounds by a factor of 0.0004536.

Since Canadian marketed production of fresh apples (i.e. in terms of price, volume and suitable varieties) does not respond adequately to the growing need of the processing industry, the growth of the apple juice sub-sector means greater demand for imported raw product and specifically for imports of concentrate. There are indications that this dependancy on "cheap foreign concentrate" will remain, due in part to the fact that Canadian producers are reluctant to grow apples aimed at the processing markets because of the anticipated low price for this kind of apple.

Marketing observations suggest a high susceptibility of apples to bruising. Cullage is a significant factor in fresh apple harvest and shipment, which explains why a variable for cullage is introduced in the Apple model. The process of moving apples to central warehousing lead to the increased handling of the product. It is estimated that there is a 50 percent loss of marketed production at retail level attributed directly to spoilage.

There is at present no "National Marketing Board" that regulates supply and price of apples. However, various "organized" marketing channels exist at the provincial level. For example, British Columbia Tree Fruits Limited under the British Columbia Tree Fruits Marketing Board received authority to sell, export, and store tree fruits. In Ontario, the apple markets are "regulated" through the Ontario Apple Marketing Commission (O.A.M.C.). Similarly, in Quebec a "regulation" permits the fixing of price for fresh apples and for processing, the organization of marketing, etc.

The impact of these marketing schemes is quite limited. The provincial nature of the Boards, the fact that apples can be shipped from one province to another, and finally the unlimilited flow of imports reduce significantly the effective "control" of the Canadian apple market.

In the absence of a historical "structural" model of the Canadian apple industry, it is inappropriate at this stage to assess future development of the sector. Available studies do not permit comprehensive evaluation of future trends in production, consumption, trade, and the displacement of domestic apples from fresh to processing markets.

Although recent trends demonstrate a continuous increase in the production of apple juice over the last decade, while the marketed production of fresh apples has experienced slower growth and sharp fluctuations (Figure 1), forecasts of the relative expansion of fresh apple versus apple juice cannot be systematically derived from the available studies.

Changes in relative prices, in input costs, as well as technological progress should "theoretically" affect the future direction of the Apple industry. Concurrently, the trade pattern in apple and apple products will be conditioned by structural adjustment in domestic consumption. Finally, prices will also be influenced by the changing conditions of supply, demand and trade and vice versa.

These basic interactions among major "parameters" of the industry and how they effectively influence the future development of the sector plus the current lack of appropriate forecasting information, indicate the need for a formal simulation model (as well as for substantial investigation of the structure of the Canadian apple industry).

TABLE 2. MARKETED PRODUCTION, PRICES AND SUBSIDY FOR APPLES

YEAR	PRODUCTION[1] ('000 tonnes)	WHOLESALE PRICE ($/tonne)	FARM PRICE[2] ($/tonne)	ASB PAYMENTS ('000 dollars)
1968	400.90	246.71	99.65	-NONE-
1969	423.24	239.88	72.42	-NONE-
1970	405.51	220.46	75.10	-NONE-
1971	391.14	205.24	67.98	-NONE-
1972	392.81	204.19	94.61	105.90
1973	374.69	260.36	175.45	-NONE-
1974	406.34	343.29	132.82	-NONE-
1975	460.42	299.20	91.17	-NONE-
1976	409.17	291.85	148.69	12,709.65
1977	411 42	347.49	168.86	136.31
1978	451.94	428.33	206.99	255.32
1979	434.90	483.97	223.02	2,936.57
1980	552.59	489.22	153.78	(-0.438)
1981	422.38	553.26	236.12	16,067.78
1982	477.63	671.88	180.23	1,230.50
1983	484.85	580.03	198.77	21,454.86

[1]Marketed production of fresh apples for all uses.

[2]Average farm price for apples includes ASB subsidy.

SOURCES: - Statistics Canada, "Reference Handbook Fruits."
- Agriculture Canada, Market Information Service.
- Agriculture Stabilization Board.

TABLE 3. SUPPLY AND DISPOSITION OF FRESH APPLES, 1968 TO 1983

YEAR	PRODUCTION	IMPORTS	TOTAL SUPPLY	EXPORTS	TOTAL CULLAGE	PROCESSING
			('000 tonnes)			
1968	400.90	23.05	423.95	71.29	66.69	127.35
1969	435.24	28.05	463.29	58.90	70.48	158.87
1970	435.51	41.90	447.41	47.24	6.00	150.15
1971	391.14	37.27	428.41	46.46	63.68	142.17
1972	392.81	39.71	432.52	45.47	63.36	155.15
1973	374.69	42.55	417.24	53.74	63.05	133.57
1974	406.34	61.77	468.11	35.34	63.98	164.95
1975	460.42	67.14	527.56	39.28	70.49	134.74
1976	409.17	79.67	488.84	45.13	60.07	180.80
1977	411.42	66.74	478.16	47.89	53.52	204.78
1978	451.94	74.79	526.43	56.09	57.95	205.15
1979	434.90	96.08	530.98	54.91	54.78	190.13
1980	552.59	78.60	631.19	60.31	70.38	236.07
1981	422.38	108.72	531.10	75.18	45.92	202.14
1982	477.63	107.68	585.31	70.60	59.54	187.40
1983	484.85	85.50	570.35	79.38	51.15	211.38

SOURCE: Derived from Statistics Canada's data. Processing refers to "sales of apples to processors," the series were obtained from Agriculture Canada, Commodity Marketing Service.

2. THEORETICAL MOTIVATION AND MODEL STRUCTURE

The theoretical framework describes the general economic rational of supply, demand and price functions for fresh apples and apple juice. These theoretical considerations (motivation) are essential in formulating and conceptualizing the functional relationships which prevail in the Canadian apple industry.

2.1 Supply and Demand for Apples

It follows that for the Total Output of apples, from Canadian farms, a specific theoretical distinction must be made between gross output and "marketed" production. The "real" level of production, in the market sense, is said to be the effective level of marketings rather than the gross volume of crop available in a given period.

This definition of production as "marketings" depicts more appropriately the responsiveness, of quantities supplied, to short term fluctuations prevailing in the markets for inputs and output. Thus, producers' decisions are explicitly assumed as ex-post adjustment procedures. One advantage of this approach is that parametric restrictions on the production function result more from a conditioning of the problem which can be translated behaviorally and which is not strictly the outcome of specific structural or technical constraints (e.g. climatic conditions impact on yield).

The differentiation, of an ex-post versus an ex-ante adjustment process, is necessary in the context of short term price signals at the marketplace and the long biological lags involved. Price fluctuations do not provoke "automatic" changes in planting. While these short-term market signals are relayed quickly to decisions concerning quantities harvested.

Since the focus of the model is on a short term forecast, it is essential that a dynamic short term response production function be retained. However, the aforementioned assumption does not completely exclude consideration of additional long term adjustment within the industry.

General behavioral rationalizations for long term decisions (based on market incentives) are not ignored. For example, the lower the expected value for apples - the smaller the investment in planting new apple trees (or in maintaining of trees), and correspondingly the lower the "expected" long term supply of fresh apples.

For the long run, the desired production rate is the one at which discounted marginal returns equaled discounted marginal costs (e.g. inputs and opportunity costs). By assuming that technological gain can be evaluated and that the yield factor can be measured - it follows that the desired production rate could be directly derived from an estimated number of trees planted. In such a case, if the discounted marginal revenue from planting new trees (or maintaining old trees) were greater than the discounted marginal cost then more trees will be planted, and an increase in total output will result.

However, since "yield per tree" is difficult to assess, given the wide variability of rootstocks, the traditional concept of long term adjustment in production is too broad to explain marketed production decisions. The Supply block is strictly defined as a short term decision mechanism viewed primarily in the context of short term changes in market prices.

Construction of the Disappearance (demand) block is based on the theory of a consumer allocation problem, with a focus on the assumption that the consumer maximizes their utility subject to a total budget constraint. Decisions made by the consumer are assumed

to be related to income, the retail price of the commodity, appropriate prices for substitutes, and some structural considerations such as changes in taste, pertaining to the fresh apple markets.

2.2 Price Determination

The Price Determination block defined for the Apple model reflects various theoretical concepts. As generally accepted where one price variable generates other price variables, a behavioral structure for the "primary" price variable (for instance, the wholesale price of fresh apples) is required but that the other price variables can be derived strictly or partly from it by using some form of linkage equations. Thus market forces at one level of price are vertically transmitted to other stages in the marketing process. At each level, however, prices can be subject to specific constraints (e.g. processing cost, transportation charges, etc.).

Assuming a state of equilibrium at each individual level of marketing, the wholesale price is said to be the key driving element of price determination and relationships. Note that these various price levels not only encompass the transmission mechanism but reflect in most cases supply or demand conditions prevailing at a particular marketing level.

2.3 Trade Flows

The determination of Trade Flows for fresh apples does not integrate domestic with foreign markets. Therefore the process of arbitrage (provoked by price differentiation between markets) is not accounted for in the model. Import or Export demand behavior is not strictly perceived from theoretical premises but rather is viewed and established as a physical adjustment of domestic supply and domestic demand with no reference to foreign markets. Consequently, exports

and imports of fresh apples are based on an ad hoc formulation which links their respective level to the quantity of domestic supply and demand, and to the import and export prices.

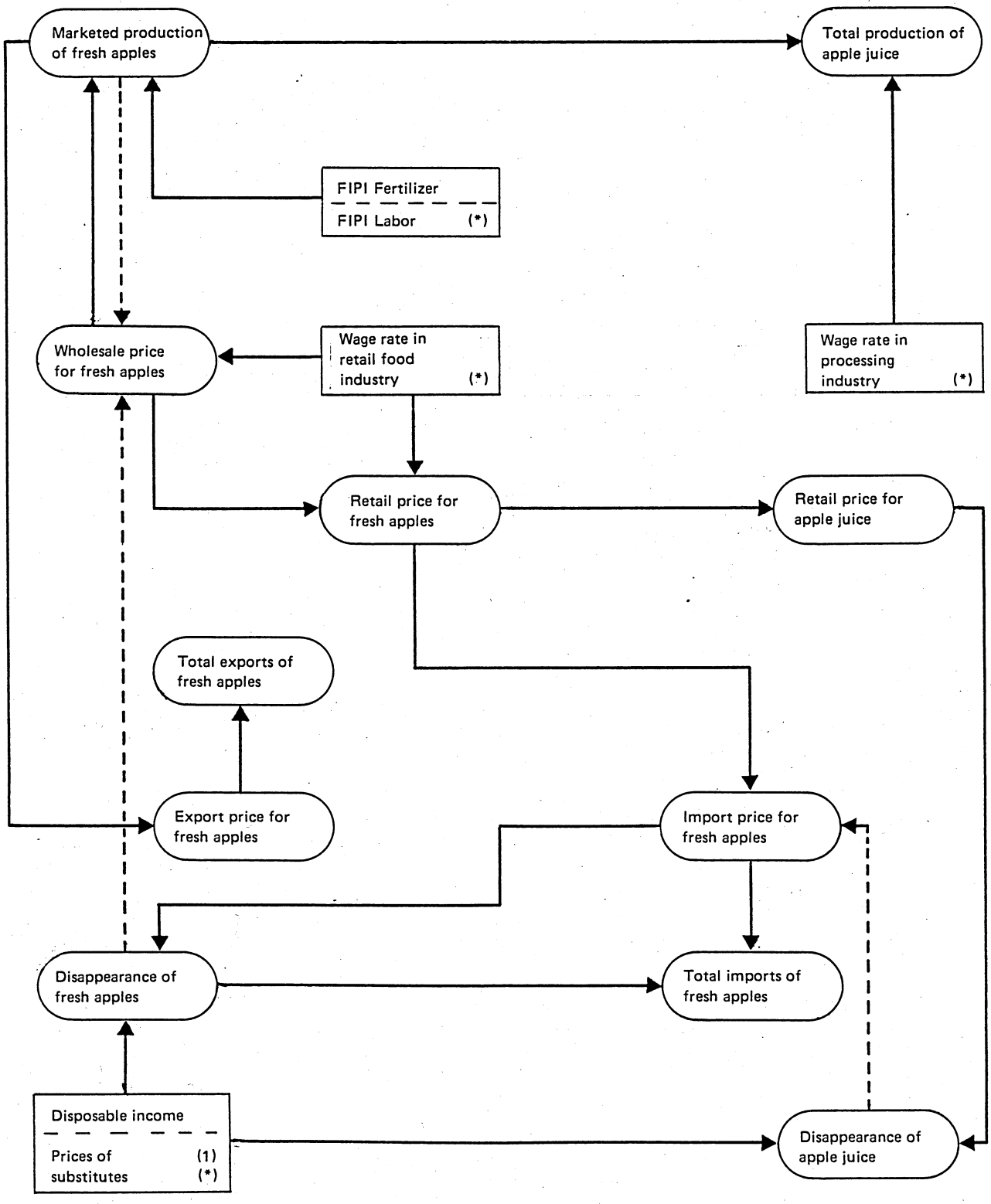
2.4 Dynamic Structure of the Model

The Apple model identifies certain key linkages between the markets for fresh apples and apple juice. No distinction is made to account for regional peculiarities of supply, demand, prices and trade. These factors are aggregated to represent the global domestic market for apples and apple juice. Data limitation, model size consideration rather than purely theoretical motivation may explain this methodological choice.

However, this approach of a "single" Canadian apple industry may be justified. For example, prices are defined as "total averages" for all of Canada because of the absence of marketing restrictions. The prices are assumed to be fully "adjustable" throughout the various regional sub-markets. Parallel to that, although local conditions (such as relative prices for land) may have some significant influence on producers' behavior, it appears that unless the model is disaggregated for a multitude of production locations, it is more relevant to consider a national framework. A regional representation describing three or four geographical locations does not necessarily solve the problem of specific location characteristics.

Yearly lags for explanatory variables (and in some cases for endogenous variables) are introduced in the production component as well as in the price and trade blocks. These lags account for dynamic adjustments taking place in the system. Links with the rest of the Canadian economy are established at various levels. For example: the production of fresh apples is linked to the farm input sector, that of apple juice to the wage rates and the price of energy. Similarly, disappearance for both fresh apples and apple juice

FIGURE 5. FLOWCHART OF THE "APPLE FORECASTING MODEL" (2)



(*) Exogenous to the Apple Model

(1) Substitutes for apple juice include canned orange juice and fluid milk, for fresh apples the substitutes are primarily cereals and bakery products (i.e. snack foods).

(2) For simplification, not all the variables and functional relationships appear in the flowchart.

reflects changes in disposable income and the consumer price index; while retail prices are tied to wages in the Retail Food Industry and changes in the blended price of oil.

A schematic and descriptive presentation of the structure of the Apple model and of the key relationships within the apple industry is given in Figure 5. These relationships are closely analysed in the next section dealing with equation specification.

The disaggregation of the apple industry between fresh apples and apple juice allows the capture of a significant part of the supply adjustment process. Low prices for fresh apples, poor crop quality, etc., generate shifts of apples from the fresh market to the market for processed products. Interaction between the production of fresh apples and that of apple juice must be viewed in an adjustment context.

3. MODEL SPECIFICATION

The behavioural equations of the Apple model were designed on the basis of the apparent structure of the Canadian apple industry; but at the same time they reflect theoretical assumptions and were subjected to some experimental trials. The final specification was also determined by data availability and reliability.

The high degree of aggregation (e.g. no regional considerations, no product split by varieties) is justified partly on the fact that relevant data for certain critical explanatory variables (such as retail price information by varieties of apple, etc.) were not at hand. Similarly, area and yield equations were not included simply because the quantitative measures of yield are imprecise and vary according to rootstocks (e.g. standard, semi-dwarf, dwarf), age and location of apple trees. Weather conditions and particularly sun-light exposure greatly influence the quality of the apple crop; however no reliable forecast for such exogenous parameters were available.

Theoretical assumptions were decisive in the choice of functional form for the Production and Demand blocks. The four equations are essentially specified to reflect as much as possible the theoretical considerations of demand and supply responses.

The influence of the "Rest of the World" (R.O.W.) markets on the Canadian apple industry is not directly addressed in this current version because reliable sources of forecasts for these variables were not identified. This lack of fundamental interaction between the Canadian and foreign markets has a significant impact on the final structure of the trade block and may constitute a major problem for the analysis of trade mechanisms effective in the apple industry.

The model can be "split" into 5 major components or blocks. The first two equations are production response functions; equations (3) and (4) constitute the Disappearance block, while the Prices relationships are identified by equations (5) to (9). The Trade Block has two equations, one for total imports (equation 10) and one for total exports (equation 11) of fresh apples. The remaining two equations are Identities respectively for the Cullage factor and the Discrepancy variable.

The specification of the model is conceptually constructed to reflect an annual framework. Therefore no seasonal adjustment is assumed as part of the model structure. Commercial inventories are excluded because of the low or zero "carry-over" from year to year. Seasonal characteristics of various endogenous variables (i.e. disappearance of fresh apples, prices, and imports and exports) are not assessed in this annual model due to the annual "restriction" of the model.

Policy variables do not appear in this present specification. The absence of supply management schemes and specific trade regulations in the apple industry explain the omission of a policy parameter in the model. The Apple model's framework can easily accomodate eventual impact analysis of such factors like ASB payments, trade control, etc.

A schematic representation of the model's equations is shown in Table 5. It should be mentioned that the treatment of farm input prices, wages and various retail prices for substitutes as exogenous variables may be rationalized by the fact that these variables are "already" endogenized by the FARM model and are available for the forecasting procedure.

TABLE 4. MAJOR COMPONENTS OF THE APPLE FORECASTING MODEL AND CLASSIFICATIONS OF THE ENDOGENOUS VARIABLES

COMPONENTS		ENDOGENOUS VARIABLES
Production	(QFRAP3)	Total marketed production of apples used as fresh (for consumption and processing).
	(QAPJ3)	Total production of apple juice (made from fresh apples or reconstituted from concentrate).
Demand	(DFRAP3)	Total domestic disappearance of fresh apples.
	(DAPJ3)	Total domestic disappearance of apple juice.
Prices	(IMPFRAP3)	Import price for fresh apples.
	(EXPFRAP3)	Export price for fresh apples.
	(WPFRAP3)	Wholesale price for fresh apples (based on three markets average).
	(RPFRAP3)	Retail price for fresh apples.
	(RPAPJ3)	Retail price for apple juice.
	(FPFRAP3)	Farm price for fresh apples (including ASB payments)

- continued -

TABLE 4. MAJOR COMPONENTS OF THE APPLE FORECASTING MODEL AND CLASSIFICATIONS OF THE ENDOGENOUS VARIABLES (concluded)

COMPONENTS		ENDOGENOUS VARIABLES
Trade	(IMFRAP3)	Total imports of fresh apples.
	(EXFRAP3)	Total exports of fresh apples.
Others	(CULFRAP3)	Cullage factor applied to production and handling of fresh apples and apple juice.
	(DISCAP3)	Discrepancy variable and balance-sheet closing identity.

NOTE: See also (Appendix I)

3.1 Production

The two equations for supply responses will provide estimates of "total marketed production" of fresh apples and the production of apple juice. Each of these "commodities" depends respectively on a different set of explanatory variables; however an inter-action exists between the two since the total production of fresh apples affects directly the level of output of apple juice.

For fresh apples, an ex-post process is chosen to determine Marketed Production defined as (QFRAP3). This variable is assumed as a function of the wholesale price for fresh apples (WPFRAP3), the lagged farm input price index for fertilizer (FIPFERT3(-1), the farm input price index for farm labor (FIPWAGE3) and a dummy variable (DUMW) for the impact of the 1981 winther freeze in Quebec.

Whereas Total Output of apple juice (QAPJ3) made from fresh apples or reconstituted from concentrates is said to depend: on the lagged costs of inputs such as the proxied wages in the food and beverages industry (WAFB3(-1)), the blended price of crude oil (PBOIL3(-1)) lagged one year, the level of total marked production of fresh apples (OFRAP3), a dummy variable (JS73) for 1973 and on the exchange rate (ER34). The inclusion of exchange rates as an explanatory variable for the total production of apple juice is based on the fact that the share of imported concentrates in the "manufacturing" of apple juice had significantly increased in recent years.

3.2 Disappearance (consumption)

As mentioned earlier the Total Disappearance of fresh apples is specified under traditional assumptions, but also following experimental procedures. Thus the endogenous variable (DFRAP3) is determined as a function of the deflated import price for fresh apples

(IMPFRAP3/CPI3), the deflated price of the closest substitute (RPCL3/CPI3) for cereals and bakery products, the exchange rate (ER34) and the level of total disposable income (PCDYS3 * POPN3).

Total Disappearance of apple juice (DAPJ3) is specified under consumer demand theory, where the endogenous variable is said to be a function of own deflated retail price (RPAPJ3/CPI3), the price of close substitutes: that of canned orange juice (RPCORJ3/CPI3) and (RPFM3/CPI3) for fluid milk, as well as total disposable income (PCDYS3 * POPN3). A dummy variable was included in the specification (JS74) for the year 1974.

3.3 Price Determination

Prices are determined at various market levels for fresh apples, but only at the retail level for apple juice, (note: import and export prices for apple juice are not considered because of data difficulties). Since all the markets are closely related to supply and demand conditions for fresh apples, thus the equations for prices are linked as much as possible to reflect the transmission mechanism.

The Import Price for fresh apples (IMPFRAP3) is derived as a function of the total marketed production lagged one year (QFRAP3(-1)), of the disappearance of apple juice (DAPJ3) (since a significant part of the import demand for fresh apples is converted into apple juice), and of the retail price for fresh apples (RPFRAP3/CPI3).

Concurrently, the Export Price for fresh apples (EXPFRAP3) is established as a function of the level of output of fresh apples (QFRAP3(-1)) lagged one year, the exchange rates (ER34), the wholesale price for fresh apples (WPFRAP3(-1)) lagged one year, the equation includes also the lagged endogenous variable.

Wholesale Price of fresh apples (WPFRAP3) is determined so that the endogenous variable depends on changes in the total disappearance of fresh apples (DEL(1:DFRAP3)), the level of wages in the "food retail and distribution" industry (WARFD3), the level of production of fresh apples (OFRAP3(-1)) lagged one year, the exchange rates (ER34) and a dummy variable (DUMW) to account for the winter freeze of 1981 which severely affected production in Quebec and thus affected prices.

Retail Price for fresh apples (RPFRAP3) reflects to a large extent the mechanism of price transmission effective within the Canadian apple sector. Whereas, the endogenous variable is generated by the wholesale price (WPFRAP3), the price of imported apples (IMPFRAP3) and the retail price for fresh fruit (RPFRFR3), and partly by a proxy for operating cost (0.2 * WARFD3 + PBOIL3) which includes wages and energy.

Given the strong relationship between the apple juice sector and the supply of fresh apples (both domestic and imported), it follows that the Retail Price Index for apple juice (RPAPJ3) is assessed in terms of the retail price for fresh apples (RPFRAP3) and the operating cost (0.2 * WARFD3 + PBOIL3). A time trend variable (TIME) is also included as an explanatory factor.

TABLE 5. MODEL SPECIFICATIONS (YEARLY FRAMEWORK)

VARIABLE (ENDOGENOUS)	EQUATIONS
Marketed production of fresh apples:	QFRAP3 = f(WPFRAP3, FIPFERT3(-1), FIPWAGE3, DUMW)
Production of apple juice:	OAPJ3 = f(WAFB3(-1), PBOIL3(-1), QFRAP3, ER34, JS73)
Total disappearance of fresh apples:	DFRAP3 = f(IMPFRAP3/CPI3, RPCL3/CPI3, ER34, PCDYS3 * POPN3)
Total disappearance of apple juice:	DAPJ3 = f(RPAPJ3/CPI3, RPCORJ3/CPI3 PCDYS3 * POPN3, JS74, RPFM3/CPI3)
Import price for fresh apples:	IMPFRAP3 = f(QFRAP3(-1), DAPJ3, RPFRAP3/CPI3)
Export price for fresh apples:	EXPFRAP3 = f(QFRAP3(-1). EXPFRAP3(-1), ER34, WPFRAP3(-1)
Wholesale price of fresh apples:	WPFRAP3 = f(DEL(1: DFRAP3), WARFD3, QFRAP3(-1), ER34, DUMW)

- continued -

TABLE 5. MODEL SPECIFICATIONS (YEARLY FRAMEWORK) (Concluded)

VARIABLE (ENDOGENOUS)	EQUATIONS
Retail price for fresh apples:	RPFRAP3 = f(WPFRAP3, (0.2 * WARFD3 + PBOIL3), IMPFRAP3, RPFRFR3)
Retail price for apple juice:	RPAPJ3 = f(RPFRAP3, (0.2 * WARFD3 + PBOIL3), TIME)
Total imports of fresh apples:	IMFRAP3 = f(DEL(1: IMPFRAP3), QFRAP3(-1), (DFRAP3 + DAPJ3)
Total exports of fresh apples:	EXFRAP3 = f(QFRAP3(-1), DFRAP3, EXPFRAP3, EXFRAP3(-1))
Cullage (factor):	CULFRAP3 = (0.2 * QFRAP3 + 0.35 IMFRAP3 - 0.2 * QAPJ3)
Discrepancy (balance-sheet identity):	DISCAP3 = QFRAP3 + QAPJ3 + IMFRAP3 - EXFRAP3 - DFRAP3 - DAPJ3 - CULFRAP3

NOTE: See (Appendix IV) for complete estimation results

3.4 Trade (Imports and Exports)

The Trade component deals exclusively with fresh apples with no consideration for juice. Data problems rather than theoretical assumptions determines this choice. For example, data on imports for juice include both apple juice concentrates and single-strength; moreover the range of the data available was not compatible with the estimation period.

No regional distinction is retained, although it may be argued that the international trade pattern varies along the principal geographical regions of Canada.

Total Imports of fresh apples (IMFRAP3) is said to be a function of changes in the import price for fresh apples (DEL(1: IMPFRAP3)), the level of domestic output (QFRAP3(-1)) lagged one year, as well as the sum of the disappearance of fresh apples and apple juice (DFRAP3 + DAPJ3).

The equation for Total Exports of fresh apples (EXFRAP3) reflects total fresh apple supply (QFRAP3(-1)) lagged one year and demand (DFRAP3) for fresh apples in Canada, plus the effect of the export price (EXPFRAP3) and the lagged endogenous variable.

4. DATA CONSIDERATIONS

As mentioned earlier, the range of potential specifications "trials" is significantly limited by data availability and reliable sources for forecasts of U.S. and World supply, demand, and prices of apples. Similarly, the lack of specific data information on varieties or on quality classification for apples prevents any disaggregation on a basis of type of apples.

As a commodity, apples are significantly heterogeneous. Physical characteristics (e.g., size, shape, colour, taste, firmness of fruits, etc...) defferentiate consumer's preference and therefore the prices of the various varieties of apples. Although those physical differences are economically less significant at the processing level (N.B. most processors blend juices from several varieties), they are definitely a major factor of influence in the retail market for fresh apples.

Moreover, it appears that not all of these various varieties of apples are complete (or absolute) substitutes to each other. Thus, the quality factor also dictates some trade pattern. For example, the increased demand by Canadian consumers for Granny Smith apples (e.g. this variety has not yet been produced significantly in Canada) has accelerated imports of fresh apples. Availability of specific varieties contributes to the competitiveness of the Canadian apple industry but because of data problems such significant parameters were excluded from the framework of the model.

4.1 Data Limitations

Therefore, the absence of quantity information on types and qualities of apples constitutes a major limitation, particularly with regard to the price factors analysis. Other data constraints are apparent particularly in dealing with the production block.

The use of weather data seems more than appropriate in the context of the determination of the total output of fresh apples in Canada. However, the interpretation of such information is very complex and difficult to assess in light of the fact that apples are produced in very different geographical areas (e.g., from the Atlantic Provinces to British Columbia). The "averaging" of a climatic factor can be misleading. Moreover, it is difficult to justify the use of a general Climatic Moisture Index (CMI) for such a wide geographical context or to obtain reliable forecasts for this parameter.

Similarly, the data situation for "planted area" also raised various difficulties of interpretation. As mentioned earlier, there have been significant shifts in the type of trees (i.e., standard, semi-dwarf, dwarf) planted in Canada over the last decade. Moreover, planting techniques vary among regions (for example: the so-called "high density planting" was adopted much more rapidly in British Columbia than other parts of Canada).

These data limitations explain to a large degree the strict definition of the Production block in terms of market factors. The use of Yield and Area equations would have definitely created strong bias in the simulation and forecast of the model.

For fresh apples, data on commercial inventories are published only on an annual basis. Therefore, any analysis of commercial inventories of fresh apples will not reflect seasonal pattern. Information on production and "per capita disappearance" of fresh apples as well as apple juice are published also on an annual basis, thus creating the same limitation for the investigation of seasonal characteristics of those factors.

As mentioned earlier linkages with the Rest of the World (R.O.W.) are absent in the Apple model. This ommission is directly due to data availability. The Trade component is particularly limited in scope, and theoretically handicapped by data constraints.

4.2 Data Sources

Most of the data used by the Apple model are from Statistics Canada CANSIM Cross-Classified database. These data are also contained in Statistics Canada Catalogue No. 32-229 and 32-230, "Apparent Per Capita Food Consumption in Canada". Data on total quantities and values of exports and imports were retrieved from Trade-Tapes.

Some of the data are from Agriculture Canada's Market Information Service. Unloads of apples and the average wholesale price for apples were obtained from that source. Data for average farm price of apples are derived from "secondary" source. Finally, all the series for exogenous variables are directly accessed from the FARM Databank, which is very advantageous in view of the forecasting phase of the model.

The data used here are on a calendar-year basis, but are also available for some variables on a monthly basis; in such cases, the final (or derived) series are computed from a simple average of the reported monthly data. Metric conversion is applied whenever necessary to maintain consistency of units.

5. EMPIRICAL RESULTS

The Apple model is estimated for the period of 1969 to 1982, using annual "calendar-year" data and the method of ordinary least squares (OLS). The complete set of the estimation results for the stochastic equations is given in Appendix IV. Estimated coefficients, with their respective standard error in parenthesis below, are shown in Table 6 while the coefficients of determination (R^2), the Durbin-Watson (D.W.) and F Statistics are presented separately in Table 7.

One of the main features of the model is the determination of structural linkages between the apple juice and the fresh apple sectors. Statistical results show significant interaction between major parameters of both sectors.

Production of fresh apples is a key explanatory factor of the level of production of apple juice (although a large portion of apple juice produced in Canada is directly obtained from reconstituted imported concentrates.) Similarly, the results indicate a strong "dependence" of the retail price of apple juice to changes in the retail price of fresh apples.

Conversely, endogenous variables of the fresh apple component are directly influenced by "internal" shifts within the market for apple juice. Changes in the total disappearance of apple juice have an almost immediate impact on trade of fresh apples, particularly on the level of imports and import price, with the latter having a determining influence on the level of domestic consumption and prices of fresh apples.

Distinction between "marketed production" and "total crop availability" is fundamental in the context of supply analysis for the fresh apple market. The former concept reflects harvesting or short term decisions - while the latter translates long-term planting process.

Given the relatively long "biological" lags between planting and harvesting (and the high degree of heterogeneity in yield among the various types of apple trees), the model defines "actual production as the quantities of fresh apples harvested or marketed. Thus, the equation for production captures the short term supply response due to changes in the relative prices of inputs and output.

Statistical results indicate that the equation for marketed production have a relatively good explanatory power ($R^2 = 0.77$) and most variables are found to be significant. The signs for wholesale price, farm input price of labor and the weather dummy all conformed to traditional assumptions. Although the sign for farm input price of fertilizer is positive, this result is still compatible with the above definition of marketed production - which means that more apples are actually "harvested" to compensate increases in the price of inputs used during the pre-harvest phase.

The partial effects of prices of the inputs and that of the output on Marketed Production of fresh apples have been assessed from short term elasticities, and appear to be reasonable. A 10.00 percent increase in the wholesale price of fresh apples will cause an increase in production of 4.10 percent. The estimated elasticities for farm input price index of fertilizer and labor are 0.72 and -0.80 respectively, indicating that an increase in the "pre-harvest" price of fertilizer will stimulate total marketed production while a comparative increase in the price of labor will bring a decrease.

The second equation presents the estimated coefficients for Total Production of apple juice. With an (R^2 of 0.99), the fit is excellent. All signs are conformed to expectation and the explanatory variables are significant. Production of apple juice is particularly sensitive to changes in the exchange rates; this is an interesting result since most of the apple juice produced in Canada is made for imported concentrates. A 10.00 percent fall in the value of the Canadian dollar increases the production of apple juice in Canada by 15.70 percent.

TABLE 6. ESTIMATED COEFFICIENTS FOR THE "APPLE FORECASTING MODEL" (PERIOD OF 1969 to 1982

1. Total marketed production of fresh apples (for all use):

QFRAP3 = 315.11 + 25.80 WPFRAP3 + 5.95 FIPFERT3(-1)
(25.02) (9.73) (1.92)

- 5.20 FIPWAGE3 - 193.31 DUMW
(1.83) (49.35)

2. Total production of apple juice (from fresh apples and reconstituted):

QAPJ3 = 251.12 + 0.89 WAFB3(-1) - 5.38 PBOIL3(-1)
(43.50) (0.08) (0.98)

+ 0.12 QFRAP3 + 204.36 ER34 - 30.06 JS73
(0.06) (45.38) (7.34)

3. Total disappearance of fresh apples:

DFRAP3 = 286.64 - 14.70 IMPFRAP3/CPI3 + 250.85 RPCL3/CPI3
(190-84) (8.47) (159.38)

- 166.22 ER34 + 0.0000002 (PCDYS3 * POPN3)
(120.14) (0.0000003)

4. Total disappearance of apple juice:

DAPJ3 = 366.78 - 15.43 RPAPJ3/CPI3 + 156.98 RPCORJ3/CPI3
(130.96) (127.62) (73.79)

+ 0.0000004 (PCDYS3 * POPN3) - 7.00 JS74
(0.0000002) (30.31)

+ 338.22 RPFM3/CPI3
(132.36)

- continued -

TABLE 6. (Continued)

5. Import price for fresh apples (from all sources)

IMPFRAP3 = 88.81 - 0.14 QFRAP3(-1) + 0.66 DAPJ3 + 3.77 RPFRAP3
(91.92) (0.26) (0.48) (0.61)

6. Export price for fresh apples (to all destination):

EXPFRAP3 = - 268.50 - 0.36 QFRAP3(-1) + 0.56 EXPFRAP3(-1)
(330.92) (0.39) (0.46)

+ 431.85 ER34 + 19.51 WPFRAP3(-1)
(332.99) (26.22)

7. Wholesale price for fresh apples:

WPFRAP3 = 3.76 + 0.01 DEL(1 : DFRAP3) + 0.04 WARFD3
(2.12) (0.003) (0.004)

- 0.02 QFRAP3(-1) + 11.72 ERE34 + 1.07 DUMW
(0.003) (2.07) (0.41)

8. Retail price for fresh apples:

RPFRAP3 = 8.99 + 4.11 WPFRAP3 - 0.38 (0.2 * WARFD3 + PBOIL3)
(4.30) (1.82) (0.22)

+ 0.08 IMPFRAP3 + 0.54 RPFRFR3
(0.03) (0.20)

9. Retail price for apple juice:

RPAPJ3 = 13.49 + 0.37 RPFRAP3 + 1.05 (0.2 * WARFD3 + PBOIL3)
(4.38) (0.07) (0.13)

- 1.04 TIME
(0.55)

- continued -

TABLE 6 (Concluded)

10. Total imports of fresh apples:

IMFRAP3 = - 71.41 - 0.025 DEL(1 : IMLPFRAP3) - 0.07 QFRAP3(-1)
(28.81) (0.05) (0.10)

+ 0.42 (DFRAP3 + DAPJ3)
(0.07)

11. Total exports of fresh apples:

EXFRAP3 = - 4.13 + 0.13 QFRAP3(-1) - 0.12 DFRAP3 + 0.03 EXPFRAP3
(20.47) (0.05) (0.07) (0.01)

+ 0.48 EXFRAP3(-1)
(0.16)

Comparatively, a 10.00 percent increase in wages (lagged) causes an increase of 11.90 percent in production, while that same relative increase for the energy cost will provoke a drop of 3.20 percent in the production of apple juice.

As previously stated, the equations for the Total Disappearance of both fresh apples and apple juice are specified mainly on the basis of the theoretical framework of demand analysis. However, the consideration of statistical results led to the substitution of the retail price for fresh apples with a proxy variable (import price for fresh apples). The use of an import price in the demand equation for fresh apples reflects among other things the high degree of dependency of domestic consumption on foreign imports for certain varieties (like Granny Smith) as well as during certain periods of the year when inventories are low. The statistical fit (R^2= 0.66) is acceptable. The signs for all the variables are compatible with theoretical expectations.

The results also indicate that Demand for fresh apples is inelastic (-0.30) with respect to the import price. Moreover, a 10.00 percent increase in the retail price of such substitutes like cereals and bakery products will generate a 7.97 percent increase in the consumption of fresh apples. The income elasticity of demand for fresh apples in Canada (0.095) means that the consumption is not very responsive to changes in the level of the income.

The equation for the Demand for apple juice is defined as a function of own retail price, the prices of two substitutes (e.g. canned orange juice and fluid milk), the total disposable income and a dummy variable. Although the fit (R^2 of 0.96) is excellent and the signs of all the variables are as anticipated, some of the explanatory variables (and in particular the retail price for apple juice) are not statistically significant.

Total Consumption of apple juice is inelastic with respect to own retail price, a 10.00 percent increase in the retail price for apple juice decreases the level of total demand by only -1.08 percent. The results indicate that changes in the retail price of fluid milk have a much greater effect on apple juice consumption with an elasticity of (2.45) compared with a value of only (1.20) in the case of the retail price for canned orange juice. Finally, the demand for apple juice appears relatively insensitive to increments in total disposable income; with an estimated income elasticity of (0.367).

It should be mentioned, that although the values for the income elasticities for fresh apples and apple juice consumption are low, these magnitudes conform to the general level of such elasticities (Hassan and Johnson's studies of Demand of Food) reported for various food items. In general, food consumption in a country like Canada is not responsive to income changes.

Import Price specification translates directly the domestic supply and demand conditions but not the external factors. With an (R^2 of 0.97), the fit is remarkable. The signs of the variables are correct, but only the retail price for fresh apples is statistically significant. Note that an increase in the demand for apple juice has a positive impact on the price for imported fresh apples, with an estimated elasticity of (0.233). This is explained by the fact that some of the fresh apples imported to Canada end up as apple juice.

TABLE 7. REGRESSION STATISTICS FOR THE "APPLE FORECASTING MODEL" (PERIOD OF 1969 TO 1982)

Endogenous Variable:	R^2	$\bar{R}^2$	D.W.	F
QFRAP3	0.77	0.67	2.64	7.52
QAPJ3	0.99	0.98	2.41	175.50
DFRAP3	0.66	0.51	2.78	4.40
DAPJ3	0.96	0.93	1.85	35.05
IMPFRAP3	0.97	0.96	1.50	120.42
EXPFRAP3	0.93	0.90	1.73	31.11
WPFRAP3	0.99	0.98	2.29	159.05
RPFRAP3	0.99	0.99	2.50	336.52
RPAPJ3	0.99	0.99	1.88	751.77
IMFRAP3	0.90	0.87	1.74	30.37
EXFRAP3	0.82	0.74	2.58	10.16

NOTE: See (Appendix IV)

The non-inclusion in the model of external variables (e.g. supply, demand or price factors outside of Canada) constitutes evidently a critical handicap in the identification of the forces which directly influence the Export Price for Canadian fresh apples. It is not surprising that the current equation suffers major theoretical and conceptual limitations and therefore it is difficult to interpret some of the statistical results. Although such results indicate an excellent fit ($R^2 = 0.93$), none of the retained explanatory variables appears statistically significant. The export price equation needs improved specification essentially the integration of some U.S. variables, since the American market constitutes a major outlet for Canadian apples.

Wholesale price for fresh apples was specified to reflect changes in total disappearance, the volume of marketed production (lagged), the exchange rates and the average wage rates in the Food distribution industry. The fit is excellent, (R^2 of 0.99). Most of the explanatory variables are relatively significant (particularly the average wage rates). All the variables are accompanied with the expected signs.

The statistical results help assess the degree of responsiveness of the Wholesale Price to percentage changes in the values of the explanatory variables. Changes in the exchange rates have the greatest direct impact on the wholesale price for fresh apples. The estimated elasticity indicates that a 10.00 percent increase in the exchange rate (drop of 10.00 percent in the value of the Canadian dollar) will bring an 18.40 percent increase in the wholesale price. This was anticipated, since an increase in the exchange rates means lower imports and therefore bring an upward pressure on domestic market prices.

The assessment of price transmission mechanism has been the subject of several econometric analysis. This interesting topic is addressed by the Apple model. As such the model evaluates the impact of changes in the wholesale price and in the import price on the observed level of the Retail Price for fresh apples. With an (R^2 of 0.99), the fit is nearly perfect. By and large the equation for the Retail Price of fresh apples presents good statistical values.

The estimated elasticities of the Retail Price for fresh apples with respect to wholesale and import prices as well as to the retail price of fresh fruits indicate that the dependent variable is more sensitive to changes in the retail price of fresh fruits (with an elasticity of 0.50) compared to changes in the wholesale price and import price for fresh apples (short run elasticity respectively 0.42).

Equation (9) defines the Retail Price for apple juice. The coefficient of determination is very high (R^2 = 0.996). Some of the explanatory variables appears statistically significant. Increases in the wage rates and the cost of energy exert upward pressure on the Retail Price for apple juice (short run elasticity of 0.60); similarly, higher retail prices for fresh apples are automatically transferred to the Retail Price for apple juice (elasticity of 0.41), which means that changes in input prices are transmitted to the processing level, but only partially so.

The equation for the Import Demand of fresh apples have the appropriate sign; however, only the total disappearance of fresh apples and apple juice is relatively significant. The equation has a good fit (R^2 = 0.90). A major comment from the observation of the results is the apparent inelasticity of Total Imports of fresh apples with respect to import price (0.0107); which implies that the Canadian market is a residual market.

The lack of responsiveness of Imports to changes in import price is due to the marketing structure for imported apples and to structural change in consumer preference. For example, there has been an increase in the demand for green apples (e.g. Granny Smith) which are not produced in Canada. Similarly, domestic production is not available for certain months of the year when apples must be imported to satisfy domestic demand. Thus, such factors rather than import price determine the effective level of imports.

Total Exports of fresh apples were estimated on the basis of several ad hoc assumptions and some theoretical consideration. Again the exclusion of non-Canadian markets from the model reduces the explanatory potential of that equation. In that perspective, equation (11) requires some modification. Under the circumstances, the results are acceptable. The fit is good (R^2 of 0.82). The signs of all the variables are compatible with traditional assumptions, that is, an increase in domestic production will generate more exports while an increase in demand will reduce total exports; conversely an increase in export price means more exports of Canadian fresh apples.

The volume of Exports is more sensitive to changes in the volume of domestic production than in total domestic demand. A 10.00 percent increase in production implies a 10.13 percent increase in exports, by comparison a 10.00 increase in domestic demand will reduce exports by only 6.01 percent. A more interesting result is the inelasticity of exports with respect to the export price for fresh apples (0.188), the apparent explanation for this relatively low elasticity is structural rigidity in the marketing process of Canadian apples on the international markets.

Increases in the costs of inputs (e.g. blended crude oil and labor) have opposite impacts on the Retail Price for fresh apples and for apple juice. While a 10.00 percent increase in those inputs costs

decreases the level of retail price for fresh apples by 2.14 percent, a similar increase generates a rise of 6.36 percent in the retail price of apple juice.

By and large, the economic properties and statistical performance of individual equations (R^2, D.W., t-test, F-test, short term elasticity, etc.) have been assessed and in most cases the results are very good. Moreover, those tests illustrate the estimated specifications of relevant factors which directly or in indirectly influence the evolution of the Canadian apple industry.

It follows from the observed results that the "total marketed production" of fresh apples is significantly affected by relative changes in the prices of both inputs and output; that the production of apple juice is sensitive to changes in the level of total supply of fresh apples; while changes in the wholesale price have an automatic impact on the retail price of fresh apples. The exchange rate appears as a key factor in the determination of the export price and wholesale price for fresh apples, which reflects the significant link between the Canadian apple industry and the rest of the world (R.O.W.).

The results also indicate a large degree of interaction between various parameters, and close linkage between the markets of fresh apples and apple juice. However, the fact that individual equations in the model are estimated by Ordinary Least Squares (OLS) technique means that few considerations are explicitly given to the eventuality of simultaneity in the model as a whole. A three-stage least squares (3SLS) or a two-stage least squares (2SLS) estimator would have been more appropriate under the condition of simultaneity and would have provided more efficient coefficients. Nevertheless, the current estimation (e.g. the OLS approximation) is acceptable since some of the equations demonstrate certain recursive characteristics.

The current specification of the model yields excellent fits for most of the equations. Only three out of the eleven estimated equations have an ($R^2 < 0.90$) while six equations have their coefficient of determination ($R^2 > 0.95$). Finally, the estimated coefficients are associated with the anticipated signs, which justifies the rational behind the current specification.

6. VALIDATION OF THE APPLE MODEL

A global evaluation of the Apple model (assuming simultaneous interactions between parameters) was performed in two phases; first over the intra-sample (ex-post simulation) or estimation period of 1969 to 1982, and subsequently for the extra-sample period (ex-post forecast) of 1983 to 1986. In both cases, the procedure consisted to simulate the model using actual exogenous variables and initial values of lagged endogenous variables.

The tests of performance (validation measures) are summarized by the values of the Mean Percentage Error (MPE) and the Root Mean Square Percentage Error (RMSPE) listed in Table 8. These measures are used to assess the ability of the model in tracking individual endogenous variables or its potential for reliable predictions.

Observations of the intra-sample (ex-post simulation) period indicate that the main components of the model perform very well. As illustrated in Table 8 the mean percentage errors are under 1.00 percent in absolute terms for most of the endogenous variables comprising production, disappearance and price, components. None of the endogenous variables in the Apple model exceeds a MPE of more than 5 percent. Only the export price and as expected the discrepancy variable demonstrate a relatively high MPE of 3.66 and 4.44 percent respectively.

For the same intra-sample (ex-post simulation) period of 1969 to 1982, most of the endogenous variables are associated to a root mean square percentage error of less than 8.00 percent. It follows that for the "within-sample" period, the model predicts relatively well such variables as the marketed production of fresh apples and apple juice, the retail prices as well as the wholesale price.

TABLE 8. INTRA-SAMPLE (1969 TO 1982) AND EXTRA-SAMPLE (1983 TO 1986) SIMULATION AND VALIDATION MEASURES OF THE "APPLE FORECASTING MODEL"

Endogenous Variable	Historical Period 1969 TO 1982		Forecast Period 1983 TO 1986
	Mean Percentage Error	Root Mean Square Percentage Error	Root Mean Square Percentage Error
Marketed production:			
QFRAP3	0.23	4.41	9.88
QAPJ3	0.31	4.74	18.16
Total disappearance:			
DFRAP3	0.13	6.37	3.18
DAPJ3	0.49	7.23	15.66
Prices:			
RPFRAP3	0.55	6.20	0.73
RPAPJ3	0.38	4.93	2.86
WPFRAP3	0.58	6.70	14.77
IMPFRAP3	1.37	10.31	3.08
EXPFRAP3	3.74	16.43	18.78
Trade:			
IMFRAP3	1.43	14.05	17.45
EXFRAP3	1.13	9.79	7.44
Others:			
CULFRAP3	0.24	5.44	0.83
DISCAP3	4.75	22.86	16.25

SOURCE: Derived from the current version of the Apple model.

The intra-sample RMSPE fell between the range of 9.00 and 16.00 percent in the case of total exports of fresh apples, the import price of fresh apples, total imports of fresh apples and the export price for fresh apples. The model has some difficulty in tracking the trade components and the prices for imports and exports.

The apparent weakness of the Apple model in predicting trade is not surprising. First, as mentioned earlier, the automatic exclusion from the model, of market conditions outside Canada, introduces a certain bias in the simulation, which reduces significantly the ability of the model in tracking the trade items. Concurrently, the high degree of variability from period to period of the trade variables amplifies the mis-specification bias. Since the model does not solve adequately at the trade level, better specifications seem necessary for that component.

The model also had difficult with the discrepancy variable. The magnitude of this variable which includes all processed apples (excluding apple juice), etc. requires certain attention. A disaggregation of the discrepancy variable into its main components (i.e. dried apples, apple fillings, apple sauce) should definitely improve the accuracy of the model.

The root mean square percentage errors (RMSPE) derived from the extra-sample (ex-post forecast) period of 1983 to 1986 are encouraging although only six endogenous variables have their RMSPE at less than 15.00 percent. All the RMSPE are below 20.00 percent; and in the specific cases of retail prices, import price and the total disappearance of fresh apples the RMSPE are below 5.00 percent. The model also forecasts very well the total export of fresh apples (RMSPE of 7.44 percent).

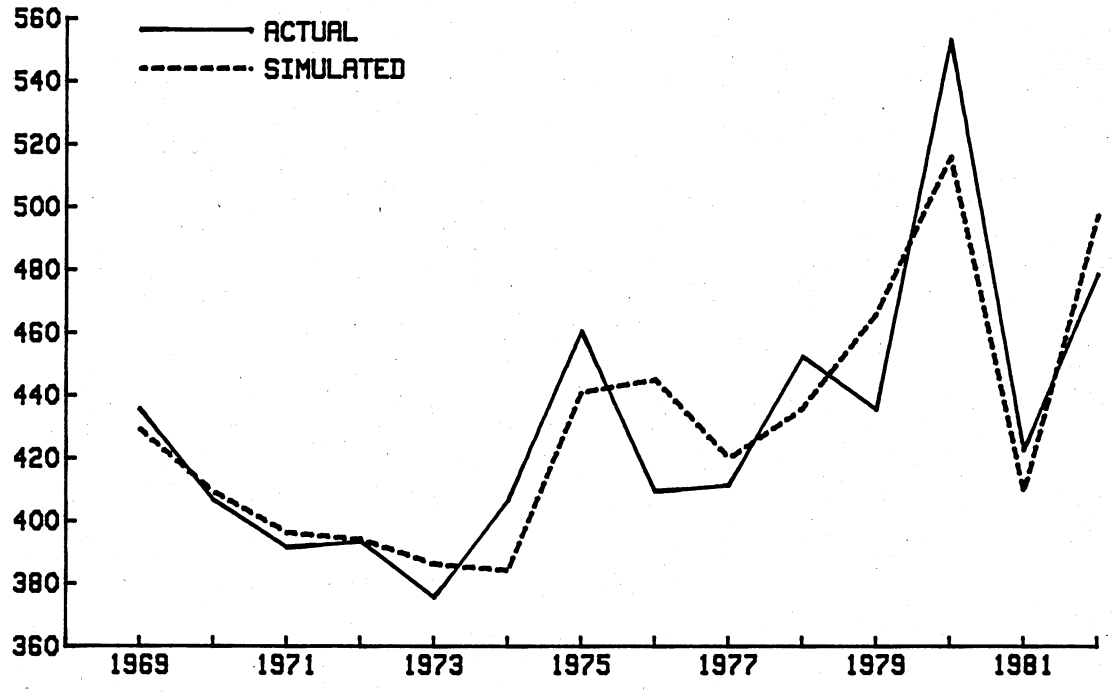
The main concern with the forecast is the production and wholesale price with their RMSPE falling into the range of 10.00 and 15.00 percent, a situation, however, which is acceptable at this stage. Deviations or loss of accuracy in the forecast for some of the endogenous variables, might be the result of errors introduced at the trade level. Mis-specification of the trade related equations could distort the overall forecast of supply and demand. Again, improvements in the trade component should correct such discrepancies.

TABLE 9. MODEL FORECASTS FOR SOME ENDOGENOUS VARIABLES (1983 TO 1986)

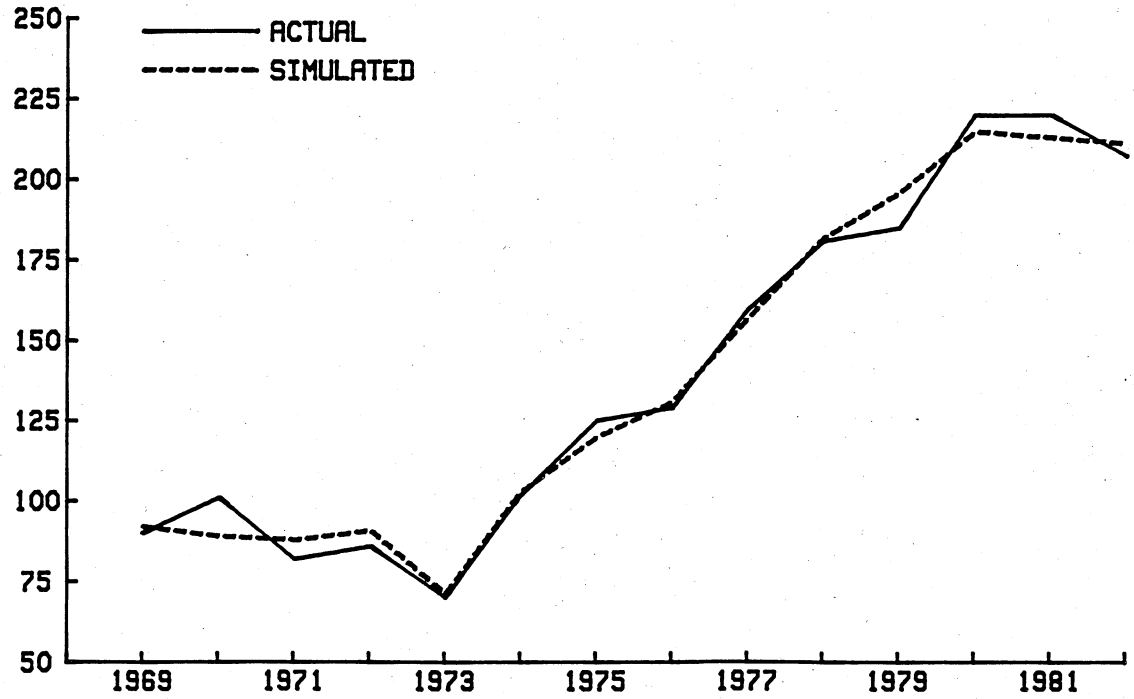
Variables	1983	1984	1985	1986
Marketed production of fresh apples: (QFRAP3)	436.95	416.88	456.25	616.19
Total production of apple juice: (QAPJ3)	204.99	226.32	262.18	270.17
Retail price for fresh apples: (RPFRAP3)	120.48	143.02	160.17	150.98
Retail price for apple juice: (RPAPJ3)	121.34	130.68	138.69	136.86
Wholesale price for fresh apples: (WPFRAP3)	12.68	14.15	15.34	14.28
Total disappearance of fresh apples: (DFRAP3)	303.70	289.10	277.95	285.77
Total disappearance of apple juice: (DAPJ3)	190.30	220.50	247.60	258.68
Total exports of fresh apples: (EXFRAP3)	73.47	74.95	76.24	83.41
Import price of fresh apples: (IMPFRAP3)	603.25	713.87	799.24	766.35

Note: The forecasts for production, disappearance and total exports are in thousand tonnes. Retail prices are based on the index of (1981 = 100); Wholesale price for fresh apples is defined as dollar/bushell; and the Imort price figures are dollars.

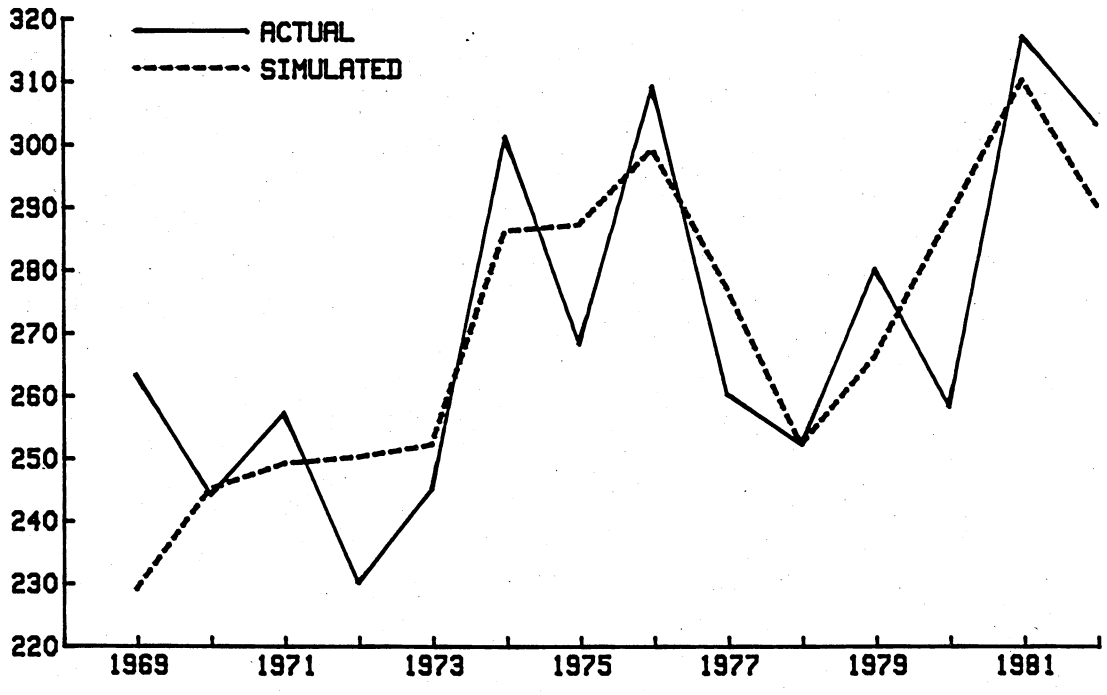
TOTAL MARKETED PRODUCTION OF FRESH APPLES, 1969-1982 ('000 TONNES)



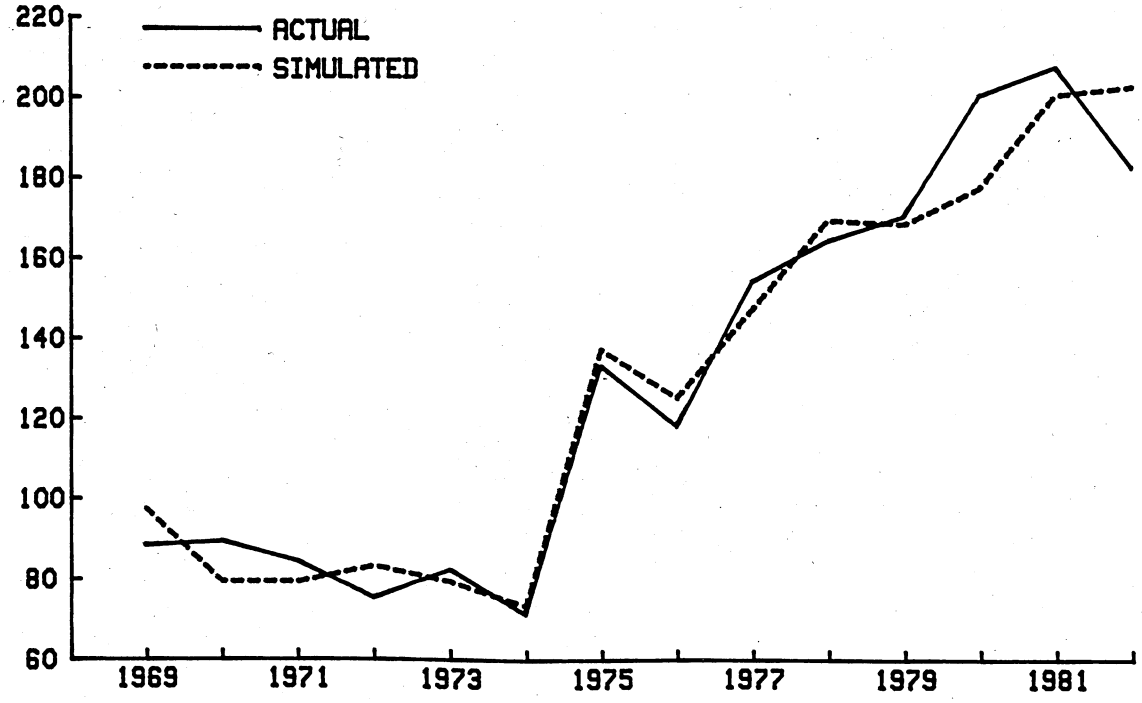
TOTAL PRODUCTION OF APPLE JUICE, 1969-1982 ('000 TONNES)

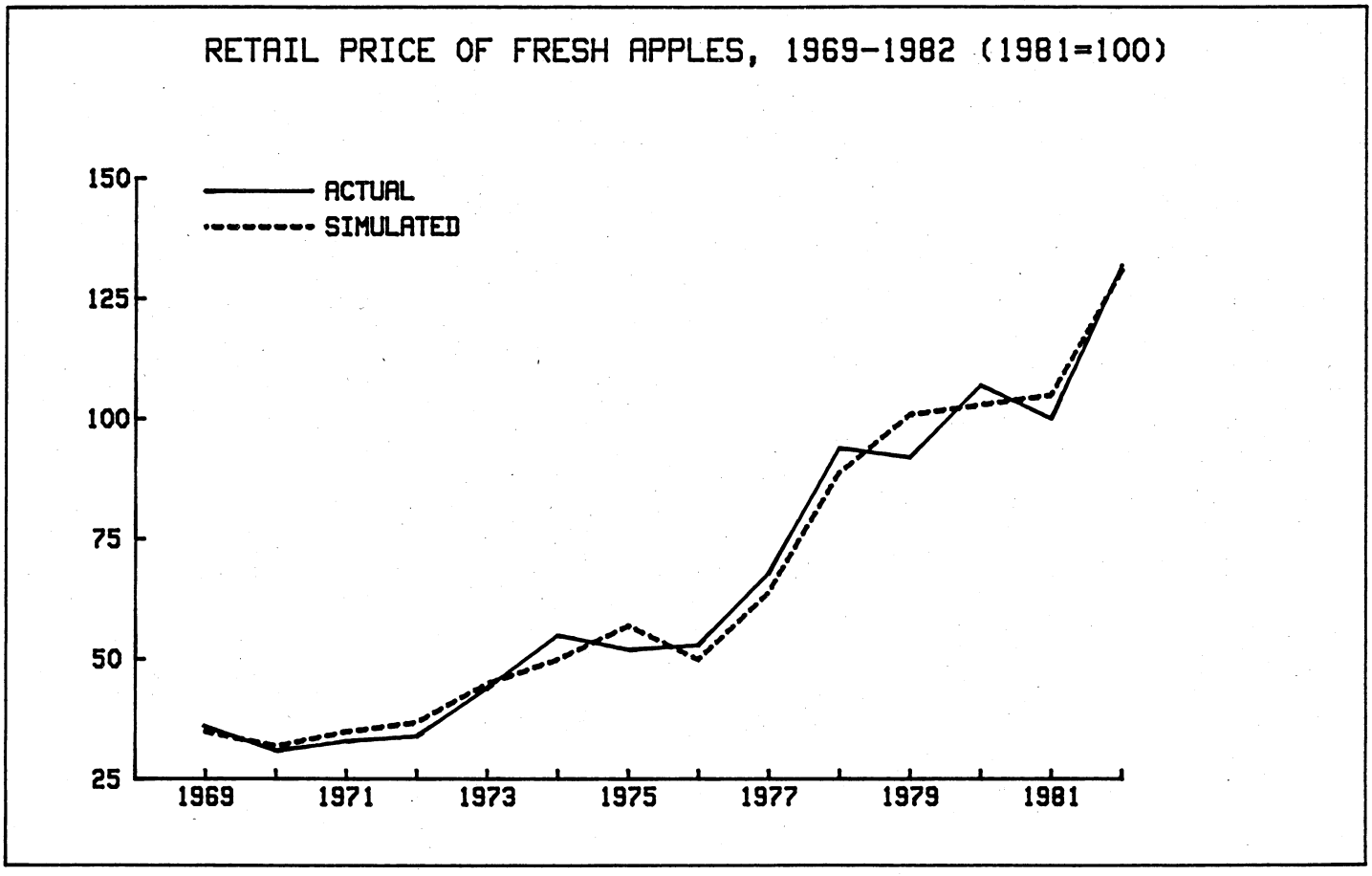


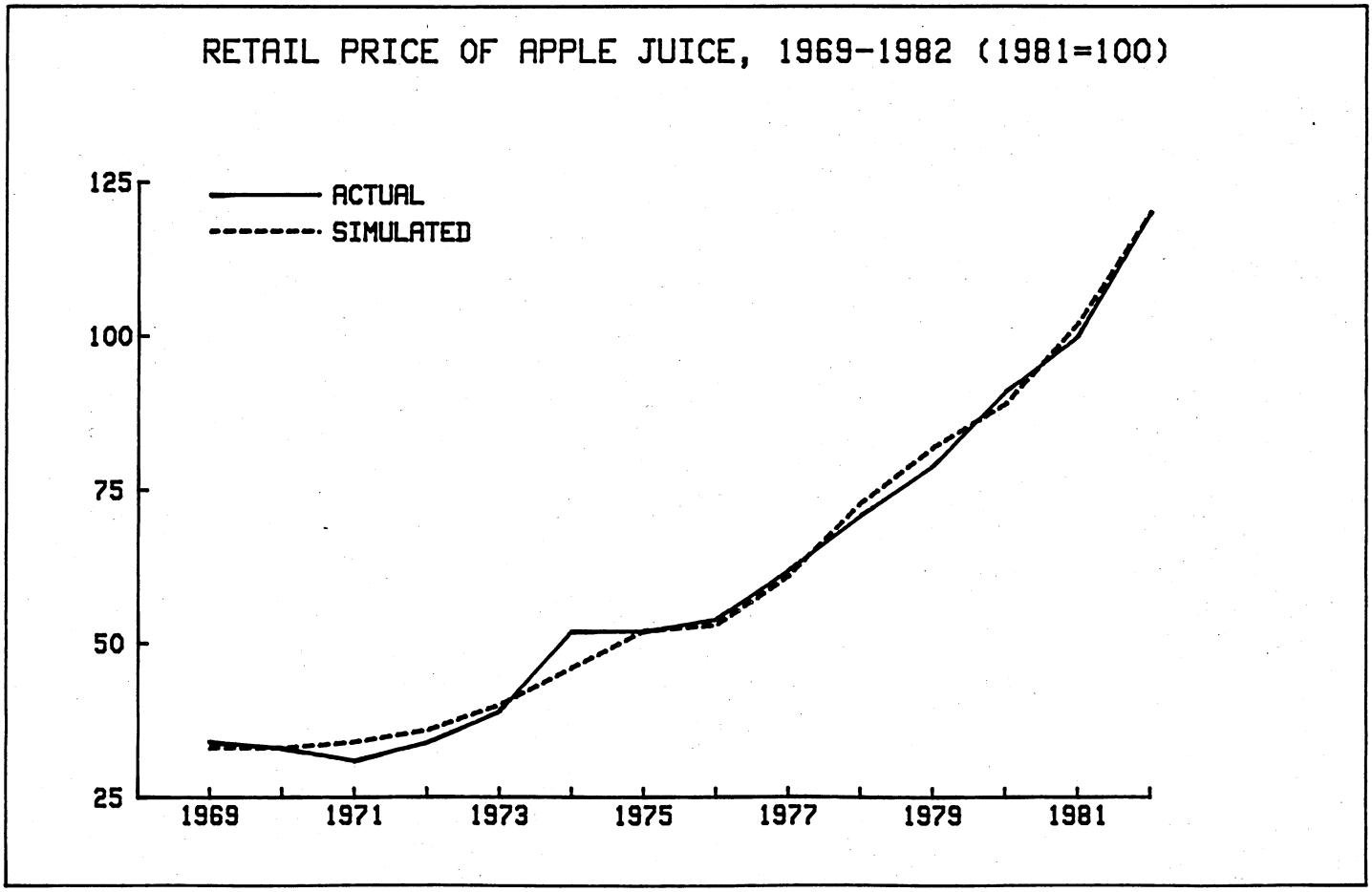
TOTAL DISAPPEARANCE OF FRESH APPLES, 1969-1982 ('000 TONNES)



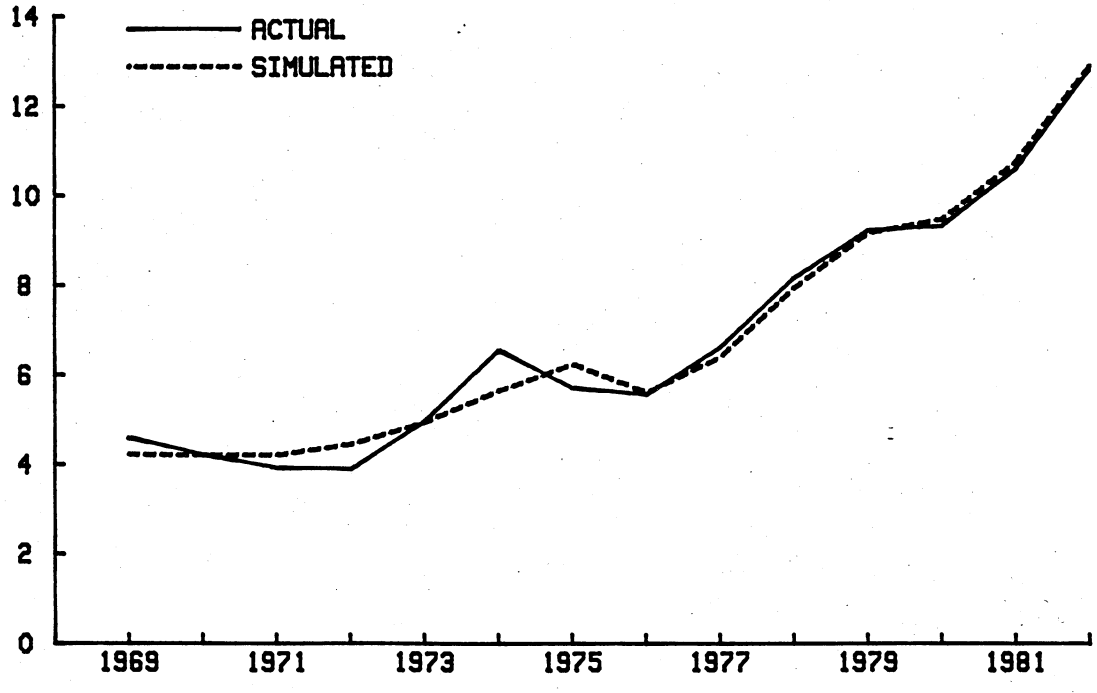
TOTAL DISAPPEARANCE OF APPLE JUICE, 1969-1982 ('000 TONNES)



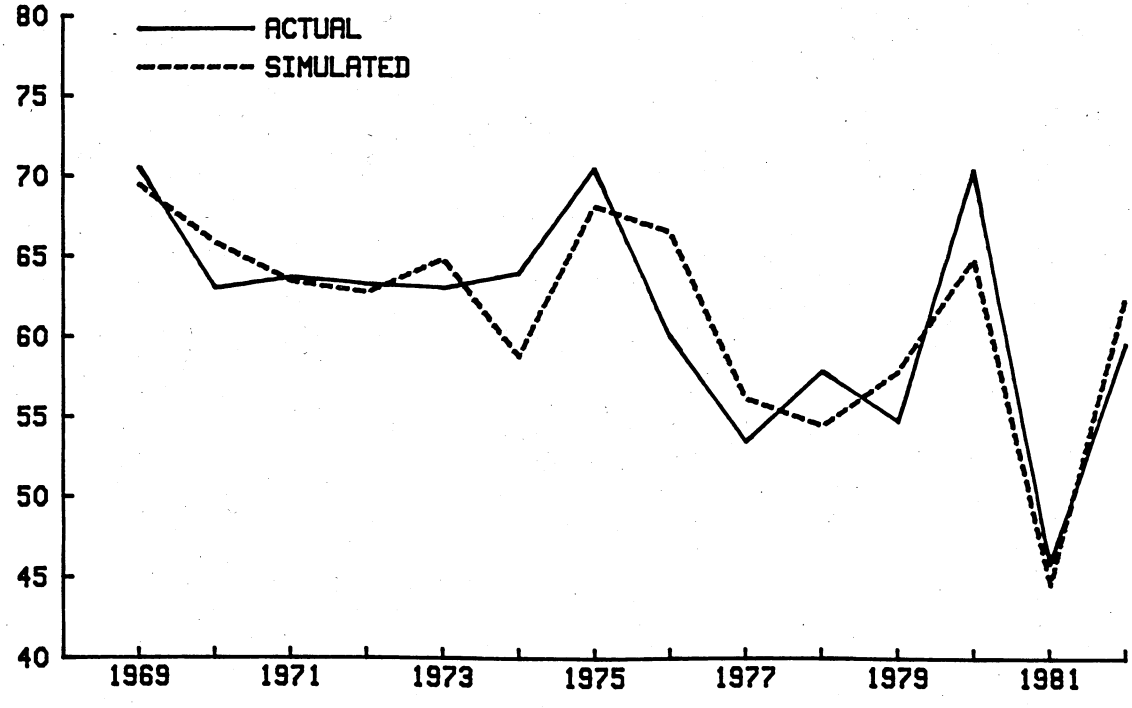

RETAIL PRICE OF FRESH APPLES, 1969-1982 (1981=100)
ACTUAL
SIMULATED
150
125
100
75
50
25
1969
1971
1973
1975
1977
1979
1981

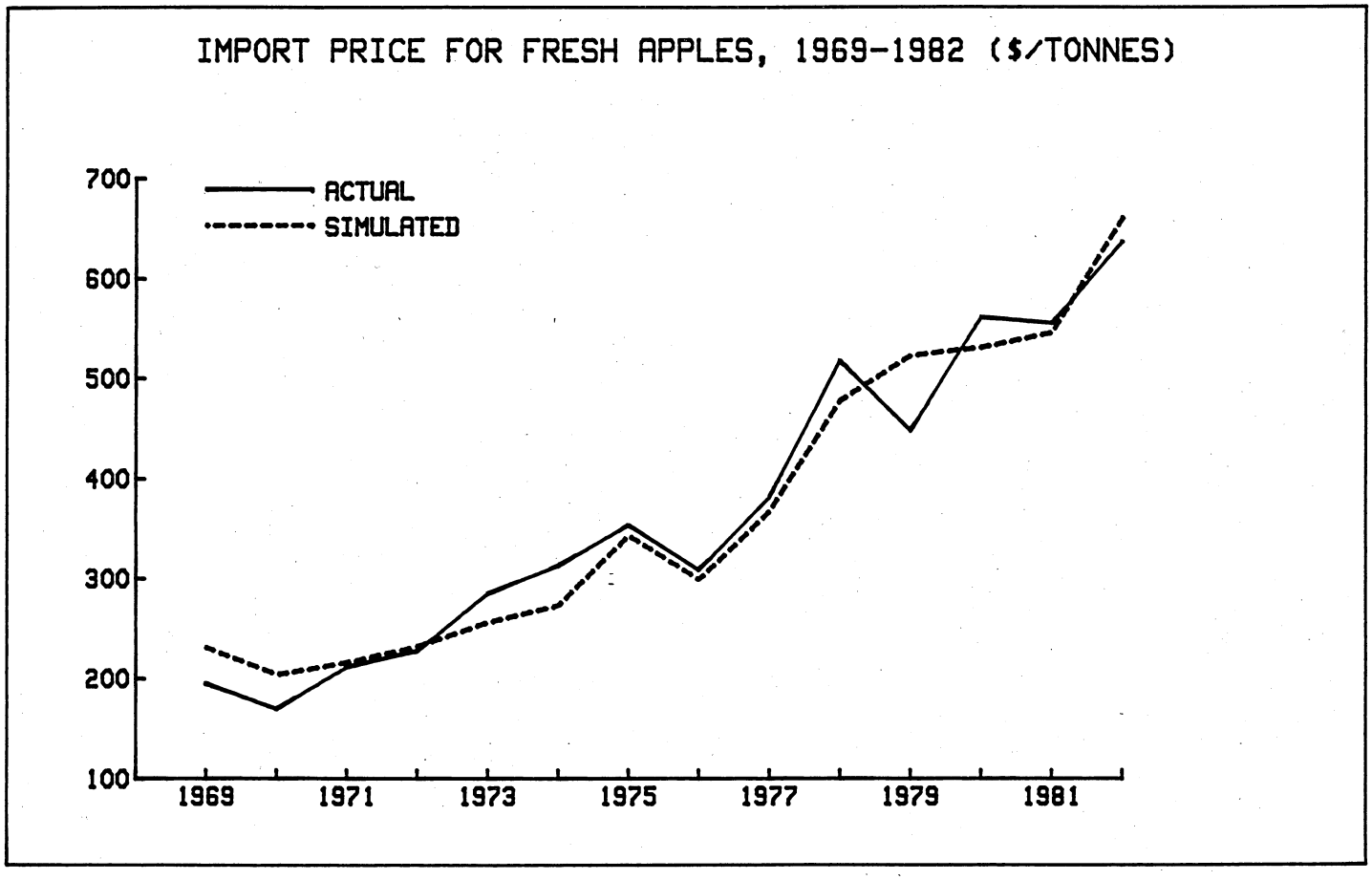

RETAIL PRICE OF APPLE JUICE, 1969-1982 (1981=100)
ACTUAL
SIMULATED
125
100
75
50
25
1969
1971
1973
1975
1977
1979
1981

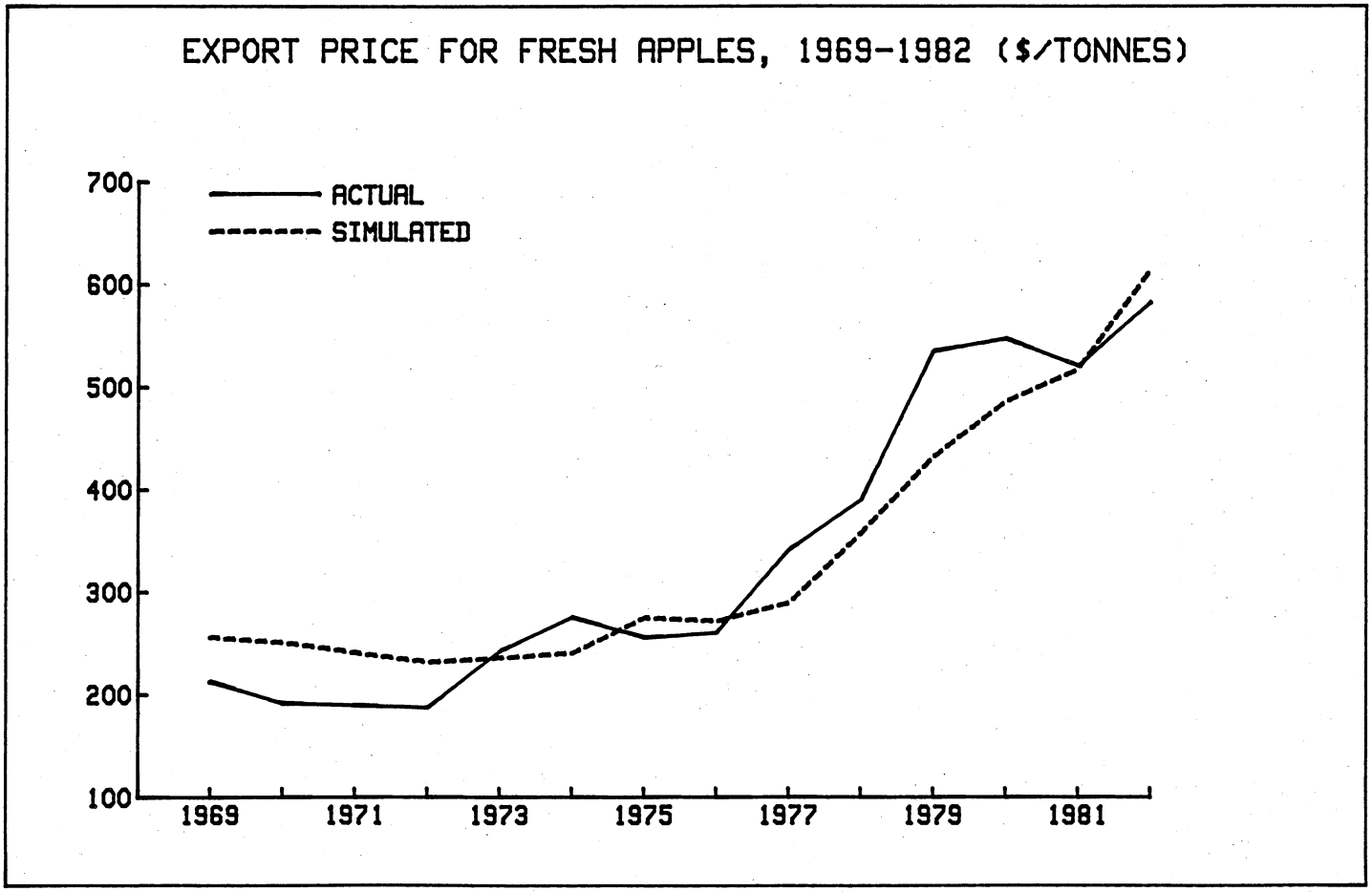
WHOLESALE PRICE OF FRESH APPLES, 1969-1982 ($/BUSHELL)



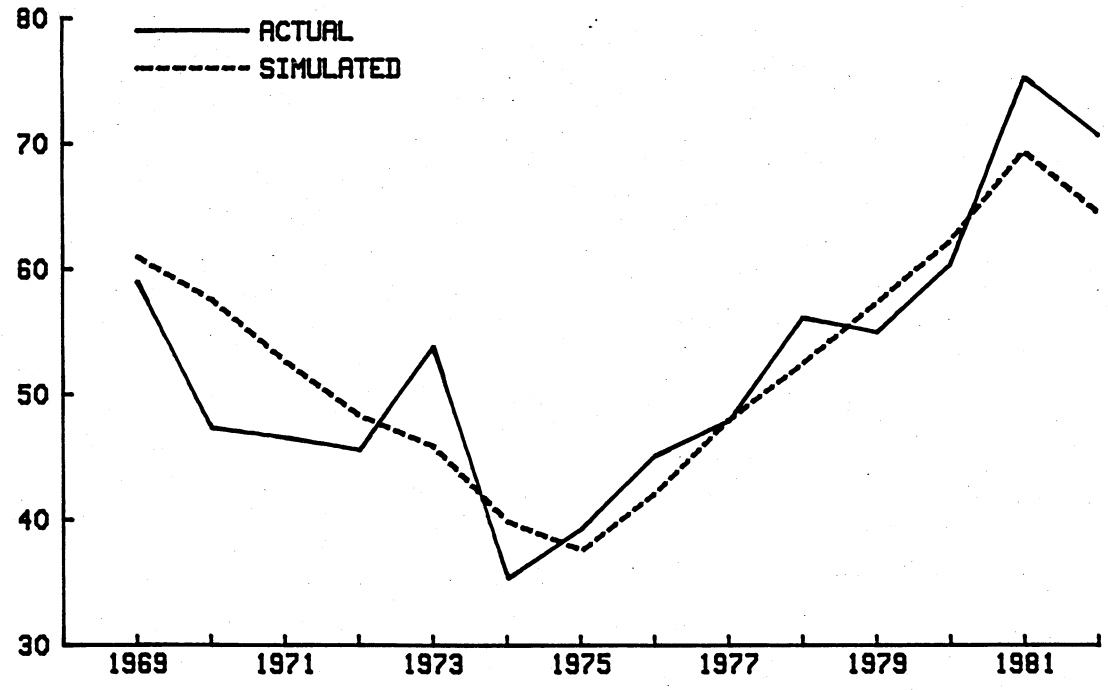
CULLAGE OF FRESH APPLES, 1969-1982 ('000 TONNES)



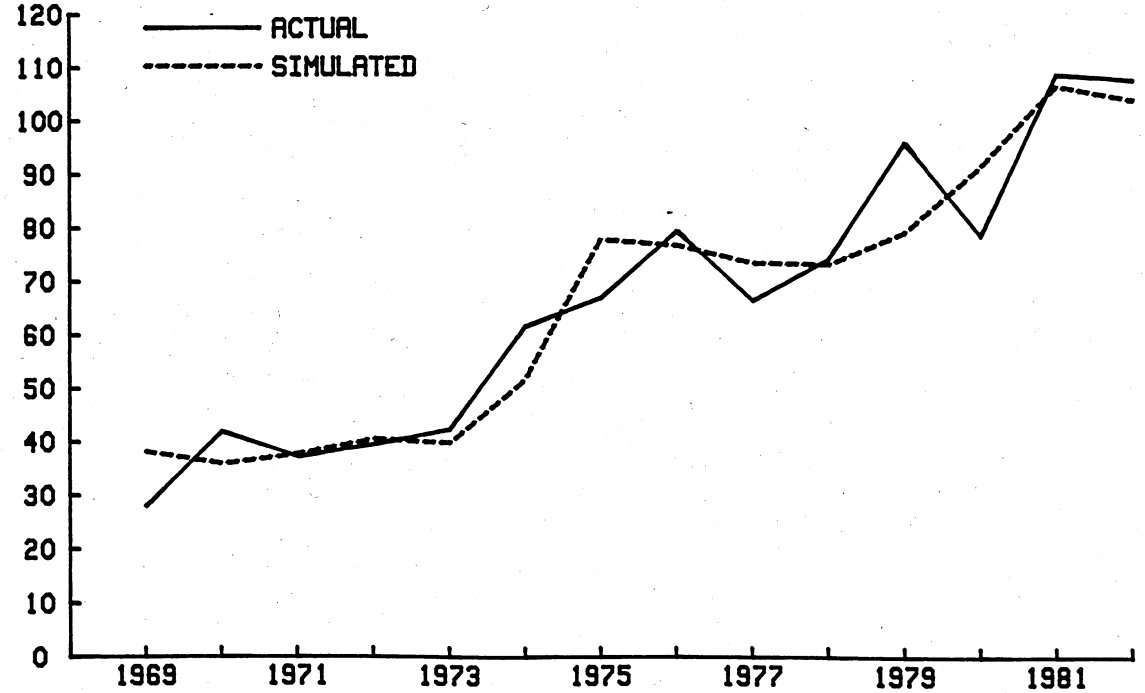

IMPORT PRICE FOR FRESH APPLES, 1969-1982 ($/TONNES)
ACTUAL
SIMULATED
700
600
500
400
300
200
100
1969
1971
1973
1975
1977
1979
1981


EXPORT PRICE FOR FRESH APPLES, 1969-1982 ($/TONNES)
ACTUAL
SIMULATED
700
600
500
400
300
200
100
1969
1971
1973
1975
1977
1979
1981

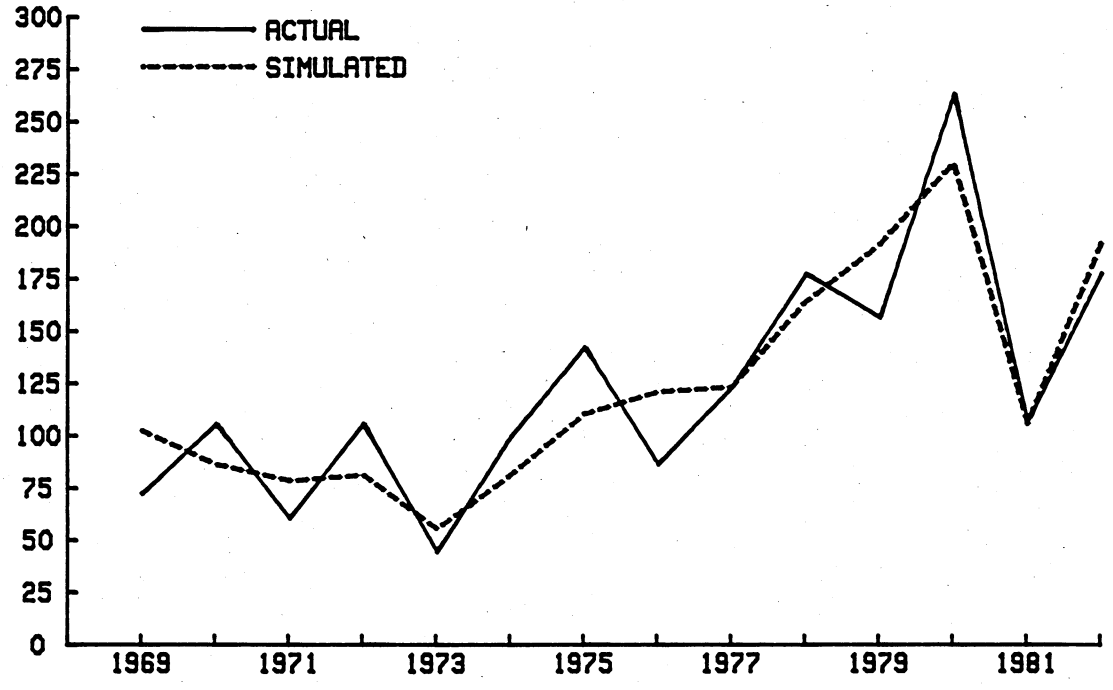
TOTAL EXPORTS OF FRESH APPLES, 1969-1982 ('000 TONNES)



TOTAL IMPORTS OF FRESH APPLES, 1969-1982 ('000 TONNES)



DISCREPANCY FACTOR FOR THE APPLE SECTOR, 1969-1982 ('000 TONNES)



7. ASSESSMENT AND FUTURE DEVELOPMENT

Examination of both estimation and simulation results suggests that the Apple model needs additional "work". First, the model should be re-defined on a quarterly basis so that it can capture the seasonal characteristics of the industry and also be integrated within the FARM forecasting quarterly framework. Similar improvement will be the inclusion into the Apple model of market information with regard to "critical" outside markets, more specifically information concerning the U.S. market for apples and apple products. This should eliminate the bias provoked by the potential mispecification of the apple trade component.

Specification and the introduction of supply and demand relationships for processed apples (other than apple juice) should definitely expand the scope and application of the Apple model for the assessment of intra-sectoral activities as well as policy analysis. Such disaggrgation should also provide a more accurate representation of the Canadian apple industry.

Net trade in apple juice was excluded from the model simply because data available for imports start from 1976. Given the fact that imported concentrates represent a continuously expanding share of inputs in the production of juice in Canada, and hence a major policy issue, additional efforts must be made to obtain data on imports of apple juice and concentrates.

Farm price was also excluded from the model's specification, since the available series included A.S.B. payments and thus do not precisely reflect market forces. This problem can be solved by using a proxy such as a farm price index for fresh apples, or deleting the A.S.B. payments from total farm value to obtain a derived series which excludes subsidies. It is critical that farm price be endogenized in the model.

Exclusive use of the OLS estimation technique had some technical deficiencies by ignoring the problem of simultaneity - Alternative estimation procedures (2SLS or 3SLS) can be part of the future plans for the model, since this may lead to more accurate estimation results and better forecasts.

Additional calculation or analysis of the statistical results may be useful for the interpretation of the responsiveness of various endogenous variables to changes outside the apple sector. For example, a complete set of long term elasticities could illustrate the specific impact on the endogenous values to changes in the pre-determined variables, and hence will provide a more consistent basis for policy evaluation.

The area of focus should also include a global re-assessment of the macroeconomic factors as explanatory variables. A close examination of the links between the apple industry and the rest of the Canadian economy will explain the functioning of that industry within the economy - but will also bring a greater insight upon the adjustment process prevailing in the apple sector, particularly on how that sector copes with movements in the rates of interest, labor availability, personal expenditures, exchange rates and market regulation.

In that context, immediate revision of the current version is necessary. Finally, the model should be adapted to tackle various policy questions relating to the development of the Canadian apple industry. Questions such as trade policy (tariffs, quotas), storage facilities, transportation costs, subsidies, and marketing practices.

The Apple Forecasting Model (as currently specified), has been partly used in conjunction to the "Tri-Partite Stabilization Program" for the Canadian apple sector. Long-term forecasts (up to the year 1989) were derived from the model for such parameters as the total marketed production of fresh apples. The forecasts provided information for establishing the future "farm income" flows. Such practical use of the Apple Model for specific policy determination is a clear indication of the need to continue the development of a forecasting framework for the apple industry.

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APPENDIX I

TABLE 1. PNEMONICS AND DEFINITION OF ALL THE VARIABLES USED IN THE APPLE FORECASTING MODEL

Endogenous Variables

CULFRAP3 - Cullage factor for fresh apples and apple juice, ('000 tonnes), Crop-Year basis.
Source: Derived series.

DAPJ3 - Total domestic disappearance of apple juice (made from fresh apples or reconstituted from concentrate in fresh-equivalent, ('000 tonnes), Crop-Year basis.
Source: Statistics Canada, Supply and Disposition of Fresh Fruits in Canada.

DFRAP3 - Total domestic disappearance of fresh apples, ('000 tonnes), Crop-Year basis.
Source: Statistics Canada, Supply and Disposition of Fresh Fruits in Canada.

DISCAP3 - Discrepancy variable, in fresh-equivalent, ('000 tonnes), Crop-Year basis.
Source: Derived Series.

EXFRAP3 - Total exports of fresh apples, ('000 tonnes), Crop-Year basis.
Source: Statistics Canada, Trade-Tapes.

- continued -

TABLE 1. (Continued)

Endogenous Variables (Continued)

EXPFRAP3 - Export price for fresh apples, (dollar/tonne), Crop-Year basis.
Source: Derived series, computed from Statistics Canada's Trade-Tapes.

FPFRAP3 - Farm price for fresh apples, (including ASB payments); (dollar/tonne), Crop-Year basis.
Source: Statistics Canada; Reference Handbook, Fruits.

IMFRAP3 - Total imports of fresh apples, ('000 tonnes), Crop-Year basis.
Source: Statistics Canada, Trade-Tapes.

IMPFRAP3 - Import price for fresh apples, (dollar/tonne), Crop-Year basis.
Source: Derived series; computed from Statistics Canada's Trade-Tapes.

QAPJ3 - Total production of apple juice (made from fresh apples or reconstituted from concentrate), in fresh equivalent, ('000 tonnes), Crop-Year basis.
Source: Statistics Canada; Supply, and Distribution of Fresh Fruits in Canada.

QFRAP3 - Total marketed production of fresh apples (for use as fresh or for processing), ('000 tonnes), Crop-Year basis.
Source: Statistics Canada, Supply and Distribution of Fresh Fruits in Canada.

- continued -

TABLE 1 (Continued)

Endogenous Variables (Continued)

RPAPJ3 - Retail prices index for apple juice, (1981 = 100), Crop-Year basis.
Source: Statistics Canada's CANSIM Mini-Base.

RPFRAP3 - Retail price index for fresh apples,(1981 = 100) Crop-Year basis.
Source: Statistics Canada's CANSIM Mini-Base.

WPFRAP3 - Wholesale price for fresh apples, (series are computed for McIntosh apples as an average of Toronto, Montreal and Vancouver weekly price quotation), (dollar/bushel), Crop-Year basis.
Source: Agriculture Canada, Market Information Service.

Exogenous Variables

CP13 - Consumer Price Index in Canada, (1981 = 100).
Source: CORDATA1.

DUMW - Dummy Variable (defined to account for the 1981 winter freeze in Quebec). Takes a value of 1 for 1981 through 1985 and zero otherwise.

ER34 - Exchange rates, (Canadian dollar vs. U.S. dollar), Crop-Year basis.
Source: FARMS's CORDATA1.

FIPFERT3 - Farm input price index for fertilizer, (1971 = 100), Crop-Year basis.
Source: Statistica Canada, and FARM's CORDATA1.

- continued -

TABLE 1. (Continued)

Exogenous Variables (Continued)

FIPWGE3 - Farm input price index for labor, (1971 = 100), Crop-Year basis.
Source: Statistics Canada, and FARM's CORDATA1.

JS74 - Dummy variable, value of 1 for the 1974/75 crop-year and zero otherwise.

PBOIL3 - Average price for petroleum, (dollar/bushell), Crop-Year basis.
Source: FARM's CORDATA1.

PCDYS3 - Per capita disposable income seasonally adjusted, (dollar), Crop-Year basis.
Source: FARM's CORDATA1.

POPN3 - Population of Canada; (thousand), Crop-Year basis. Data are observed as of July 1, of each year.
Source: See Allan Wilmot.

RPCL3 - Retail price index for cereals and bakery products, (1981 = 100), Crop-Year basis.
Source: Statistics Canada's CANSIM Mini-Base.

RPCORJ3 - Retail price index for canned orange juice, (1981 = 100), Crop-Year basis.
Source: Statistics Canada's CANSIM Mini-Base.

RPFM3 - Retail price index for fluid milk, (1981 = 100), Crop-Year basis.
Source: Statistics Canada's CANSIM Mini-Base.

- continued -

TABLE 1 (Concluded)

Exogenous Variables (Continued)

RPFRFR3 - Retail price index for fresh fruits, (1981 = 100), Crop-Year basis.
Source: Statistics Canada's CANSIM Mini-Base.

TIME - Time trend variable.

WARFD3 - Average weekly wage rates in the retail and distribution of food sector, (dollar), Crop-Year basis.
Source: FARM's CORDATA1.

APPENDIX II

TABLE 1. EXOGENOUS VARIABLES ASSUMPTIONS

VARIABLE	FORECAST PERIOD 1983	1984	1985	1986
Consumer Price Index: (CPI3)	117.23	122.32	126.98	130.75
	5.82%	4.34%	3.81%	2.97%
Exchange Rates: (ER34)	1.23	1.295	1.36	1.358
	-0.11%	5.28%	5.02%	-0.15%
FIPI Fertilizer: (FIPFERT3)	90.17	94.45	96.37	101.63
	-5.75%	4.75%	2.03%	5.46%
FIPI Labor: (FIPWAGE3)	111.88	116.73	119.98	123.33
	5.27%	4.34%	2.78%	2.79%
Price of Petroleum: (PBOIL3)	34.66	35.12	37.44	37.56
	8.04%	1.33%	6.61%	0.32%
Per Capita Disposable Income:	108.56	114.83	121.52	127.60
(PCDYS3)	4.42%	5.78%	5.83%	5.0%
Population: (POPN3)	249.07	251.20	253.52	255.83
	1.02%	0.86%	0.92%	0.91%
CPI for Cereals & Bakery:	110.99	116.77	122.33	124.35
(RPCL3)	4.90%	5.21%	4.76%	1.65%
CPI for Canned Orange Juice:	111.34	127.37	138.97	140.00
(RPCORJ3)	0.59%	14.40%	9.11%	0.74%
CPI for Fluid Milk: (RPFM3)	111.82	120.14	129.15	135.73
	2.63%	7.44%	7.50%	5.09%
CPI for Fresh Fruits:	116.41	132.60	144.93	142.45
(RPFRFR3)	-4.16%	13.91%	9.30%	-1.70%
Wages in the Food Retail Industry:	242.31	249.48	250.63	262.63
(WARFD3)	8.33%	2.96%	0.46%	4.79%
Wages in the Food Processing Industry:	392.92	415.55	417.47	437.46
(WAFB3)	7.67%	5.76%	0.46%	4.79%

NOTE: Assumptions are based on FARM's forecasts, with the exception of the CPI for canned orange juice and the Farm price for apples. Per capita disposable income is seasonally adjusted.

APPENDIX III

TABLE 1. CONSUMPTION AND RETAIL PRICE FOR FRESH APPLES AND APPLE JUICE, 1967 TO 1983

YEAR	Per Capita Consumption of Fresh Apples	Per Capita Consumption of Apple Juice	Retail Price Index for Fresh Apples	Retail Price Index for Apple Juice
1967	9.64	4.54	31.01	29.83
1968	12.19	3.77	34.44	30.48
1969	12.52	4.19	35.50	34.47
1970	11.44	4.18	31.30	32.86
1971	11.90	3.87	32.94	30.93
1972	10.54	3.43	34.32	34.20
1973	11.08	3.72	44.38	38.75
1974	13.43	3.18	55.39	51.62
1975	11.77	5.87	52.20	52.28
1976	13.40	5.12	53.23	53.67
1977	11.17	6.60	67.71	62.48
1978	10.74	6.96	94.07	71.34
1979	11.81	7.19	92.43	79.10
1980	10.78	8.34	106.67	91.82
1981	12.99	8.50	100.00	100.00
1982	12.29	7.40	132.12	120.06
1983	12.59	9.06	119.61	117.97

NOTE: Per Capita Consumption is in kilograms. Retail Price Indices are based on 1981 = 100.

Source: Statistics Canada, CANSIM.

APPENDIX III

TABLE 2. PER CAPITA CONSUMPTION OF FRESH APPLES AND FRESH FRUITS - APPLES AS PERCENTAGE OF TOTAL FRUITS CONSUMPTION

Year	Fresh Apples (kg)	Total Fresh Fruits (kg)	Apples/Total Fruits %
1968	12.19	51.57	23.64
1969	12.52	51.24	24.43
1970	11.44	50.17	22.80
1971	11.90	51.32	23.19
1972	10.54	48.80	21.60
1973	11.08	51.03	21.71
1974	13.43	54.28	24.74
1975	11.77	54.70	21.52
1976	13.40	59.24	22.62
1977	11.17	56.21	19.87
1978	10.74	53.53	20.06
1979	11.81	54.12	21.82
1980	10.78	54.57	19.75
1981	12.99	57.19	22.71
1982	12.29	54.16	22.69
1983	12.59	56.63	22.23

Source: Agriculture Canada, "Handbook of Food Expenditures, Prices and Consumption", Marketing and Economics Branch.

1: QFRAP3 = QFRAP3.0+QFRAP3.1*WPFRAP3+QFRAP3.2*FIPFERT3(-1)+QFRAP3.3*FIPWAGE3+QFRAP3.4*DUMW

NOB = 14 NOVAR = 5
RANGE = 1969 TO 1982
RSQ = 0.7696 CRSQ = 0.6672 F(4/9) = 7.515
SER = 26.1473 SSR = 6153.160 DW(0) = 2.64 COND(X) = 49.82
LHS MEAN = 430.44100 SR = 0.00439

COEF	VALUE	ST ER	T-STAT	MEAN
QFRAP3.0	315.11400	25.02210	12.59350	1.00000
QFRAP3.1	25.79680	9.72509	2.65260	6.86035
QFRAP3.2	5.95353	1.92193	3.09769	52.22850
QFRAP3.3	-5.19823	1.82831	-2.84319	66.36420
QFRAP3.4	-193.31200	49.34830	-3.91730	0.14286

COEF	PARTIAL	BETA
QFRAP3.0	0.97278	0.00000
QFRAP3.1	0.66240	1.57236
QFRAP3.2	0.71834	3.10832
QFRAP3.3	-0.68788	-2.91916
QFRAP3.4	-0.79393	-1.54880

2: QAPJ3 = QAPJ3.0+QAPJ3.1*WAFB3(-1)+QAPJ3.2*PBOIL3(-1)+QAPJ3.3*QFRAP3+QAPJ3.4*ER34+QAPJ3.5*JS73

NOB = 14 NOVAR = 6
RANGE = 1969 TO 1982
RSQ = 0.99097 CRSQ = 0.98532 F(5/8) = 175.498
SER = 6.5898 SSR = 347.402 DW(0) = 2.41 COND(X) = 78.59
LHS MEAN = 139.84000 SR = 0.00027

COEF	VALUE	ST ER	T-STAT	MEAN
QAPJ3.0	-251.11500	43.49600	-5.77328	1.00000
QAPJ3.1	0.88772	0.08430	10.53030	187.34500
QAPJ3.2	-5.37898	0.98088	-5.48384	8.43731
QAPJ3.3	0.12091	0.05527	2.18775	430.44100
QAPJ3.4	204.36400	45.37830	4.50356	1.07715
QAPJ3.5	-30.06130	7.34411	-4.09326	0.07143

COEF	PARTIAL	BETA
QAPJ3.0	-0.89802	0.00000
QAPJ3.1	0.96577	1.24360
QAPJ3.2	-0.88875	-0.69727
QAPJ3.3	0.61182	0.10077
QAPJ3.4	0.84684	0.33240
QAPJ3.5	-0.82270	-0.14772

3: DFRAP3 = PCFR3.0+PCFR3.1*IMPFRAP3/CPI3+PCFR3.2*RPCL3/CPI3+PCFR3.4*ER34+PCFR3.5*PCDYS3*POPN3

NOB = 14 NOVAR = 5
RANGE = 1969 TO 1982
RSQ = 0.6616 CRSQ = 0.5112 F(4/9) = 4.399
SER = 18.8720 SSR = 3205.390 DW(0) = 2.78 COND(X) = 107.28
LHS MEAN = 270.40500 SR = 0.00415

COEF	VALUE	ST ER	T-STAT	MEAN
PCFR3.0	286.63800	190.84100	1.50197	1.00000
PCFR3.1	-14.70310	8.47438	-1.73501	5.53270
PCFR3.2	250.84900	159.37800	1.57393	0.85924
PCFR3.4	-166.21600	120.14200	-1.38349	1.07715
PCFR3.5	2.22105E-07	2.69290E-07	0.82478	1.28840E+08

COEF	PARTIAL	BETA
PCFR3.0	0.44768	0.00000
PCFR3.1	-0.50064	-0.39008
PCFR3.2	0.46459	0.76195
PCFR3.4	-0.41878	-0.54472
PCFR3.5	0.26509	0.55501

4: DAPJ3 = PCAPJ3.0+PCAPJ3.1*RPAPJ3/CPI3+PCAPJ3.2*RPCORJ3/CPI3+PCAPJ3.5*PCDYS3*POPN3+PCAPJ3.7*JS74+PCAPJ3.8* ...
RPFM3/CPI3

NOB = 14 NOVAR = 6
RANGE = 1969 TO 1982
RSQ = 0.95635 CRSQ = 0.92906 F(5/8) = 35.053
SER = 13.0917 SSR = 1371.140 DW(0) = 1.85 COND(X) = 121.09
LHS MEAN = 129.80300 SR = -0.00008

COEF	VALUE	ST ER	T-STAT	MEAN
PCAPJ3.0	-366.77900	130.95500	-2.80080	1.00000
PCAPJ3.1	-15.42710	127.62000	-0.12088	0.90695
PCAPJ3.2	156.98000	73.39330	2.13889	0.92475
PCAPJ3.5	3.74740E-07	1.51759E-07	2.46932	1.28840E+08
PCAPJ3.7	-7.00365	30.31230	-0.23105	0.07143
PCAPJ3.8	338.22100	132.35900	2.55534	0.93910

COEF	PARTIAL	BETA
PCAPJ3.0	-0.70363	0.00000
PCAPJ3.1	-0.04270	-0.03282
PCAPJ3.2	0.60317	0.33469
PCAPJ3.5	0.65767	0.51424
PCAPJ3.7	-0.08142	-0.03808
PCAPJ3.8	0.67038	0.44189

5: IMPFRAP3 = IMPFR3.0+IMPFR3.1*QFRAP3(-1)+IMPFR3.2*DAPJ3+IMPFR3.3*RPFRAP3

NOB = 14 NOVAR = 4
RANGE = 1969 TO 1982
RSQ = 0.97306 CRSQ = 0.96498 F(3/10) = 120.417
SER = 28.4692 SSR = 8104.950 DW(0) = 1.50 COND(X) = 39.09
LHS MEAN = 367.19600 SR = -0.00002

COEF	VALUE	ST ER	T-STAT	MEAN
IMPFR3.0	88.81200	91.92450	0.96614	1.00000
IMPFR3.1	-0.13783	0.26219	-0.52568	424.96000
IMPFR3.2	0.65934	0.47929	1.37566	129.80300
IMPFR3.3	3.77495	0.61240	6.16416	66.58920

COEF	PARTIAL	BETA
IMPFR3.0	0.29219	0.00000
IMPFR3.1	-0.16399	-0.03967
IMPFR3.2	0.39891	0.21303
IMPFR3.3	0.88975	0.80931

6: EXPFRAP3 = EXPFR3.0+EXPFR3.1*QFRAP3(-1)+EXPFR3.2*EXPFRAP3(-1)+EXPFR3.3*ER34+EXPFR3.4*WPFRAP3(-1)

NOB = 14 NOVAR = 5
RANGE = 1969 TO 1982
RSQ = 0.93256 CRSQ = 0.90259 F(4/9) = 31.114
SER = 46.3595 SSR = 19342.800 DW(0) = 1.73 COND(X) = 85.35
LHS MEAN = 337.65700 SR = -0.00018

COEF	VALUE	ST ER	T-STAT	MEAN
EXPFR3.0	-268.49600	330.91600	-0.81137	1.00000
EXPFR3.1	-0.36395	0.39195	-0.92857	424.96000
EXPFR3.2	0.55728	0.45533	1.22390	310.63600
EXPFR3.3	431.85300	332.99400	1.29688	1.07715
EXPFR3.4	19.50790	26.21830	0.74406	6.28125

COEF	PARTIAL	BETA
EXPFR3.0	-0.26108	0.00000
EXPFR3.1	-0.29568	-0.10730
EXPFR3.2	0.37774	0.50397
EXPFR3.3	0.39680	0.25719
EXPFR3.4	0.24073	0.29117

7: WPFRAP3 = WPFR3.0+WPFR3.1*DEL(1 : DFRAP3)+WPFR3.3*WARFD3+WPFR3.4*QFRAP3(-1)+WPFR3.5*ER34+WPFR3.6*DUMW

NOB = 14 NOVAR = 6
RANGE = 1969 TO 1982
RSQ = 0.99004 CRSQ = 0.98382 F(5/8) = 159.054
SER = 0.3514 SSR = 0.988 DW(0) = 2.29 COND(X) = 64.38
LHS MEAN = 6.86035 SR = -0.00003

COEF	VALUE	ST ER	T-STAT	MEAN
WPFR3.0	-3.75963	2.11648	-1.77636	1.00000
WPFR3.1	0.01330	0.00342	3.88695	3.59592
WPFR3.3	0.03652	0.00350	10.44850	132.81300
WPFR3.4	-0.01660	0.00323	-5.13856	424.96000
WPFR3.5	11.71710	2.06635	5.67043	1.07715
WPFR3.6	1.06645	0.40882	2.60861	0.14286

COEF	PARTIAL	BETA
WPFR3.0	-0.53185	0.00000
WPFR3.1	0.80858	0.16112
WPFR3.3	0.96526	0.69147
WPFR3.4	-0.87606	-0.26306
WPFR3.5	0.89486	0.37519
WPFR3.6	0.67796	0.14018

8: RPFRAP3 = RPFR3.0+RPFR3.1*WPFRAP3+RPFR3.2*(0.2*WARFD3+PBOIL3)+RPFR3.3*IMPFRAP3+RPFR3.4*RPFRFR3

NOB = 14 NOVAR = 5
RANGE = 1969 TO 1982
RSQ = 0.99336 CRSQ = 0.99041 F(4/9) = 336.524
SER = 3.1947 SSR = 91.854 DW(0) = 2.50 COND(X) = 48.97
LHS MEAN = 66.58920 SR = 0.00012

COEF	VALUE	ST ER	T-STAT	MEAN
RPFR3.0	-8.98779	4.29500	-2.09262	1.00000
RPFR3.1	4.10722	1.81969	2.25710	6.86035
RPFR3.2	-0.38324	0.21593	-1.77484	37.10970
RPFR3.3	0.07654	0.02898	2.64100	367.19600
RPFR3.4	0.54178	0.20415	2.65383	61.86120

COEF	PARTIAL	BETA
RPFR3.0	-0.57211	0.00000
RPFR3.1	0.60121	0.34788
RPFR3.2	-0.50918	-0.22841
RPFR3.3	0.66077	0.35704
RPFR3.4	0.66257	0.52416

9: RPAPJ3 = RPAPJ3.0+RPAPJ3.1*RPFRAP3+RPAPJ3.2*(0.2*WARFD3+PBOIL3)+RPAPJ3.3*TIME

```
NOB = 14      NOVAR = 4
RANGE =  1969 TO 1982
RSQ =    0.99559      CRSQ =    0.99426      F(3/10) =    751.767
SER =    2.1246       SSR =     45.141       DW(0) =    1.88       COND(X) =     36.38
LHS MEAN =      60.96840      SR =         0.0002
```

COEF	VALUE	ST ER	T-STAT	MEAN
RPAPJ3.0	13.49160	4.38322	3.07801	1.00000
RPAPJ3.1	0.37243	0.06886	5.40830	66.58920
RPAPJ3.2	1.04532	0.13499	7.74337	37.10970
RPAPJ3.3	-1.03963	0.55394	-1.87678	15.50000

COEF	PARTIAL	BETA
RPAPJ3.0	0.69749	0.00000
RPAPJ3.1	0.86326	0.43312
RPAPJ3.2	0.92578	0.72451
RPAPJ3.3	-0.51037	-0.15507

10: IMFRAP3 = IMFR3.0+IMFR3.1*DEL(1 : IMPFRAP3)+IMFR3.3*QFRAP3(-1)+IMFR3.4*(DFRAP3+DAPJ3)

```
NOB = 14      NOVAR = 4
RANGE =  1969 TO 1982
RSQ =    0.90109      CRSQ =    0.87142      F(3/10) =     30.368
SER =    9.4287       SSR =     888.998      DW(0) =    1.74       COND(X) =     39.23
LHS MEAN =      66.45630      SR =        -0.00053
```

COEF	VALUE	ST ER	T-STAT	MEAN
IMFR3.0	-71.40590	28.80750	-2.47873	1.00000
IMFR3.1	-0.02485	0.05239	-0.47445	28.67380
IMFR3.3	-0.06649	0.10426	-0.63776	424.96000
IMFR3.4	0.41686	0.06699	6.22235	400.20800

COEF	PARTIAL	BETA
IMFR3.0	-0.61691	0.00000
IMFR3.1	-0.14837	-0.05781
IMFR3.3	-0.19770	-0.11074
IMFR3.4	0.89148	1.03307

11: EXFRAP3 = EXFR3.0+EXFR3.1*QFRAP3(-1)+EXFR3.2*DFRAP3+EXFR3.3*EXPFRAP3+EXFR3.4*EXFRAP3(-1)

NOB = 14 NOVAR = 5
RANGE = 1969 TO 1982
RSQ = 0.81862 CRSQ = 0.738 F(4/9) = 10.155
SER = 5.7179 SSR = 294.249 DW(0) = 2.58 COND(X) = 36.57
LHS MEAN = 52.60980 SR = 0.00023

COEF	VALUE	ST ER	T-STAT	MEAN
EXFR3.0	-4.12598	20.46500	-0.20161	1.00000
EXFR3.1	0.12540	0.04659	2.69169	424.96000
EXFR3.2	-0.11695	0.07408	-1.57878	270.40500
EXFR3.3	0.02933	0.01397	2.09966	337.65700
EXFR3.4	0.47791	0.15701	3.04388	52.65870

COEF	PARTIAL	BETA
EXFR3.0	-0.06705	0.00000
EXFR3.1	0.66783	0.49160
EXFR3.2	-0.46571	-0.28261
EXFR3.3	0.57340	0.38999
EXFR3.4	0.71222	0.48159

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