AN ECONOMETRIC MODEL OF INTERNATIONAL TRADE OF FROZEN CONCENTRATED ORANGE JUICE

BY

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by

Luiz José Maria Irias

To my wife, Raulina, my daughters, Ana Claudia and Ana Cristina, and my parents.

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TABLE OF CONTENTS

TABLE OF CONTENTS--Continued

TABLE OF CONTENTS--Continued

LIST OF TABLES

LIST OF TABLES--Continued

LIST OF TABLES--Continued

LIST OF FIGURES

Abstract of Dissertation Presented to the Graduate Council of the University of Florida in Partial Fulfillment of the Requirements for the Degree of Doctor of Philosophy

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A simultaneous equation econometric model of international trade of frozen concentrated orange juice was developed for two major producing and exporting countries (the USA and Brazil) and four major importing countries or groups of countries, i.e., Canada, the USA, the EEC7 countries (West Germany, The Netherlands, the United Kingdom, Belgium, Luxembourg, Denmark and France) and the European non-EEC3 countries (Sweden, Norway and Finland). The model consists of demand and price equations for FCOJ and other orange juices for the USA retail, wholesale (Florida) and import (FCOJ from Brazil) markets, and for Brazil and the USA FCOJ export markets (Canada and Europe).

The system of structural-form equations was estimated by two-stage least squares.

Florida's wholesale prices, orange production forecasts, USA import and export prices, exchange rates and occurrence of freeze in Florida were found to play major explanatory roles in the various price equations. Florida's wholesale FCOJ price, together with the USA import price of FCOJ from Brazil, determines the price spread. This spread is the key variable in the simultaneous determination of imports by the USA, and the USA export price to Canada and Europe. USA export prices are the major variables in the simulatenous determination of Brazilian export prices to Canadian and European markets.

USA imports of FCOJ from Brazil were found to have an elastic response to the price spread (Florida's wholesale price minus import price). Brazilian exports to Canada and USA exports to Europe were found to have an elastic response to respective own-prices. Brazilian FCOJ was found to be a substitute for USA FCOJ in the Canadian market, while in the European markets the two products behaved quite independently of each other.

CHAPTER I

PROBLEM SETTING

Statement of the Problem

Volume of world trade of processed citrus products has increased dramatically within the last fifteen years. Among processed citrus, orange juice is by far the most important traded product as compared with fresh grapefruit and lemon juice, pulp, oil and other by-products. The majority of orange juice trade has been in the form of frozen concentrated juice with some hot pack and single strength juice also traded.

From 1969 to 1978 total orange juice exports increased from 197.6 to 646.1 million gallons of single strength juice equivalent, an increase of nearly 230 percent (Table A.1. - Appendix A). In the USA and Canada, orange juice consumption has been increasing. Myers (1978b) reports a consumption increase of over 85 percent in Canada from 1968 to 1976. From 1972 to 1979 Florida's domestic movement of frozen concentrated orange juice (FCOJ) increased more than 50 percent. Canned and chilled orange juice domestic movement increased nearly 70 percent during the same period (Florida Canners Association, 1971-1980). Similar trends in consumption took place in Europe beginning in the early sixties

when Brazil offered FCOJ at low prices (Lingens, 1978). European countries increased imports of orange juice by 60 percent from 1969 to 1978 (Table B.1. - Appendix B). Brazil's exports to this region, in the same period of time, increased by more than 750 percent (Table A.2. - Appendix A).

Brazil, the United States of America (USA), Israel, Spain, Italy, Morocco and Mexico are the leading orange juice producing and exporting countries. These countries have accounted for almost 90 percent of total exports (Table 1). This volume increased considerably from 1975 to 1978. Other exporting countries include Greece, South Africa, Belize and Argentina.

The USA is the world's largest producer of oranges and orange juice, and the state of Florida is the primary producing region (Table 2). According to the Florida Crop and Livestock Reporting Service (1979), practically 80 percent of the USA orange production is processed and Florida alone accounts for almost 90 percent of the entire portion which is processed. From 1969 to 1978, the USA average share of total orange juice exports was around 15 percent. Brazil's share of the export volume has increased steadily.

Brazil is the largest exporter of orange juice (Table 1) and the second largest orange producer (Table 2). The state of São Paulo accounts for more than 62 percent of Brazil's commercial orange production and for practically all of the

Table 1. Shares of total exports of orange juice for major exporting countries, 1969-1978

Year	Brazil	USA	Israel	Spain	Italy	Morocco	Mexico	Other Countries[1]	Total
	Percent								
1969	14.94	14.58	12.03	7.20	15.24	11.77	.19	24.05	100.00
1970	18.38	18.28	10.01	10.00	14.11	12.58	.44	16.20	100.00
1971	32.30	15.19	13.96	7.85	9.56	4.89	.75	15.50	100.00
1972	32.31	14.65	12.60	7.86	8.90	5.97	2.45	15.26	100.00
1973	38.04	15.47	10.74	6.07	6.16	5.66	3.27	14.59	100.00
1974	35.88	16.70	12.78	6.02	5.49	4.10	3.64	15.39	100.00
1975	52.84	16.13	9.83	4.79	3.83	2.45	1.02	9.11	100.00
1976	51.89	16.63	8.12	8.80	1.16	2.62	2.10	8.68	100.00
1977	53.52	17.08	7.55	4.26	1.73	2.66	5.99	7.21	100.00
1978	65.61	8.98	6.63	3.79	1.83	2.08	4.62	6.46	100.00
Average	44.49	14.99	9.85	6.25	5.33	4.47	2.89	11.73	100.00

[1] Includes Algeria, Argentina, Belize, Cyprus, Ghana, Greece, Jamaica, South Africa and Trinidad-Tobago.

Source: Computed from Table A.1. Appendix A.

Table 2. Orange production in the United States of America, Brazil and other major orange-producing countries, 1972-1979

Year	Brazil			USA[c]			Other countries[d,3]	Total
	State of São Paulo[a]	Other states[1]	Total[b]	Florida	Other states[2]	Total		
	million boxes of 90 pounds							
1972	60.7	20.1	80.8	137.0	54.4	191.4	206.0	478.2
1973	62.4	58.3	120.7	169.7	55.0	224.7	209.9	555.3
1974	82.0	70.6	152.6	165.8	50.4	216.2	219.5	588.3
1975	84.7	70.4	155.1	173.3	64.5	237.8	216.8	609.7
1976	99.6	80.8	180.4	181.2	61.6	242.8	205.3	628.5
1977	92.0	83.5	175.5	186.8	56.1	242.9	208.2	626.6
1978	150.0	42.4	192.4	167.8	52.3	220.1	187.8	600.3
1979	151.5	45.3	196.8	164.0	46.5	210.5	180.9	588.2
Total	782.9	471.4	1,254.3	1,345.6	440.8	1,786.4	1,634.4	4,675.1
Percent[4]	16.75	10.08	26.83	28.78	9.43	38.21	34.96	100.00

[1] Includes the states of Bahia, Minas Gerais, Paraná, Rio Grande do Sul, Rio de Janeiro, Santa Catarina and Sergipe. [2] Includes the states of Arizona, California and Texas. [3] Includes Argentina, Belize, Israel, Italy, Jamaica, Mexico, Morocco, Spain and South Africa. [4] Average percentage of total orange production.

Sources: [a] United States Department of Agriculture, Foreign Agricultural Service, 1980a and 1980b. [b] Food and Agriculture Organization of the United Nations, 1973-1979; and United States Department of Agriculture, Foreign Agricultural Service, 1980c. [c] Florida Crop and Livestock Reporting Service, 1976 and 1979. [d] Food and Agriculture Organization of the United Nations, 1973-1979.

citrus industry processing capacity.[1] More than 80 percent of São Paulo's orange production is estimated to be processed into FCOJ (United States Department of Agriculture, Foreign Agricultural Service, 1980a), and almost all of the FCOJ is exported.[2] The Brazilian share of total orange juice exports increased from 14.94 percent in 1969 to 65.61 percent in 1978 with an average share for the period of 44.49 percent (Table 1).

Israel ranks third in orange juice exports followed by Spain, Italy, Morocco and Mexico (Table 1). Export markets for the fresh fruit are the primary outlets for Isreali citrus fruit, followed by the domestic fresh market. The citrus processing industry is the third most important market alternative for the Israeli product under the Citrus Marketing Board policies (Melamed, 1977). Spain, Italy and Greece are orange juice exporting countries that are entirely dependent on the market in the European Economic Community (EEC). Among the remaining countries that export orange juice, Mexico is the most important. From an insignificant position in the late sixties, Mexico moved to

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[1]Except for small plants located in the northeastern state of Sergipe and in the southern states of Santa Catarina and Rio Grande do Sul, Brazil's citrus processing industry is located entirely in the state of São Paulo.

[2]Domestic consumption of processed oranges in Brazil is estimated to be 5 to 7 percent (Myers, 1978a; United States Department of Agriculture, Foreign Agricultural Service, 1980a).

be the fourth most important exporting country in 1977 and 1978, its shares of total exports being 5.99 and 4.62 percent, respectively, in those years (Table 1).

From 1969 to 1978, Brazilian USA and Israeli orange juice exports accounted for nearly 70 percent of the total trade. From 1975 to 1978, these countries exported almost 80 percent of the total. Brazil and the USA accounted for an average of 60 percent of the total orange juice exports and from 1975 to 1978 these two countries exported around 70 percent of the total (Table 1). They are the major competing suppliers in world orange juice markets.

The major orange juice importing countries are located in Europe and North America. From 1969 to 1978, 12 countries in these two regions imported nearly 90 percent of total orange juice traded (Table 3). Most European imports go to EEC member countries and specifically to West Germany, The Netherlands, the United Kingdom, Belgium, Luxembourg, Denmark and France (the EEC7). These countries imported an average of 63.07 percent of the total world imports.

The European non-EEC countries are the next largest orange juice importing region, accounting for 18 percent of the total volume traded. Within this region Sweden, Norway and Finland (the European non-EEC3) import 9 percent of the world total (Table 3) and have the highest per capita orange juice consumption indices in Europe (Lingens, 1978).

North America, as represented by Canada and the USA, is ranked as the third most important orange juice importing

Table 3. Shares of total imports of orange juice for major importing countries, 1969-1978

Year	EEC		European non-EEC		Canada	USA	Other countries[5]	Total
	EEC7[1]	Others[2]	non-EEC3[3]	Others[4]				
	Percent							
1969	67.20	.74	9.53	10.84	8.89	1.99	.81	100.00
1970	66.70	1.91	11.68	10.44	7.15	.65	1.47	100.00
1971	67.90	3.33	8.91	8.04	6.91	3.59	1.32	100.00
1972	66.65	2.63	7.75	8.05	6.51	7.32	1.09	100.00
1973	68.20	1.32	8.58	8.10	7.72	4.52	1.56	100.00
1974	64.22	1.12	9.24	10.52	8.06	3.42	3.42	100.00
1975	62.20	.43	8.14	9.23	9.49	4.80	5.71	100.00
1976	60.79	.19	9.80	8.73	8.95	4.80	6.74	100.00
1977	61.60	.17	9.11	8.89	9.35	6.75	4.13	100.00
1978	51.98	.29	7.53	7.64	11.37	18.92	2.27	100.00
Average	63.07	1.11	8.89	8.90	8.59	6.31	3.13	100.00

[1]EEC7 as defined in this study includes West Germany, The Netherlands, the United Kingdom, Belgium, Luxembourg, Denmark and France. [2]Other EEC includes Italy and Iceland. [3]European non-EEC3 as defined in this study includes Sweden, Norway and Finland. [4]Other European non-EEC3 includes Austria, East Germany, Iceland, Spain and Yugoslavia. [5]Other countries include Antigua, Australia, Barbados, Jamaica, South Africa and Trinidad-Tobago.

Source: Computed from Table B.1. Appendix B.

region accounting for an average of 15 percent of the total. While Canada's share of total imports has been relatively constant at about 8 percent, the USA import share has fluctuated from .65 percent in 1970 to 18.92 percent in 1978.

Most previous studies on production, consumption and trade of orange juices with an international perspective concentrate on one sector or on one country or world region. In the USA a number of studies focused on orange juice import and export trade issues with domestic and/or foreign perspectives (Polopolous, 1968; Ward & Niles, 1975; Ward, 1976a; Myers et al., 1979). Most of these studies viewed the import-export issues from the viewpoint of the Florida citrus industry. Ward's (1976a) study was the first major FCOJ trade model addressing import and export issues in a simplified world context. It provided an understanding of the major economic relationships of Florida's imports and exports. The model consists of a system of simultaneous equations explaining imports to Florida, export price from Florida to Europe, European demand for Florida FCOJ and a definitional equation for the price spread.[3] European demand was found to be highly sensitive to Florida concentrate price changes.

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[3]Price spread was defined as the difference between the quarterly average Florida domestic FOB price and the quarterly average price of imports to Florida from Brazil, excluding tariffs. The import price was adjusted by the cost of converting bulk concentrate to equivalent gallons of retail pack concentrate (Ward, 1976a, pp. 105-106).

The desirability of a two-pricing system between the domestic and European markets was clear. Price spread changes were found to be the major factor influencing the level of Florida imports of FCOJ. Myers et al. gave an overview of the FCOJ import-export policies and programs by evaluating how different governmental policies, industry programs and economic factors affect the volume and directions of product flows throughout the system. An important contribution of this study was to show the interdependency between price spreads, tariff levels, and duty drawback provisions[4] and their effects on the quantity of Florida imports. It was shown that under the current set of import-export policies a trade-off exists between the percent of imports offset with exports and the magnitude of the price spread. Even at a zero price spread it is possible to import and export using the drawback provisions without losing money. The necessary condition is a relatively higher export price as compared with the domestic price. Studies by Prato (1969), Rausser (1971) and Buckley (1977) addressed the USA FCOJ domestic economic issues. They focused on the estimation and analysis of consumer demand structures within the USA domestic markets with little reference to the role of imports and exports.

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[4]The duty drawback provisions of the U. S. Tariff Act of 1930 permit processors to import foreign FCOJ in bulk form and to recover 99 percent of the duties by exporting like amounts of FCOJ in bulk or consumer pack within a 5-year period from date of importation (Myers et al., 1979).

Brazilian participation in world trade of orange juice has been studied by Morais and Medeiros (1978), and by Moretti (1978). Morais and Medeiros describe the Brazilian citrus industry in a general fashion. Moretti's work uses an analytical framework to describe and to analyze important market factors affecting Brazilian trade of FCOJ. He used a single-equation model to estimate export demand relationships. Major study results indicate that concentrate exports were highly responsive to changes in prices and exchange rates.

European markets are quite important in orange juice consumption. Priscott (1969), Ward (1976b), and Nguyen (1977) are the major studies which addressed trade, consumption patterns, and structural consumption relations in these markets. These studies focused on Florida's FCOJ exports to Western European countries. Their results showed highly price-elastic markets in most of the countries with changes in exchange rates affecting export demands. Ward's (1976b) study also addressed the benefits to the Florida citrus industry of discounting its export price to Europe relative to the domestic price by using the relatively cheaper imported product.

Chern (1973), and Tilley and Lee (1981) studied consumer demand for orange juice in Canada. Chern used a single-equation model to estimate Canadian demand for FCOJ, canned single strength orange juice (CSSOJ) and chilled orange juice (COJ). An aggregation of the three products was

found to have a unitary price elasticity, an elastic response to income and a positive but a statistically insignificant effect of advertising. Individual orange juice product estimates indicated that FCOJ was price-inelastic and had a strong consumer response to advertising. CSSOJ and COJ demand was found to be price-elastic with no immediate response to advertising. All products were positively related to income changes. Tilley and Lee (1981) used a system of simultaneous equations to analyze Canadian orange juice consumer demand and import demand from Brazil and from the USA. Canada's imports from Brazil were found to be highly price-elastic, while imports from the USA were quite price-inelastic. Cross-price effects on imports indicate that an absolute change in the import price from the USA would have a greater impact on Canadian imports from Brazil than the impact on Canadian imports from the USA, given the same change in the import price from Brazil.

Despite significant research efforts a more complete world trade model for orange juice has not been developed. Such a model should explain levels of consumption, trade flows, inventories and prices for major producing and consuming countries. Also, the model should have the capability of evaluating the impact of the introduction of, and changes in, protective trade barriers, such as tariffs and quotas. These are major trade issues affecting economic, social and political decisions in the citrus industry around the world. A model of world orange juice trade would give a

better understanding of the economic relations and interrelations of these factors under domestic and international conditions.

Objectives

The overall objective of this study is to provide an economic analysis of domestic and foreign trade of orange juice products (frozen concentrate and other forms of orange juice traded) for major producing and consuming countries. This analysis will address the basic economic relations and interrelations in the determination of levels of consumption, trade flows and prices. An attempt will be made to:

1. identify the most important factors affecting trade of orange juice products;

2. evaluate to what extent changes in domestic and foreign demand for the USA orange juice products affect the USA FCOJ imports;

3. evaluate whether foreign and domestic promotion programs for the USA orange juice products provide an "umbrella" for the market expansion for the same products from other producing-exporting countries;

4. determine the impact of pricing strategies and price changes on exports and imports of orange juice products among producing-exporting and importing countries.

In order to accomplish these objectives an economic model for international trade in orange juice products will be developed. This model will focus on two basic orange juice products: frozen concentrated and an aggregate of

other product forms of orange juice. Unless otherwise specified, these products are expressed in gallons of single strength juice equivalent. For modeling purposes the world trade of these orange juice products consists of a simplified geographical scenario of two major producing and exporting countries (the United States of America and Brazil) and four major importing countries or groups of countries (Canada, the United States of America, the EEC7 and the European non-EEC3 countries).

CHAPTER II

AN ECONOMIC PROFILE

The purpose of this chapter is to describe and discuss the orange juice industry. The first section analyzed basic economic relations concerning production, consumption and trade of orange juices, while the second section discusses major structural and institutional factors affecting the industry.

Trade Flows

Figure 1 summarizes orange juice flows for major exporting and importing countries. Solid arrows indicate export flows and broken arrows indicate import flows. Numbers shown are estimated average percentages of exports or imports from 1969 to 1979, except in the case of Florida where the percentages are for the 1972 to 1979 period.

The USA, as the largest producer and consumer and the second largest exporter of orange juice, is the primary economic indicator of this industry around the world. The state of Florida is by far the largest USA supplier of orange juices, followed by the states of Arizona, California and Texas. While Florida's orange production is practically all utilized for processed products, the production from

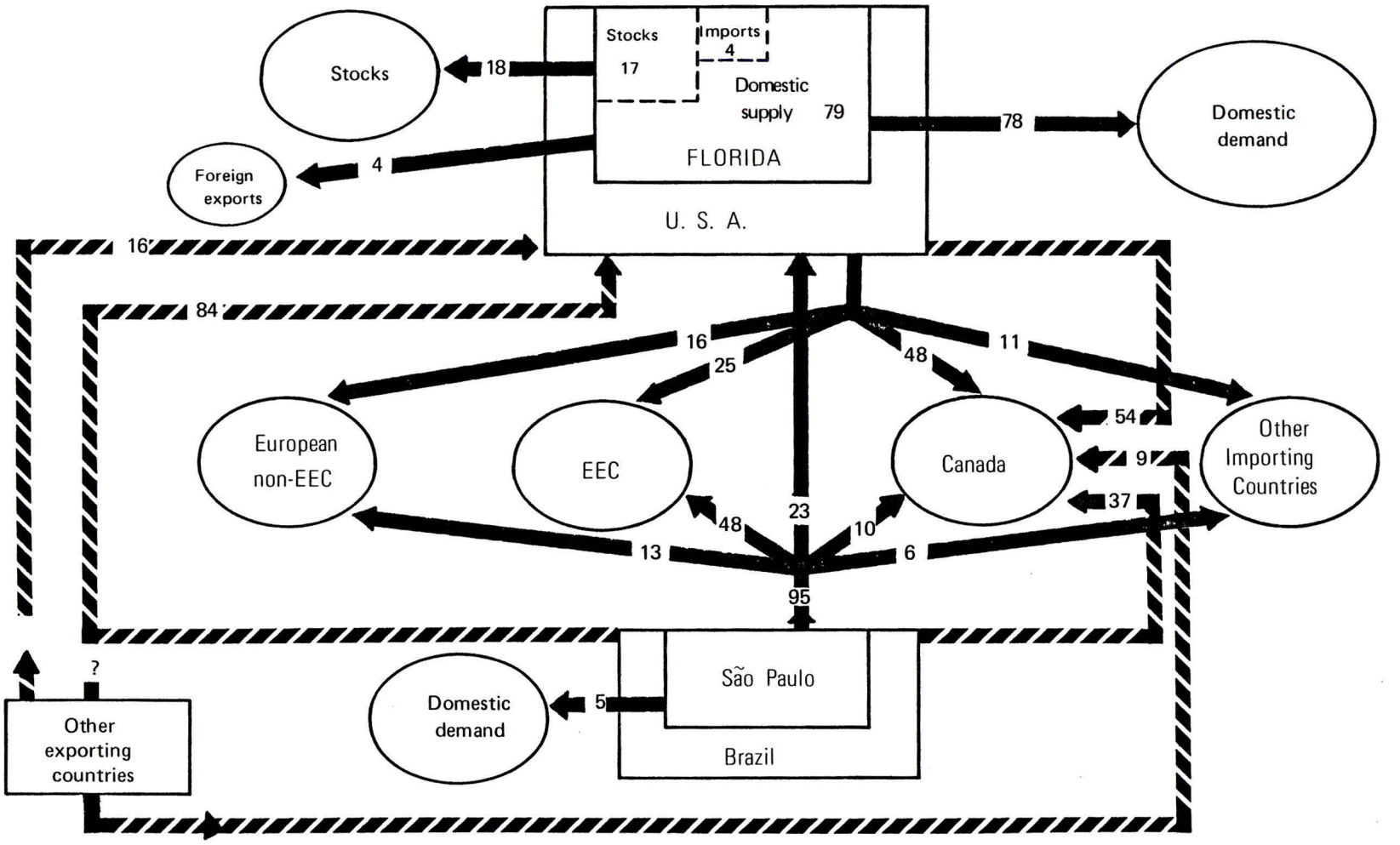

Figure 1. Orange juice trade flows for major exporting and importing countries.
Note: Solid arrows indicate export flow and broken arrows indicate import flows. Numbers are approximated average percentage of exports or imports from 1969 to 1979 (Appendices A, B and C).

other states is mainly for fresh products (Myers, 1978b). Detailed data on processed orange products are not available for the states of Arizona, California and Texas. Therefore most of the discussion on the USA processed orange industry will be related to state of Florida data.

In the last eight years (1972 to 1979) an average of approximately 79 percent of Florida's total supply of orange juices was produced from the current crop of domestic oranges. The remaining supply came from stocks from previous years (17 percent) and from imports (4 percent). In the past, Florida has been a net exporter of orange juice. Only in the recent two years (1978 and 1979) have Florida's processors imported more than they have exported. This occurred following a freeze in 1977 that substantially reduced domestic production. Florida accounted for more than 70 percent of USA total imports and 80 percent of total USA exports from 1972 to 1979 (Appendix B and Appendix C). Florida's canned and chilled orange juices exports represent about 50 percent of the USA other orange juices (single strength and hot pack) exports (Table A.4. - Appendix A and Appendix C).

Florida imports and export data by country are not available. Because of Florida's market dominance, United States Department of Commerce data can be used to identify sources and country of destination. Brazil has been the primary source of the USA imports of FCOJ. Brazilian imports averaged around 84 percent of total USA FCOJ imports from

1969 to 1979. Mexico and Belize accounted for 10 and 1 percent respectively (Figure 1, Table 4). USA FCOJ imports varied from 2.6 million gallons in 1970 to a record of 156.4 million single strength equivalent gallons in 1979 (Table B.2. - Appendix B). FCOJ is the leading citrus export product in the USA accounting for approximately 77 percent of total exports. Single strength and hot pack accounted for the remaining 23 percent over the eight-year period shown in Table 5. In the six years preceeding the 1977 Florida freeze, the USA FCOJ exports were increasing rapidly. In 1978, exports decreased by almost 40 percent from those of 1977. Practically 48 percent of all the USA orange exports go to Canada (Figure 1 and Table A.3. - Appendix A). The EEC countries, led by The Netherlands and West Germany, accounted for an average of more than 25 percent, and the European non-EEC countries accounted for almost 17 percent of USA exports (Table A.4. - Appendix A). In 1974 the Brazilian orange industry faced its first crisis when exports declined by more than 10 percent. The economic recession in Europe, high stock levels in most of the importing countries, and quality control problems of the reconstituted Brazilian juice in those countries are factors contributing to the decline.

Prices for the Brazilian product (FOB Santos) declined below the 1974 minimum export price of 560 dollars per metric ton established by CACEX[1] (Morais and Medeiros, 1978).

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[1]CACEX - Carteira de Comércio Exterior, Export Trade Office of the Bank of Brazil, Inc., associated with the Ministry of Finance. CACEX's major role is to implement and enforce official government policy regarding exports and imports.

Table 4. Market shares for major suppliers of the United States of America imports of orange juice, 1969-1979

Year	Brazil	Mexico	Belize	Other countries[1]	Total
	Percent				
1969	53.30	9.77	23.99	12.94	100.00
1970	49.68	21.91	28.33	.08	100.00
1971	81.37	6.49	7.47	4.67	100.00
1972	77.61	12.87	2.69	6.83	100.00
1973	46.56	20.43	4.71	28.30	100.00
1974	67.20	24.57	1.73	6.50	100.00
1975	85.38	10.03	00	4.59	100.00
1976	89.14	4.22	00	6.64	100.00
1977	67.89	27.74	.36	4.01	100.00
1978	92.00	6.99	00	1.01	100.00
1979	95.07	4.72	00	.21	100.00
Total	84.41	10.23	1.29	4.07	100.00

[1]Includes Argentina, Israel, Italy, Japan, Spain, South Africa and eleven other countries.

Source: Computed from Table B.2. Appendix B.

Table 5. The United States of America exports of FCOJ and of other orange juices,[1] 1972-1979

Year	FCOJ		Other orange juices[1]		Total	
	Volume[2]	Percent	Volume[2]	Percent	Volume[2]	Percent
1972	34,585	68.89	15,620	31.11	50,205	100.00
1973	47,155	75.42	15,367	24.58	62,522	100.00
1974	45,155	76.68	14,951	23.32	64,106	100.00
1975	56,150	80.05	13,990	19.95	70,140	100.00
1976	69,096	80.89	16,322	19.11	85,418	100.00
1977	69,486	80.29	17,053	19.71	86,539	100.00
1978	42,428	73.11	15,609	26.89	58,037	100.00
1979	48,539	73.57	17,439	26.43	65,978	100.00
Total	416,594	76.73	126,351	23.27	542,945	100.00

[1]Includes orange juices exported as single strength and as concentrated but not frozen (hot pack).

[2]In 1,000 gallons of single strength juice equivalent.

Source: Computed from Table A.4. Appendix A.

Nominal price changes for Brazilian FCOJ exports to major markets (Table 6). Average prices in 1975 were the lowest prices shown in all markets. Price levels recovered following the 1977 Florida freeze. Western Europe countries, and especially the EEC countries and the European non-EEC countries, have been the primary customers for Brazilian FCOJ exports accounting for almost 61 percent of Brazil's total concentrate exports from 1969 to 1979 (Figure 1 and Table A.2. - Appendix A). West Germany, The Netherlands and Sweden accounted for more than 40 percent of Brazilian FCOJ exports. The USA bought an average of 23 percent of the Brazilian product. The USA recorded 187.4 million gallons of FCOJ in single strength juice equivalent imports from Brazil in 1978 when it emerged as Brazil's most important buyer.

As a result of the 1977 Florida freeze and the subsequent reduced orange production, domestic prices of orange juices increased in the USA. Both wholesale and retail prices increased substantially as compared with 1976 levels (Table 7). In 1978 FCOJ prices increased as much as 71 percent at wholesale and 59 percent at retail from respective price levels of the year before the freeze. Non-frozen orange juice prices increased approximately 30 percent in both markets. The increased price differential between wholesale domestic and imported juice made it profitable for the USA importers and processors to buy foreign orange juice

Table 6. Brazilian FCOJ weighted average export price (FOB Santos) in major markets, 1972-1979

Year	EEC[1]	European non-EEC[2]	Canada	USA	Other countries[3]	Total
	--------current cents per gallon of single strength juice equivalent---------					
1972	36.93	38.57	37.96	38.34	36.56	37.48
1973	41.51	40.54	38.43	44.47	39.41	41.39
1974	43.04	44.61	43.64	40.93	45.41	42.94
1975	35.38	36.85	35.35	35.57	37.00	35.77
1976	38.05	37.66	36.90	37.10	38.25	37.84
1977	62.91	59.82	59.02	75.04	73.54	65.26
1978	77.34	74.20	81.44	77.62	82.95	78.01
1979	75.61	73.90	76.50	75.29	79.35	75.78

[1]Includes West Germany, the United Kingdom, The Netherlands, Belgium, Luxembourg, Denmark and France. [2]Includes Sweden, Norway, Finland and 7 other European countries. [3]Includes Israel, Japan, Venezuela and eleven other countries.

Source: Computed from Brazil, Serviço de Estatística Econômica e Financeira, Ministério da Fazenda, 1970-1979.

Table 7. Weighted average wholesale and retail prices of FCOJ and of other orange juices[1] in the United States of America, 1972-1979

Year	FCOJ		Other orange juices[a]	
	Wholesale[a]	Retail[b]	Wholesale[a]	Retail[b]
	-----current dollar per gallon of single strength juice equivalent-------			
1972	.81139	1.25078	1.09515	1.77025
1973	.75906	1.23319	.99571	1.71801
1974	.79321	1.27437	1.11686	1.80698
1975	.86490	1.37840	1.20589	1.88345
1976	.83684	1.41075	1.33023	1.94496
1977	1.14948	1.70821	1.54129	2.19211
1978	1.43292	2.23701	1.84367	2.69041
1979	1.43489	2.40002	1.97372	2.96256

[1]Includes canned single strength and chilled orange juices at Florida's wholesale level, and single strength orange juices in cans, glasses, and other containers at the USA retail level.

Sources: [a]Florida Department of Citrus, Economic Research Department, 1972-1980; and [b]Florida Department of Citrus and A. C. Nielsen Company, 1972-1980.

concentrate, pay the USA import duty[2] and sell the imported product in the domestic market. FCOJ export prices from the USA have been consistently quoted higher than prices for the Brazilian product (Table 8). Brazilian FCOJ exports are in 65° brix concentrate in bulk drums, while most of the USA exports are in consumer retail pack at 42° brix to Europe and Canada. Brazilian FCOJ exports to Canada have expanded substantially during the seventies (Table A.2. - Appendix A). From under 6 million single strength equivalent gallons in 1969 and 1970, exports of the Brazilian orange juice to Canada increased by more than 600 percent, reaching a record of 43.0 million gallons in 1978. Total Brazilian FCOJ exports in 1979 declined to 371.4 million single strength juice equivalent gallons or approximately 12 percent less than the record level of 1978.

As previously stated, Europe and Canada are the most important importers of orange juice. Per capita import indices and FCOJ market shares to major suppliers were constructed for these regions for the last eight years (Table 9). Scandinavian countries (the European non-EEC3) have the highest per capita imports in Europe. According to Lingens (1978), per capita consumption of orange juice in Sweden is more than five gallons of single strength

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[2]Import duty on FCOJ imports has been 34 cents per pound of solids or 34.986 cents per gallon of single strength juice equivalent or 487.22 USA dollars per metric ton of 65° brix concentrate.

Table 8. Brazilian and the United States of America FCOJ weighted average export prices (FOB) in three major markets, 1972-1979

Year	EEC7[1]		European non-EEC3[2]		Canada	
	Brazil	USA	Brazil	USA	Brazil	USA
	------current USA dollars per gallon of single strength juice equivalent-----					
1972	.36908	.62114	.38503	.82022	.37957	.90133
1973	.41549	.51342	.40967	.74340	.38433	.90879
1974	.43042	.59091	.44630	.81385	.43641	.92286
1975	.35365	.63207	.37995	.86196	.35354	1.00308
1976	.37413	.56843	.37662	.83142	.36899	1.00201
1977	.62909	.70637	.61148	.95143	.59024	1.22939
1978	.77343	1.49492	.73833	1.29239	.81436	1.71403
1979	.75615	1.47822	.73134	1.26381	.76502	1.75170

[1]Includes West Germany, The Netherlands, the United Kingdom, Belgium, Luxembourg, Denmark and France. [2]Includes Sweden, Norway and Finland.

Sources: Computed from Brazil, Serviço de Estatística Econômica e Financeira, Ministério da Fazenda, 1970-1979; and from United States Department of Commerce, Bureau of the Census, 1969-1979a.

Table 9. Orange juice imports per capita and major FCOJ suppliers market share in EEC7[1], European non-EEC3[2] and Canada, 1972-1979

Year	Imports per capita[3]			FCOJ market shares[4]						
	EEC7[1]	European non-EEC3[2]	Canada	EEC7[1]		European non-EEC3[2]		Canada		
				Brazil	USA	Brazil	USA	Brazil	USA	Others[5]
1972	.38	1.00	1.81	88.71	11.29	57.23	42.77	36.63	51.05	12.32
1973	.63	1.53	2.22	89.29	10.71	59.56	40.44	39.12	47.00	13.88
1974	.43	1.89	2.21	90.36	9.64	68.48	31.52	19.18	60.36	20.46
1975	.68	2.13	2.87	90.98	9.02	72.22	27.78	47.94	46.82	5.24
1976	.93	2.50	2.83	87.99	12.01	77.40	22.60	39.21	54.86	5.93
1977	.75	2.54	2.96	88.07	11.93	76.64	23.36	39.28	49.31	11.41
1978	.66	2.42	3.61	94.38	5.62	89.92	10.08	61.07	34.13	4.80
1979	.85	2.54	3.71	94.56	5.44	91.06	8.94	56.37	40.10	3.53

[1]Includes West Germany, The Netherlands, the United Kingdom, Belgium, Luxembourg, Denmark and France. [2]Includes Sweden, Norway and Finland. [3]Gallons of single strength juice equivalent per capita. In the EEC7 and the European non-EEC3 countries includes only imports from Brazil and the USA. [4]Percent. [5]Includes Argentina, Belize, Israel, Jamaica, Mexico and nineteen other countries.

Sources: Computed from Tables B.3. to B.5., Appendix B; Table A.4., Appendix A and International Monetary Fund (population), 1970-1980.

juice equivalent per year. Considerable attention is given to juice quality and packing procedures in Sweden. In EEC7 total orange juice imports in 1979 from Brazil and the USA, were around 169.2 million single strength juice equivalent gallons, an increase of more than 590 percent from the 1969 import level (Table B.4. - Appendix B). Orange juice imports per capita more than doubled in that region in the last eight years (Table 9). In Sweden, Norway and Finland, Brazil substantially increased its FCOJ market share from 57.23 percent in 1972 to 91.06 percent in 1979. Even though the USA's participation in this market increased in absolute terms, the USA share of total FCOJ exports declined from 42.77 to 8.94 percent from 1972 to 1979 (Table 9). All orange juice used in Canada is imported. Brazil and the USA are again the major suppliers with a large group of other countries far behind. In 1978 and 1979, Brazil's market share exceeded 50 percent. The USA share dropped below 40 percent in 1978 and was just over 40 percent in 1979.

Structural and Institutional Factors

The purpose of this section is to describe and discuss major structural and institutional factors affecting production, consumption and trade in the orange juice industry.

In Brazil the major government impact on trade of FCOJ is exercised through CACEX and the Citrus Juice Export Committee integrated by government officials (CACEX,

Ministry of Agriculture, and state of São Paulo) and by citrus grower and processor representatives. The most important activities of CACEX are to license FCOJ exports, to establish and enforce reference prices for oranges to be processed, to set minimum FCOJ export prices, and to control stocks. The remainder of this section is organized to cover import and export incentives, market promotion programs, exchange rate policies, protective restrictions, and preferential concessions.

Import and Export Incentives

In the USA the duty drawback provisions of the Tariff Act of 1930 are a very important mechanism influencing FCOJ trade. Under such provisions processors can import foreign FCOJ in bulk form and recover 99 percent of the import tariff (34 cents per pound of solids) by exporting a like amount of product in bulk or consumer pack within a five-year period from the date of importation (Myers et al., 1979). The rationale for such trade activity was discussed by Ward (1976a) and expanded by Myers et al. (1979). Import tariff, the price spread (the differential between domestic and import FCOJ prices), duty drawback provisions and export prices are key determinants of USA FCOJ imports and exports. If the price spread is higher than the tariff, then it is profitable to sell imported FCOJ in the domestic markets. However, if the price spread is equal to or less than the tariff on imports, then processors will not be able to

realize profits on the imported FCOJ unless they have an option to export part of the reprocessed product and then recover most of the tariff paid by taking advantage of duty drawback. As long as the price spread is less than the tariff level, more juice needs to be exported under duty drawback for a given export price. As the spread approaches the tariff level, fewer exports are needed to compensate for imports. Under the present set of USA FCOJ import-export policies, a trade-off exists between the percent of imports offset with exports and the magnitude of price spread. Myers et al. (1979) showed that, even at a zero price spread, it is possible to import and export FCOJ and use the duty drawback provisions without losing money. The necessary condition is a relatively higher export price as compared with the USA domestic price.

Brazil[3] does not have specific incentives for citrus growers, but does have federal and state support programs for the agricultural sector. Among others, citrus producers are entitled to subsidized credit, research and extension programs. The government also gives some assistance in establishing grower prices for oranges to be processed through the Citrus Juice Export Committee. However, oranges are not included in the minimum price program carried out by the federal government for major agricultural products. The subsidized credit program of zero interest rates on loans

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[3]Most of the discussion of export incentives in Brazil was organized from United States Department of Agriculture, Foreign Agricultural Service, 1980a and 1980b.

for fertilizer and of 15 to 18 percent a year for other production activities, can be a great incentive in view of Brazil's high rate of inflation in the past years (more than 40 percent). Processors and exporters have various incentives in Brazil. Under a national policy, given the non-existence of similar domestic products, processors are allowed to import plant parts and equipment duty-free. Also available are subsidized credit for investments in new factory equipment (in 1979 the interest rate was 22 percent a year for five- or six-year loans), and for financing production for exports (in 1979 the interest rate was 8 percent a year discounted at the time of the loan). Under the latter program, an exporter is allowed to borrow up to 30 percent of the value of his exports in the previous year and repay it in no more than a year. Oranges processed for export are not subject to state and federal value-added taxes (ICM and IPI)[4] and profits from FCOJ export sales are exempt from corporate income taxes.

A tax credit of 20 percent on value of exports, which could be used to offset taxes on domestic sales, has been reduced since 1979 by one percent per quarter so that it will be completely eliminated by the end of 1983. Initiated late

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[4]ICM (Imposto de Circulação de Mercadorias) is a state-levied value-added tax, and IPI (Imposto de Produtos Industrializados) is a federal-levied value-added tax on industrial products.

in 1979, when the Brazilian cruzeiro[5] was substantially devaluated against the USA dollar, an export tax on FCOJ was introduced as a measure intended to support export prices and to guarantee an adequate domestic supply of oranges and processed products.

Market Promotion Programs

Brazilian citrus industry market promotion activities have been minimal. Domestically, the only information available (Myers, 1978a) was related to industry participation in expanding internal use through the development of a school lunch market for FCOJ in São Paulo and in other central and southern Brazil states. Growers, in general, are not directly involved in any demand-creation efforts. In external markets the situation is similar. Only one Brazilian processor (Cutrale), jointly with Coca Cola, was participating in an effort to package and market concentrate in a form which requires no refrigeration. A successful market test was completed in Sweden, and production and distribution began in 1979 (Myers, 1978c). Processors appear to be quite unenthusiastic about market promotion programs, given the unusually strong current demand for their product. Practically all processed products are exported.

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[5]Cruzeiro is the Brazilian monetary unit. Brazil's exchange rate policy is discussed with more detail in the subsection on that topic.

In the USA, and in particular the Florida citrus industry, a great effort has been under way for several years to promote citrus products from Florida in domestic and in foreign markets. Domestically, Florida Department of Citrus expenditures for promotions on orange juice products are reported to be more than 12.6 million dollars as an average for the last seven fiscal years (Table 10). To this effort one should add specific brand and distributor's advertising programs around the country. Florida's shipments of orange juice to domestic markets has increased by more than 50 percent in the last eight years (Table C.3. - Appendix C). In foreign markets, the Florida citrus industry has been promoting orange juices in Western Europe and in Canada. Since 1966-67 their major promotional effort in Europe has been through the Three-Party Market Development Program.[6] The main target of the program, as measured by distribution of total expenditure, appears to be the Scandinavian countries (European non-EEC3). About half of the promotional expenditure has been used in Sweden, Norway and Finland (Table 10). The other half of the promotional expenditures has been used in the seven EEC countries. Effectiveness of the three-party program has been reported by the studies of Lee (1977, 1978) and

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[6]This program has been supported by Florida Department of Citrus, United States Department of Agriculture, Foreign Agricultural Service, and European distributors. See Lee et al. (1978) for a more complete description.

Table 10. Promotional expenditures of the three-party program in Europe and of advertising programs in the USA and Canada for orange juices from Florida, 1972/73 - 1978/79

Fiscal year[1]	Three party program in Europe				USA	Canada
	EEC7[2]	European non-EEC3[3]	Others[4]	Total		
	1,000 dollars					
1972-73	636.4	788.7	190.4	1,615.5	9,790.0	311.4
1973-74	723.3	756.7	137.0	1,617.0	6,743.4	434.1
1974-75	397.2	650.9	121.2	1,169.3	12,131.4	483.6
1975-76	518.0	733.8	105.9	1,357.7	12,938.5	557.2
1976-77	507.6	680.5	157.1	1.345.2	16,360.4	462.6
1977-78	507.3	444.0	113.9	1,065.2	12,792.9	659.4
1978-79	470.8	404.9	157.5	1,033.2	17,791.9	738.8
Total	3,760.6	4,459.5	983.0	9,203.1	88,548.5	3,647.1

[1]Includes expenditure from July to June (twelve months), except for the three-party program in 1975-76 (July 1975 to September 1976 or fifteen months) and from 1976-77 to 1978-79 (October to September or twelve months).

[2]Includes West Germany, The Netherlands, the United Kingdom, Belgium, Luxembourg, Denmark and France. [3]Includes Sweden, Norway and Finland. [4]Includes Austria, Iceland, Italy and Switzerland.

Source: Florida Department of Citrus, 1980.

Lee et al. (1979). Overall conclusions from those studies are favorable to the program. Additional dollar sales generated by the program are far in excess of its costs. These studies did not identify any direct link of the three-party program expenditures to Florida's imports of FCOJ. In Canada, the Florida Department of Citrus advertising program for orange juices has also increased substantially. From 1972/73 to 1978/79 promotional expenditures in Canada increased by practically 140 percent, achieving in that period an average fiscal year expenditure of more than one-half million dollars (Table 10). A multi-level study by Tilley and Lee (1981) on Canadian demand for orange juice found a weak positive sales response as advertising expenditure increased.

Exchange Rate Policies

Exchange rates express the monetary value of a national currency per unit of another country's currency. Changes in this relation reflect changes in the domestic currency's purchasing power as compared with the foreign currency. In terms of commodity trade, an exporting country's devaluation is equivalent to a commodity price cut viewed by the foreign importer. A devaluation of the Brazilian cruzeiro relative to the USA dollar means that fewer dollars are needed to buy a unit of a given commodity from Brazil for any given price expressed in cruzeiros. The final effect of exchange rate changes on the amount of trade

depends on other factors such as commodity elasticities, government import-export policy and adjustments of the international monetary system. These factors will be incorporated in the theoretical discussion of exchange rates in the next chapter. The remaining part of this subsection will discuss exchange rate changes and exchange rate policies in Brazil and in the USA.

In Brazil the official exchange rate has been historically controlled by the Government to a greater or lesser degree, depending on the time period analyzed (Veiga, 1974). Since 1968, Brazil has been using a system of mini-adjustments of the cruzeiro against the USA dollar. These adjustments, most of them devaluations, have been made at short and random intervals (one or two months) to minimize the speculative demand for dollars. The cruzeiro is devalued at a rate approximately equal to the difference between Brazil's internal inflation rate and the average inflation rate of Brazil's major trading partners, basically the USA, Western Europe and Japan (Alves & Pastore, 1978, p. 866). A departure from the mini-devaluation policy by the Brazilian Government took place in December 1979 when the cruzeiro was devalued by 30 percent (Fundação Getúlio Vargas, 1972-1980). This was part of an overall change of the country's economic programs in an expectation of better economic results that would help it pay its increasing international debt (especially oil bills and loans), as well as to fight the high and increasing levels of internal

inflation. The annual rate of inflation in 1979, estimated by Fundação Getúlio Vargas (Conjuntura Econômica 34, February, 1980 p. 14), was 77.2 percent or almost twice as much the 40.8 percent level in 1978.

Foreign exchange market forces are the basic determinants of exchange rate values for the dollar in the USA. The change from a fixed to a floating system of exchange rates by the international monetary community in early 1973 (Abrams, 1980) was another factor that can be used to explain increasing variability of the USA dollar against major foreign currencies. Schuh (1974) argued that the exchange rate has had an important role in explaining depressed prices of agricultural products associated with an overvaluation of the dollar prior to 1971, as well as the increases in the same prices in 1973-74 associated with a devaluation of the dollar. Studies by Vellianitis-Fidas 1976, and by Johnson et al., 1977 that attempt to empirically evaluate the effects of exchange rate variability on the USA trade in agricultural commodities fail to support the hypothesis that devaluation had a substantial effect on prices. Both studies found that the exchange rate was found to be less important than other factors in explaining high USA agricultural products prices.

Trade Restrictions and Concessions

Trade restrictions include a variety of protective import tariffs, quotas and non-tariff barriers designed to

shield domestic industry and/or to enforce quality control measures as a way to protect consumers. Moretti (1978) gave a complete description of duties on citrus and citrus products entering the major importing countries. Great variation in those duties is apparent. For example, FCOJ is free of tariffs in Norway, however it is subject to 200 percent ad valorem duty in Venezuela. Orange juice entering the EEC is subject to a common external ad volorem tariff of 12 to 19 percent according to the specific gravity of the juice. However, the EEC allows for a partial or total suspension of imports and the establishment of a minimum import price, if the market for certain processed fruits, including orange juices, experiences or is threatened with serious distrubances (Taylor, 1978). Canada has an overall five percent ad valorem duty on orange juice. However, the product is free of duty to commonwealth suppliers and to all other supply sources of unsweetened orange concentrate if not less than 58° brix. Finland has a 30 percent duty on orange juices that can qualify for a substantial reduction if it is imported for industrial manufacture. In Sweden there is a duty of 5.00 to 7.50 krona per 100 kilograms for orange juice without added sugar, according to the container size, and 30.00 krona per 100 kilograms for orange juices with added sugar. In the USA FCOJ imports are subject to a tariff of 34 cents per pound of solids and, as previously discussed in this chapter, FCOJ importers can use the duty drawback provision to recover 99 percent of the duty paid

if a similar quantity is exported. Japan uses quotas as a way to protect its domestic industry.

Preferential concessions are forms of favorable treatment (tariff reductions or other forms) given to one country or to a group of countries. The EEC allows a 70 percent preferential duty reduction on orange juice imports from Algeria, Israel, Morocco and Tunisia, while other suppliers must pay the full amount. Italy and Greece, as producers of citrus and citrus products within the community, have benefited by the condition of free trade between members. This treatment will soon be extended to Spain if it becomes a member of the EEC in the near future.

Other regional organizations and trading blocs[7] with a large variety of agreements and commitments may also affect trade of orange juices. Cuba, for example, has been reported as a potential producer of orange juice in the future (Wolff, 1978) and, as a member of the COMECON will have preferential treatment in that market.

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[7]European Free Trade Association (EFTA) includes Austria, Norway, Portugal, Sweden, Finland, Iceland and Switzerland. Council for Mutual Economic Assistance (COMECON) includes Eastern European nations, the Soviet Union, Mongolia and Cuba. Yugoslavia does not participate fully and Finland, Iraq and Mexico are "cooperant" members of COMECON. Other groups are the Latin America Free Trade Area (LAFTA), the Caribbean Free Trade Area (CARIFTA) and the Central American Common Market (CACM; Ryan & Tontz, 1978).

CHAPTER III

THE ECONOMIC MODEL

In this chapter efforts are devoted to setting up the conceptual development of the economic model of the orange juice industry. The goal is to develop the reasoning for a set of equations that summarize the most important market segments of the industry. The first section gives an overview of the underlying economic theory. A brief discussion of theory of consumer behavior is followed by a review of recent theoretical developments of exchange rate effects on commodity prices and trade. In the second section the economic model is formally specified with flow charts and sets of equations. This specification results from putting together important economic considerations from Chapter II, and theoretical guidelines, logical reasoning, experience and basic knowledge of the orange juice industry. Finally, the third section summarizes the estimation of the empirical model.

Theoretical Background

The analytical framework of this study can be described as a system of demand and price equations for orange juice. The set of demand equations (retail, wholesale, import or export) are derived, in the sense that they reflect consumer

preferences.[1] In some markets the derived concept will also include a chain effect, for example, retail variables may be in a wholesale equation, or retail and wholesale variables may be in an import or export equation. In such cases, the derived demand relations are also partial reduced-form equations derived from a more complete structure. The price equations stem from the simultaneous nature of the system. This formulation attempts to capture the price transmission effects within different levels of a given market and across markets. Bredahl et al. (1979) emphasize the role of elasticity of price transmission in estimating the elasticity of export demand for a given commodity. Their major concern relates to the implications of government policies that insulate domestic consumers and producers from external price fluctuations.

The basic economic foundations for the price equations for product sources other than the USA is price leadership.[2] The USA sets the price and prices from other sources are derived from it. The USA price equations are basically derived from Florida's wholesale prices which have as major determinant measures of orange juice stocks and crop sizes. Exchange rates are included as price equation shifters in

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[1]The underlying theories of consumer behavior (utility function and revealed preference) will not be discussed in detail in this study. Most Microeconomics textbooks discuss these theories. For example, see Henderson and Quandt, 1980; Russell and Wilkinson, 1979; Phlips, 1974; and Silberberg, 1978. For modern treatments of revealed preference theory see Uzawa, 1960; and Richter, 1966.

[2]For more detail on price leadership, see for example Russell and Wilkinson, 1979; Gould and Ferguson, 1980. For application of price leadership in the citrus industry see Buckley, 1977.

most of the structure. The role of exchange rate should be reviewed, not only for its importance as discussed in Chapter II of this study, but also because of the recent attempts to develop a theoretical framework explaining its effects on commodity prices and trade.

Most of the work on exchange rates, as economic policy variables, has been in the context of their impact on the balance of payments of a country. In recent years attempts have been made to formulate a theoretical framework that incorporates the role of exchange rate policy on commodity analysis in a less aggregate basis (Schuh, 1974; Kost, 1976). Both studies use the same economic framework (supply and demand analysis in an industry with export potential). Schuh concentrated relatively more on the role fo the exchange rate within the USA economy with particular interest in the distribution of benefits of economic progress and adoption of new technologies. Kost, on the other hand, was more general in the sense that his discussion attempted to cover the effects of changes in exchange rates on commodity production, consumption, trade levels, and prices for any two trading partners.[3] Only the effects of devaluation by exporting countries will be discussed here under Kost's theoretical framework.[4]

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[3]Empirical works have, in general, provided support for exchange rate effects on commodity analysis with their major differences on its magnitude. See for example Greenshields, 1974; Vellianitis-Fidas, 1976; Johnson et al., 1977; and Collins et al., 1980.

[4]For more detailed analysis and effects of other sources of exchange rate changes see Kost's paper.

Figure 2 summarizes these major effects under a simplified set of assumptions[5] for a given commodity. This figure has three basic segments describing the economic conditions for this special commodity in the exporting country (exporter), in the importing country (importer), and at the international level (trade sector). Its horizontal axes measure quantity in any unit and its vertical axes measure prices. Solid lines in Figure 2 show the classical equilibrium in these two economies after trade, under the assumption that currency ratios are one to one. PE_o and QT_o are equilibrium price and traded quantity, respectively. Broken lines show a situation of equilibrium after trade associated with a devaluation of the exporting country currency (say the Brazilian cruzeiro) relative to the importing country currency (say the USA dollar). These exchange rate changes (from a ratio of one to one to a ratio of two cruzeiros to one dollar) are shown in the importer segment on Figure 2. Its vertical axis was stretched out with the devaluation of the exporter's currency. Under a new price scale the structure of demand

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[5]These assumptions are: (1) The model consists of a two-country world or one country-rest of the world (potential exporter and importer), (2) competitive economic systems exist in both countries, (3) a single homogenous commodity is traded, (4) there are no transport costs and no trade barriers, and (5) the market for the single homogenous commodity can be specified by a single downward-sloping demand function and a single upward-sloping supply function for each country (Kost, 1976).

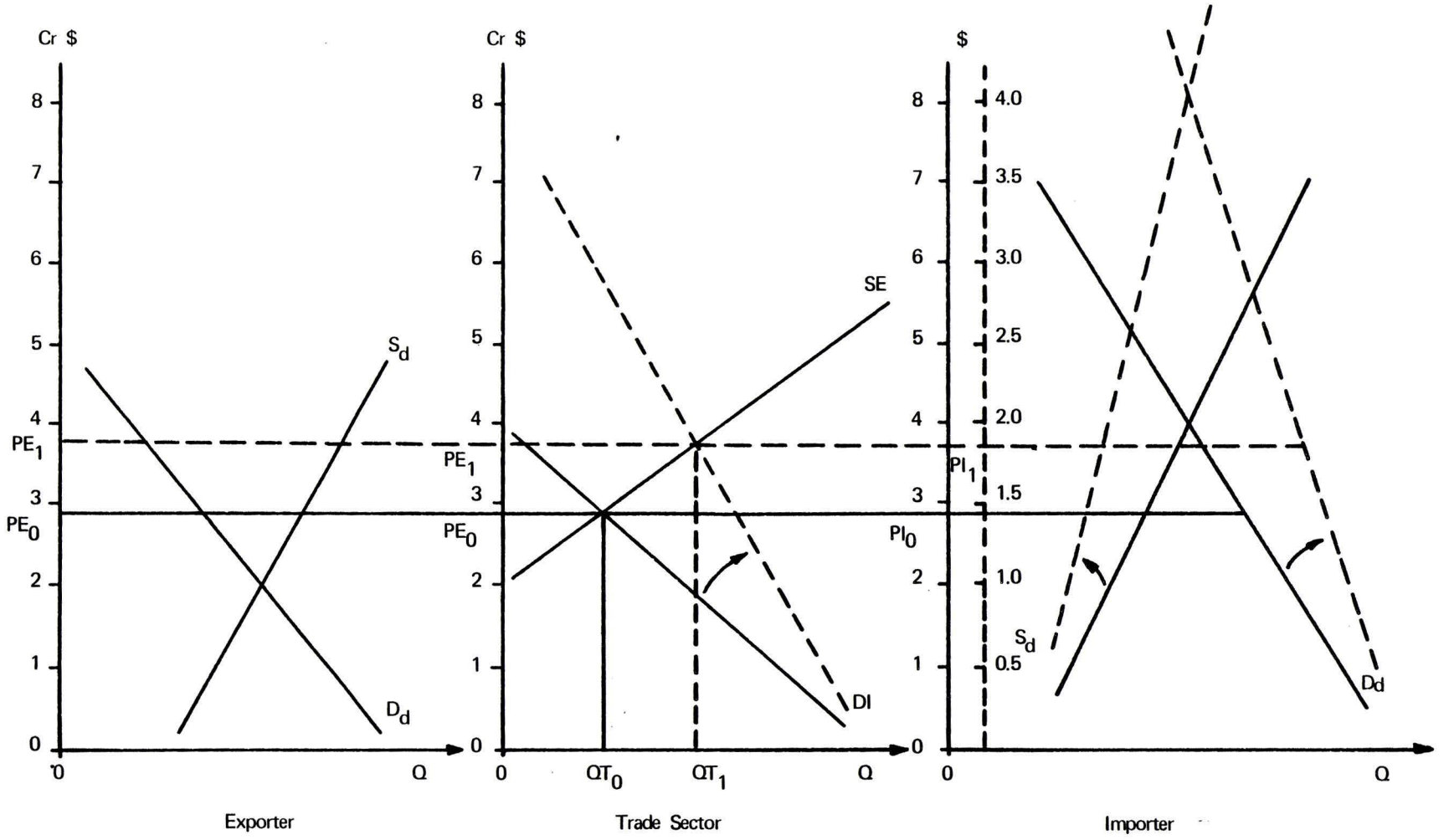

Figure 2. Effects of currency devaluation by exporting country on equilibrium price and quantity for a given commodity.

and supply functions for the importing country will pivot up from their respective intersection with the horizontal axis such that internal equilibrium price (dollars) and quantity will remain as before. Demand for imports (DI) function in the trade sector also moves in the same fashion, given that it is derived from importer demand and supply structure. Since this structure did not change in the exporting country, then the derived supply for exports (SE) in the trade sector segment does not change either. The new equilibrium implies a relatively large traded quantity of of the commodity (QT_1), a higher export price in the exporting country currency (PE_1) and a lower import price expressed in the importing country currency (PI_1). The impact of exchange rate effects on prices and quantities is determined in large degree by the elasticity of supply for exports and by the elasticity of demand for imports[6] which in turn depend on the respective domestic demand and supply elasticities in the exporting and importing countries. In this particular case of devaluation by the exporting country, the role of the export supply elasticity is quite important. One can see that the effects of currency devaluation by an exporter will be relatively more on prices (or traded quantity) if the supply export elasticity is relatively more inelastic (or elastic). Since agricultural products are

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[6]Another important determinant is the magnitude of the exchange rate changes.

traditionally quite inelastic, then it is very likely that exchange rate effects will be larger on prices than on quantity.

In this study it is assumed that total orange juice supply is relatively fixed for both sources (Brazil and the USA). Given previous discussion and the fact that domestic demand for orange juice in Brazil is very small, as compared with large demand in the USA, it is reasonable to expect that a devaluation of the Brazilian cruzeiro will have a relatively larger effect on export price than on export quantity. The same change in the USA dollar is expected to result in a relatively larger effect on export quantity than on export price if the orange juice export supply elasticities are relatively more inelastic in Brazil and relatively less inelastic in the USA.

The Economic Model

The economic model is essentially a model that explains the trade flows and prices. Supply of fruit is assumed to be exogenous.[7] Variables expected to influence the demand structure, but not incorporated in previous discussions, will also be included in the proper segment of the economic model. Two flow charts, together with four sets of

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[7]This assumption stems from the nature of orange production. New orange groves may require four to five years before reaching commercial production capacity. This is certainly a major constraint on the USA and Brazil supply responses from changes in orange juice market conditions in a given year. Thus, a simplified assumption of fixed or practically fixed supply is quite reasonable, especially in this study that uses bimonthly data.

equations, describe the economic model for orange juices in the USA, Canada, the EEC7 (seven countries of the European Economic Community), and the European non-EEC3 (three European countries non-EEC members) markets.[8]

FCOJ and Other Orange Juices Market Structure in the USA

Relations and interrelations of the major variables of the model describing the orange juice market structure in the USA are shown in Figure 3 and Equations 1 through 16.[9] The set of equations formally specifies the derivation of 16 endogenous variables[10] in behavioral relations (Equations 1 through 4, Equation 7, Equations 9 through 11, and Equations 13 and 14) or in identity relations

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[8]The Brazilian domestic market is not included in the model because of its small size (less than 5 percent of the orange juice production) and lack of systematic data.

[9]A variable superscript sign plus (+) or minus (-) indicates the expected directional relationship between variables of the equation. Variables without a sign do not have a basis for hypothesizing the relationship. The subscript t stands for time period (December-January 1971/72 to February-March of 1979). Unless otherwise specified, most of the non-monetary variables are expressed in gallons of single strength or reconstituted juice equivalent per thousand persons. Monetary variables are expressed in USA dollars in terms of 1975 prices. For more details see Appendix E.

[10]Endogenous, or current endogenous or jointly dependent variables, are those variables whose values are determined within a set of equations. Predetermined variables, which can be subdivided into exogenous, lagged exogenous, or lagged endogenous, are those variables used as explanatory variables in the set, but which are completely determined outside the system (exogenous) or are past values of current endogenous variables

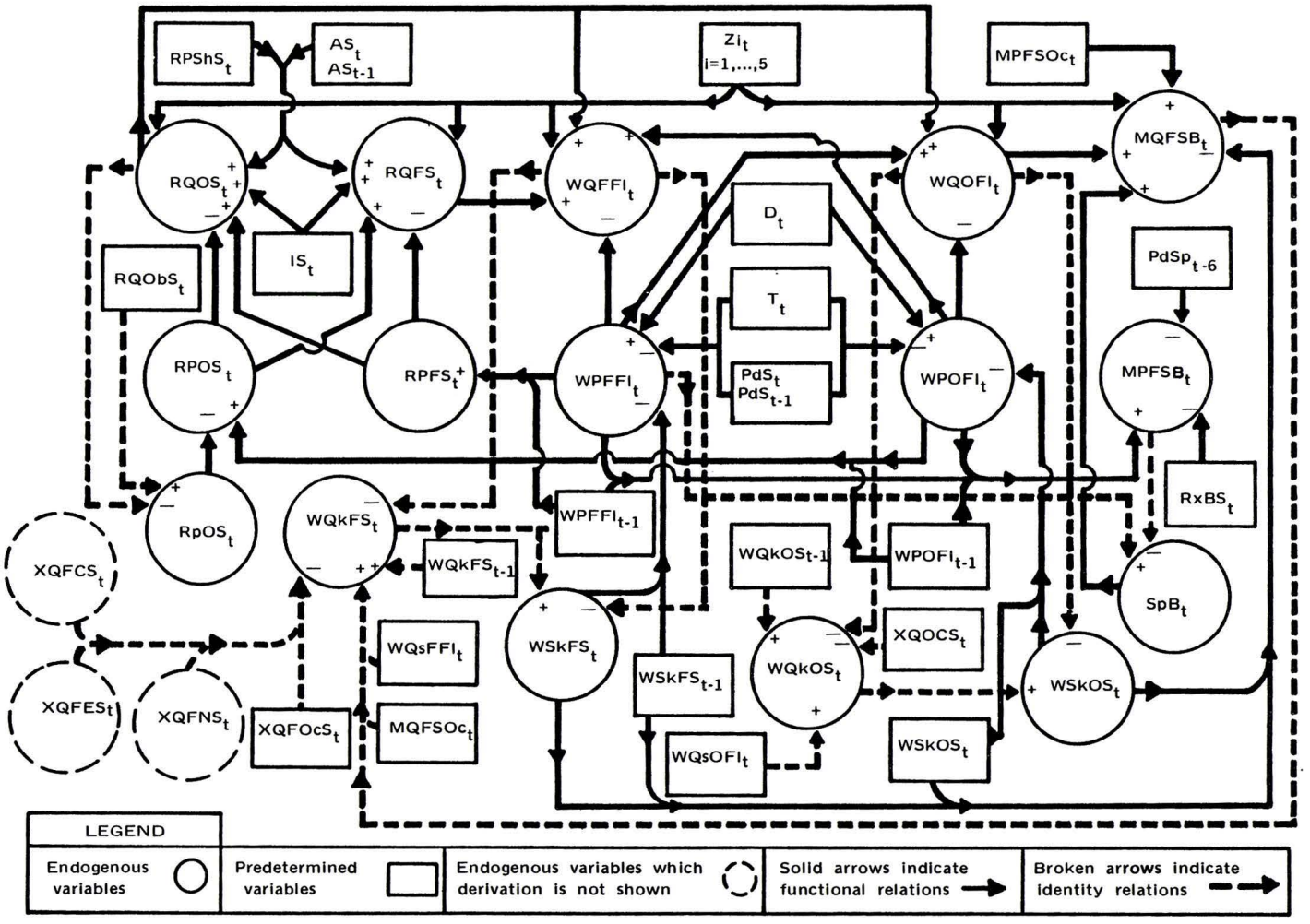

Figure 3. Orange juice market structure in the USA.

(Equations 5, 6, 8, 12, 15 and 16).

$$RQFS_t = f_1\ (RPFS_t^-,\ RPShS_t^+,\ RPOS_t^+,\ IS_t^+,\ AS_t^+,\ AS_{t-1}^+,\ Z1_t,\ Z2_t,\ Z3_t,\ Z4_t,\ Z5_t) \quad (01)$$

$$RPFS_t = f_2\ (WPFFl_t^+,\ WPFFl_{t-1}^+) \quad (02)$$

$$WQFFl_t = f_3\ (WPFFl_t^-,\ WPOFl_t^+,\ RQFS_t^+,\ RQOS_t^+,\ Z1_t,\ Z2_t,\ Z3_t,\ Z4_t,\ Z5_t \quad (03)$$

$$WPFFl_t = f_4\ (WSkFS_t^-,\ WSkFS_{t-1}^-,\ PdS_t^-,\ PdS_{t-1}^-,\ D_t^+,\ T_t^-) \quad (04)$$

$$WSkFS_t = WQkFS_t/WQFFl_t \quad (05)$$

$$WQkFS_t = [(WQkFS_{t-1} + WQsFFl_t + MQFSB_t + MQFSOc_t - WQFFl_t)\ PlS_t - (XQFCS_t)\ PlC_t - (XQFES_t)\ PlE_t - (XQFNS_t)\ PlN_t - (XQFOcS_t)\ PlOc_t]/PlS_t \quad (06)$$

$$MQFSB_t = f_5\ (SpB_t^+,\ WQOFl_t^+,\ MPFSOc_t^+,\ WSkFS_t^-,\ WSkFS_{t-1}^-,\ WSkOS_t^-,\ WSkOS_{t-1}^-,\ Z1_t,\ Z2_t,\ Z3_t,\ Z4_t,\ Z5_t) \quad (07)$$

$$SpB_t = WPFFl_t - MPFSB_t \quad (08)$$

$$MPFSB_t = f_6\ (WPFFl_t^+,\ WPFFl_{t-1}^+,\ WPOFl_t^+,\ WPOFl_{t-1}^+,\ PdSp_{t-6}^-,\ RxBS_t^-) \quad (09)$$

$$RQOS_t = f_7\ (RPOS_t^-,\ RPShS_t^+,\ RPFS_t^+,\ IS_t^+,\ AS_t^+,\ AS_{t-1}^+\ Z1_t,\ Z2_t,\ Z3_t,\ Z4_t,\ Z5_t) \quad (10)$$

$$RPOS_t = f_8\ (WPOFl_t^+,\ WPOFl_{t-1}^+,\ RpOS_t^-) \quad (11)$$

$$RpOS_t = RQObS_t/RQOS_t \quad (12)$$

$$WQOFl_t = f_9\ (WPOFl_t^-,\ WPFFl_t^+,\ RQOS_t^+,\ Z1_t,\ Z2_t,\ Z3_t,\ Z4_t,\ Z5_t) \quad (13)$$

$$WPOFl_t = f_{10}\ (WSkOS_t^-,\ WSkOS_{t-1}^-,\ PdS_t^-,\ PdS_{t-1}^-,\ D_t^+,\ T_t^-) \quad (14)$$

$$WSkOS_t = WQkOS/WQOFl_t \quad (15)$$

$$WQkOS_t = [(WQkOS_{t-1} + WQsOFl_t - WQOFl_t)\ PlS_t - XQOCS_t)\ PlC_t]/PlS_t \quad (16)$$

A description of all variables in the specification of the USA market relationships is presented in Table 11.

The demand structure for orange juices in this market is formulated separately for FCOJ (Equations 1 through 9) and for other orange juices (Equations 10 through 16). The underlying reasons stem from the importance of these two forms of orange juice marketed in the USA, as discussed

Table 11. Description of variables in the orange juice market structure in the USA

Variables[1]	Description
Endogenous variables	
$RQFS_t$	Retail quantity of FCOJ in the USA
$RPFS_t$	Retail price of FCOJ in the USA
$WQFFl_t$	Wholesale quantity of FCOJ in Florida
$WPFFl_t$	Wholesale price of FCOJ in Florida
$WSkFS_t$	Wholesale stock of FCOJ in the USA, expressed in bimonths of Florida supplies
$WQkFS_t$	Wholesale quantity in stock of FCOJ in the USA
$MQFSB_t$	Import quantity of FCOJ by the USA from Brazil
SpB_t	Price spread between Florida's FCOJ wholesale price ($WPFFl_t$) and the USA FCOJ import price from Brazil ($MPFSB_t$)
$MPFSB_t$	Import price of FCOJ by the USA from Brazil
$RQOS_t$	Retail quantity of other orange juices in the USA
$RPOS_t$	Retail price of other orange juices in the USA
$RpOS_t$	Retail proportion of other orange juices marketed in cardboard containers in the USA
$WQOFl_t$	Wholesale quantity of other orange juices in Florida
$WPOFl_t$	Wholesale price of other orange juices in Florida
$WSkOS_t$	Wholesale stock of other orange juices in the USA, expressed in bimonths of Florida supplies
$WQkOS_t$	Wholesale quantity in stock of other orange juices in the USA

(continued)

Table 11 (continued)

Variables[1]	Description
$XQFCS_t$	Export quantity of FCOJ to Canada from the USA
$XQFES_t$	Export quantity of FCOJ to the EEC7 countries from the USA
$XQFNS_t$	Export quantity of FCOJ to the European non-EEC3 countries from the USA
Predetermined variables	
$MQFSOc_t$	Import quantity of FCOJ by the USA from other countries
$MPFSOc_t$	Import price of FCOJ by the USA from other countries
$XQFOcS_t$	Export quantity of FCOJ to other countries from the USA
$XQOCS_t$	Export quantity of other orange juices to Canada from the USA
$RPShS_t$	Retail price of frozen orange-flavored synthetics and drinks in the USA
$RQObS_t$	Retail quantity of other orange juices in cardboard containers in the USA
$WQkFS_{t-1}$	Wholesale quantity in stock of FCOJ in the USA in the previous period
$WQsFFl_t$	Wholesale quantity supplied of FCOJ in Florida
$WQkOS_{t-1}$	Wholesale quantity in stock of other orange juices in the USA in the previous period
$WQsOFl_t$	Wholesale quantity supplied of other orange juices in Florida
$WPFFl_{t-1}$	$WPFFl_t$ lag by one period
$WQOFl_{t-1}$	$WPOFl_t$ lag by one period
$WSkFFl_{t-1}$	$WSkFFl_t$ lag by one period

(continued)

Table 11 (continued)

Variables[1]	Description
$WSkOFl_{t-1}$	$WSkOFl_t$ lag by one period
$RxBS_t$	Brazil exchange rate expressed in cruzeiros per USA dollar
IS_t	Income per capita in the USA, seasonally adjusted at annual rates, expressed in thousand dollars
AS_t, AS_{t-1}	Current and lagged advertising expenditures (generic and brand) by the Florida Department of Citrus in the USA, expressed in dollar per thousand persons
PdS_t, PdS_{t-1}	Current and lagged estimates of orange production in the USA, expressed in billion boxes of 90 pounds
$PdSp_{t-6}$	Estimates of orange production in the state of São Paulo (Brazil) lag of six periods, expressed in billion boxes of 90 pounds
PlS_t, PlC_t, PlE_t, PlN_t and $PlOc_t$	Estimates of population in the USA, Canada, the EEC7, the European non-EEC3 and in other countries, respectively, expressed in million persons
D_t	Dummy variables to account for the effects of the USA freeze in 1977. D_t is equal to one for observations from February-March bimonth of 1977 on, and zero otherwise
T_t	Linear time trend to account for time-related changes in prices

(continued)

Table 11 (continued).

Variables[1]	Description
Zi_t	Five (i=1,...,5) dummy variables to account for bimonth seasonal effects on demand. $Z1_t$ is equal to one for December-January bimonths, and zero otherwise. Similarly, $Z2_t$ through $Z5_t$ is equal to one for February-March, April-May, June-July and August-September bimonths, respectively, and zero otherwise

[1]Unless otherwise specified non-monetary variables are expressed in gallons of single strength or reconstituted juice equivalent per thousand persons. Monetary variables are expressed in the USA dollar in terms of 1975 prices. Price variables are expressed in the USA dollars per gallon of single strength or reconstituted juice equivalent. A "t" subscript on a variable stands for "time period," which is from December-January bimonth of 1971/1972 to February-March bimonth of 1979. For more detail see Appendix E.

previously (Chapter II), and the existence of systematic data for both of them. There is no doubt about the significance of estimating demand relations for FCOJ. However, the quantity of other forms of orange juice marketed in the USA has increased considerably. For example, Florida's wholesale domestic sales of canned and chilled orange juices increased by almost 70 percent from 1972 to 1979 (Table C.2. - Appendix C). Thus, the inclusion of a set of demand and price equations for other orange juice is required to complete the model in this market. The retail and wholesale sectors for FCOJ and other orange juices are described by Equations 1 through 6 and by Equations 10 through 16. The wholesale sector is specified only for Florida since this state accounts for almost 90 percent of the total oranges processed in the country (Florida Crop and Livestock Reporting Service, 1979) and detailed data are not available for the other states. USA imports[11] are described by Equations 7 through 9. In the import segment only the demand structure for FCOJ imports is specified, since the USA does not import significant quantities of other forms of orange juices.

As shown by the flow chart in Figure 3 all sectors of the USA market are linked together so that changes in any variable are likely to have some effects on all variables determined by the system. It should be pointed out that

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[11]USA export components will be described in the formulation of the demand structure of the other markets as defined in this study.

wholesale prices, especially for FCOJ, and the FCOJ import price from Brazil, are variables that play major roles in the model. Wholesale prices are important determinants of retail prices in both forms of orange juices and wholesale prices of FCOJ together with the FCOJ import prices from Brazil determine the price spread, a key variable in this model. Another role of the domestic-import price relation would be in the derivation of the USA export prices which will be discussed in the next sub-section, where the FCOJ demand structures for other markets are conceptually formulated.

The USA market structure for orange juices is conceptually quite similar to the model developed by Ward (1976a).[12] However, it is different in the sense that it also includes the retail sector of FCOJ and other orange juices. In addition, the wholesale sector also addresses the demand structure for other orange juices, and domestic and import prices are endogenous. Another important difference is the simultaneous linkage of major supply sources of orange juices in the most important markets (the USA, Canada, the EEC7 and the European non-EEC3).

The remaining part of this sub-section will discuss the formulation of each equation in the system, as well as the expected directional effects of each variable.

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[12]Ward's FCOJ model endogenously determines Florida's domestic demand and demand for imports (domestic and import prices are exogenous), and Florida's export quantities and prices to Canada and Europe.

Retail FCOJ

Retail quantity of FCOJ in the USA ($RQFS_t$) is formulated as a function of its own price ($RPFS_t$), prices of orange-flavored synthetics and drinks and other orange juices as substitute products ($RPShS_t$ and $RPOS_t$), income (IS_t), advertising (AS_t and AS_{t-1}), and seasonal variation in consumption ($Z1_t$ through $Z5_t$) (Equation 1). The hypothesized signs are consistent with traditional neoclassical demand theory and previous FCOJ demand research by Tilley (1979) and Ward and Tilley (1980). The impact of advertising on demand is assumed to have a lag structure of one time period. The underlying assumption is that some of the effects of advertising on consumption are expected to be reflected at later periods. Lee (1980) reviewed the Florida Department of Citrus, Economic Research Department research program in the area of measuring advertising effectiveness. A common agreement is that the effects of advertising are not immediately perceived. That is, consumer responses to advertising have a decay or carryover effect over time. Since, in this model a time period aggregates two months (bimonthly data base), the specified structure of the advertising variables (AS_t and AS_{t-1}) will include four months, so that most of the effects of advertising on FCOJ retail demand are expected to be captured.

FCOJ retail price (Equation 2) is assumed to be a positive fucntion of current and lagged wholesale price ($WPFF1_t$ and $WPFF1_{t-1}$). Within this time period (four months)

it is expected that market agents will have sufficient time to fully adjust retail prices to most changes in wholesale prices.

Wholesale FCOJ

The wholesale FCOJ demand structure is described by Equations 3 through 5. Florida's wholesale quantity ($WQFFl_t$) is hypothesized to be negatively related to its own wholesale price ($WPFFl_t$), and positively related to wholesale price of other orange juices ($WPOFl_t$), retail quantity of FCOJ ($RQFS_t$), and retail quantity of other orange juices ($RQOS_t$). Seasonal variation (Zl_t through $Z5_t$) in the wholesale demand for FCOJ is also expected. Underlying most of this formulation is the assumption that wholesale demand is derived from retail demand. Retail quantities ($RQFS_t$ and $RQOS_t$) are expected to translate consumers' preferences to the wholesale sector. Retail quantity of other orange juices ($RQOS_t$) is hypothesized to affect FCOJ wholesale demand ($WQFFl_t$) positively, since it can be reconstituted from bulk FCOJ.[13]

Wholesale price of FCOJ in Florida (Equation 4) is assumed to be determined by an estimate[14] of wholesale stocks of FCOJ in the USA ($WSkFS_t$), orange production in the USA (PdS_t), a dummy variable to account for the effects

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[13]It should be recalled that FCOJ, in this study, is defined so as to include all container forms of marketing the product. Florida's processors supply FCOJ in retail-size, bulk and institutional containers.

[14]An estimate because data on $WSkFS_t$ determinant variables are available only for Florida processors.

of the January of 1977 freeze (D_t), and a linear time trend variable expected to capture the effects of time-related changes (T_t). $WSkFS_t$ and PdS_t are assumed to be negatively related to wholesale prices under a lag structure. The FCOJ stock variable ($WSkFS_t$) is defined by equations 5 and 6 (identities) as the ratio of FCOJ quantity in stocks in the USA at the end of the bimonth[15] to Florida's domestic movement ($WQFFl_t$) for the same time period. Under this definition, $WSkFS_t$ is expressed in bimonths of domestic (Florida) supplies, such that the seasonal effect of stocks on wholesale prices can be accounted for. A specification that includes current and lagged FCOJ stock variables ($WSkFS_t$ and $WSkFS_{t-1}$) is expected to capture most of its effects on FCOJ wholesale prices. Large stocks are expected to cause processors to reduce current prices in order to increase sales. Current and lagged orange production estimates (PdS_t, PdS_{t-1}) in the USA[16] are also assumed to affect $WPFFl_t$. The reasoning for it is that changes in expected production would lead processors to adjust current prices, given anticipated juice supplies. The freeze in 1977 (D_t) is expected to have a positive impact on wholesale prices, reflecting current and/or future reductions on supply.

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[15]FCOJ quantity in stocks in the USA at the end of the bimonth (Equation 6) is determined by the quantity in stocks in the USA from previous bimonth plus current Florida domestic supply and the USA imports from Brazil and from other countries minus current Florida domestic demand and the USA exports to Canada, the EEC7, the European non-EEC3, and other countries.

[16]It is assumed that the wholesale price equation for FCOJ (Equation 4), as well as the wholesale price equation for

FCOJ Imports

USA import demand for FCOJ from Brazil is specified in Equation 7 through 9. In this formulation, Florida's wholesale prices ($WPFFl_t$ and $WPOFl_t$) and the import price of FCOJ from Brazil ($MPFSB_t$) are the major factors influencing the USA import demand equations.

The price spread (SpB_t) between the FCOJ domestic wholesale price in Florida ($WPFFl_t$) and the import price from Brazil ($MPFSB_t$) plays a major role, as suggested by Ward (1976a), in the determination of USA imports from Brazil (Equations 7 and 8). SpB_t is expected to be positively related to imports, meaning that, as this price differential increases (decreases), quantity of FCOJ imported from Brazil is likely to increase (decrease). While the preceding relationship determines the USA FCOJ import demand, the other variables in Equation 7 are assumed to be major import demand shifters. Wholesale quantity of other orange juices ($WQOFl_t$) is expected to be positively reflected to FCOJ imports under the assumption that pressure from domestic wholesale sales of other forms of orange juices may lead to more FCOJ imports.

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other orange juices (Equation 14), are both affected by changes on orange production in the USA as whole, even through the equations are for Florida's orange juices. The reasoning for such formulation is as follows. If Florida's orange production changes, the state supply of orange juices, and consequently their prices, is very likely to change, given that, in Florida, practically all orange production is processed. If orange production in other states changes, the most likely result would be changes in the market for fresh oranges.

Import price of FCOJ from other sources ($MPFSOc_t$), as the price of an expected substitute product, is hypothesized to be positively related to imports from Brazil ($MQFSB_t$). In this formulation stocks play a direct role[17] on FCOJ imports. Imports are seen as the immediate source to raise stocks to some desired level, independent of future allocation. In this context stocks and imports move in opposite directions. Larger stocks should lessen the need for imports, while as stocks fall below some critical level, imports are viewed as immediately available supply. Even with stocks above the critical level, strong pressure from Canadian and European buyers of the USA product may lead to more imports in order to average down export prices. Bimonthly dummy variables ($Z1_t$ through $Z5_t$) are included to account for seasonal influences on FCOJ imports.

It is assumed that current and lagged Florida FCOJ wholesale price ($WPFF1_t$, $WPFF1_{t-1}$) are the major determinants of import prices from Brazil ($MPFSB_t$) (Equation 9). In other words, to determine $MPFSB_t$, Brazilian export agents and institutions first consider FCOJ market conditions in Florida, directly through market information and indirectly through actions of importers. $WPOF1_t$ and $WPOF1_{t-1}$ are included in the import price equation because pressure on the domestic wholesale market of other orange juices is

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[17]The indirect role of stock on imports comes from its effects on domestic prices ($WPFF1_t$) and, consequently, on price spreads (SpB_t) and on the level of imports.

expected to put upward pressure on prices in that market. Brazilian FCOJ exporters may react to this movement by arguing for higher prices, assuming that some FCOJ imports are reconstituted and sold in that market. São Paulo's orange production ($PdSp_t$)[18] enters the import price equation only under a lag of six periods ($PdSp_{t-6}$), which is assumed to be the best formulation to capture the traditional negative effect of changing production on prices. This lag structure is directly associated with the fact that most Brazilian crop official estimates--as in the case of oranges--are done in a yearly basis. Production reports are more likely to influence prices in the next period of production and marketing. The last determinant of import prices, as in Equation 9, is cruzeiros per USA dollar ($RxBS_t$). $RxBS_t$ is expected to be negatively related to $MQFSB_t$.

Retail and Wholesale Other Orange Juices

Most of the discussions with regard to FCOJ in the USA domestic markets can be fully extended to the formulation of demand structures for other forms of orange juices as described by Equations 10 through 16. In Equation 11, retail prices of other orange juices ($RPOS_t$) are functions of $WPOFl_t$, $WPOF_{t-1}$ and of the proportion of orange juices sold in cardboard containers ($RfOS_t$), as defined by Equation 12.

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[18] In this case, only orange production in São Paulo is included as that state is the source of all FCOJ exports.

It is expected that as this proportion increases retail prices will decrease because cardboard containers are cheaper than glass and cans. It should also be pointed out that the USA does not import other orange juices. In the determination of the wholesale stocks of other orange juices in the USA ($SWkOS_t$), as described by Equation 15, the supply side (see Equation 16) is comprised only of the USA quantity in stocks from the previous period and current domestic supply ($WQkOS_{t-1}$ and $WQsOFl_t$). The demand side includes Florida's domestic demand ($WQOFl_t$) and exports to Canada ($XQOCS_t$). USA exports of other orange juices to Europe are of relatively minor importance.

FCOJ Market Structure in Canada

The conceptual structure of the economic model showing the relations and interrelationships of variables for the Canadian and European markets is described by the flow chart in Figure 4. These segments of the model were simplified to include only the international trade sector and, specifically, only FCOJ exports to these màrkets from Brazil and from the USA. In most of these markets the domestic producing sector of orange juices is quite small or non-existent so that it is reasonable to assume that all domestic demand forces can be captured by the trade demand structures. Thus, the system of equations resulting from this formulation is a partially reduced form system. It is reduced in the sense that variables, characteristically defined as most likely to have a direct effect on wholesale (orange production) or on

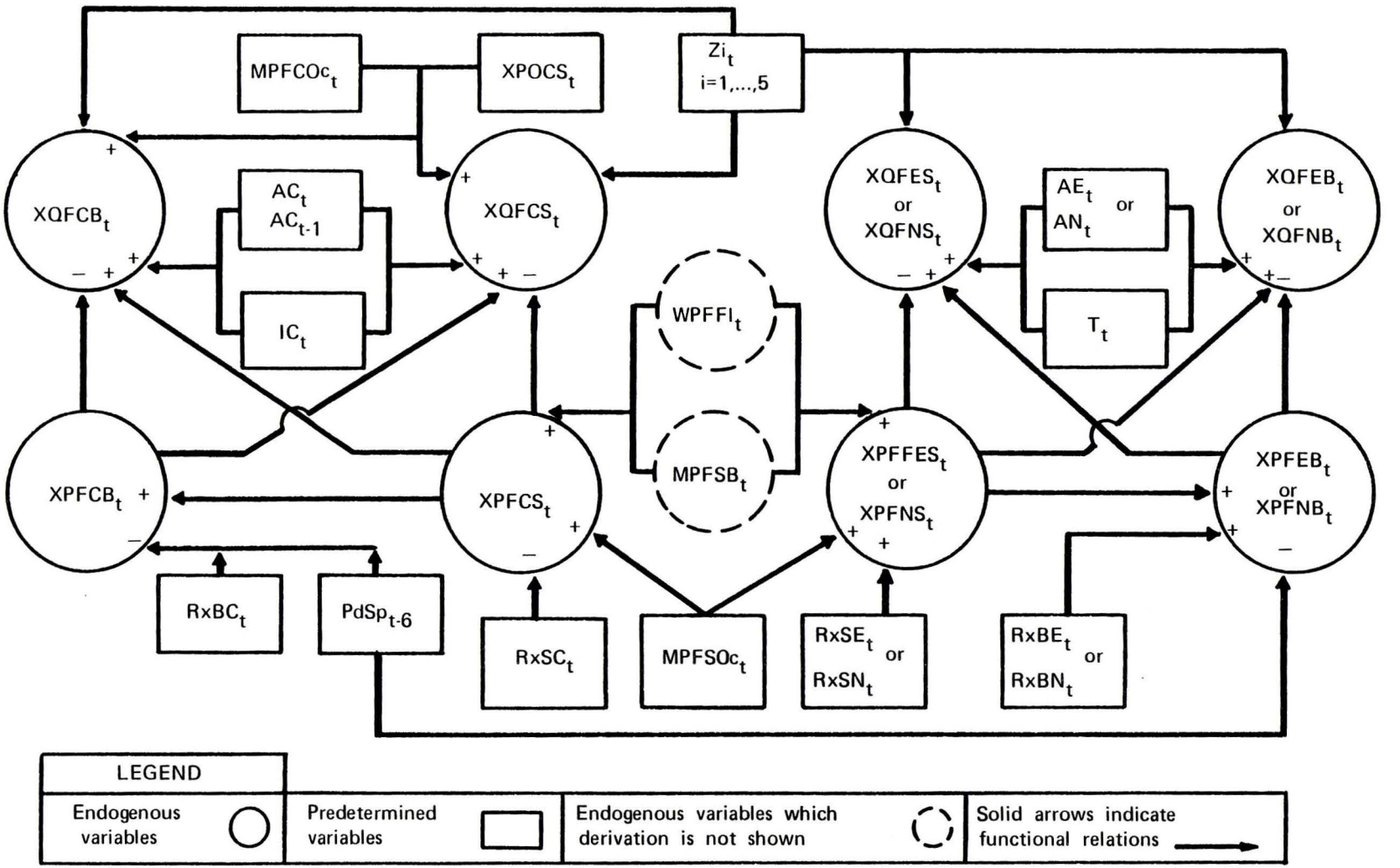

Figure 4. Orange juice market structure in Canada, the EEC7 and the European non-EEC3 countries.

retail (income and advertising expenditures) sectors, are included in the international trade equations. It is partial because the set of equations still contains endogenous variables. The simplification that only Brazil and the USA export FCOJ to these markets is possible because other sources of orange juices have been supplying relatively small quantities.

This formulation of Canadian and European demand for FCOJ from Brazil and the USA is in some way similar to the model developed by Tilley and Lee (1981) for the Canadian retail and import level purchases and prices for orange juices. The similarities are translated in the common way of treating some variables as endogenous or as predetermined. For example Canadian FCOJ trade with the two suppliers (quantities and prices) is determined by the system. However, in the Tilley and Lee model Canadian import prices from Brazil and the USA are exogenous. Another difference is that their model includes retail demand structures (quantity and price) for all orange juices, as well as an aggregated demand for other sources of Canadian imports.

Major roles in the specification are again played by Florida's FCOJ wholesale price ($WPFFl_t$) and by the import price of FCOJ from Brazil ($MPFSB_t$). Together their important role is through the price spread (SpB_t) in the determination of USA imports from Brazil and the impact of these imports

on the USA export prices. It was shown that widening price spreads associated with declining import prices from Brazil or higher domestic prices are likely to result in more imports into the USA. Higher price spreads may lead to a greater export price discounting because more imports are available to average down export prices, and Brazilian imports also have a lower relative price. The net effect of a wider spread on USA exports will thus depend on the degree of discounting and the substitution relationships in the import markets.

In the Canadian market four endogenous variables are determined within the structure (Equations 17 through 20) and there are 16 other variables in the system. Among these variables, $WPFF1_t$ and $MPFSB_t$ are endogenously determined in the USA market. The other variables are predetermined. The following equations represent the FCOJ market structure in Canada and Table 12 has a description of all variables of the structure.

$$XQFCB_t = f_{11}\ (XPFCB_t^-,\ XPFCS_t^+,\ MPFCOc_t^+,\ XPOCS_t^+,\ IC_t^+,\ AC_t^+,\ AC_{t-1}^+,\ Z1_t,\ Z2_t,\ Z3_t,\ Z4_t,\ Z5_t) \quad (17)$$

$$XQFCB_t = f_{12}\ (XPFCS_t^+,\ PdSp_{t-6}^-,\ RxBC_t^-) \quad (18)$$

$$XQFCS_t = f_{13}\ (XPFCS_t^-,\ XPFCB_t^+,\ MPFCOc_t^+,\ XPOCS_t^+,\ IC_t^+,\ AC_t^+,\ AC_{t-1}^+,\ Z1_t,\ Z2_t,\ Z3_t,\ Z4_t,\ Z5_t \quad (19)$$

$$XPFCS_t = f_{14}\ (WPFF1_t^+,\ MPFSB_t^+,\ MPFSOc_t^+,\ RxSC_t^-) \quad (20)$$

Table 12. Description of variables in the FCOJ market structure in Canada

Variables[1]	Description
Endogenous variables	
$XQFCB_t$	Export quantity of FCOJ to Canada from Brazil
$XPFCB_t$	Export price of FCOJ to Canada from Brazil
$XQFCS_t$	Export quantity of FCOJ to Canada from the USA
$XPFCS_t$	Export price of FCOJ to Canada from the USA
$WPFFl_t$	Wholesale price of FCOJ in Florida
$MPFSB_t$	Import price of FCOJ by the USA from Brazil
Predetermined variables	
$MPFSO_t$	Import price of FCOJ by the USA from other countries
$MPFCO_t$	Import price of FCOJ by Canada from other countries
$XPOCS_t$	Export price of other orange juices to Canada from the USA
$RxBC_t$	Brazil exchange rate expressed in cruzeiros per Canadian dollar
$RxCS_t$	The USA exchange rate expressed in cents of dollar per Canadian dollar
IC_t	Income per capita in Canada, seasonally adjusted at annual rates, expressed in thousands of Canadian dollar
AC_t, AC_{t-1}	Current and lagged advertising expenditures of the Florida Department of Citrus in Canada, expressed in dollars per thousand persons

(continued)

Table 12 (continued)

Variables[1]	Description
$PdSp_{t-6}$	Estimates of orange production in the state of São Paulo (Brazil) lag of six periods expressed in billion boxes of 90 pounds
Zi_t	Five (i=1,...,5) dummy variables to account for bimonth seasonal effects on demand. $Z1_t$ is equal to one for December-January bimonths, and zero otherwise. Similarly $Z2_t$ through $Z5_t$ is equal to one for February-March, April-May, June-July and August-September bimonths, respectively, and zero otherwise.

[1]Unless otherwise specified non-monetary variables are expressed in gallons of single strength juice equivalent per thousand persons. Monetary variables are expressed in the USA dollar in terms of 1975 prices. Price variables are expressed in the USA dollars per gallon of single strength juice equivalent. A "t" subscript on a variable stands for "time period," which is from December-January bimonth of 1971/1972 to February-March bimonth of 1979. For more details see Appendix E.

Brazilian FCOJ Exports to Canada

In Equation 17, quantity of FCOJ exported to Canada from Brazil ($XQFCB_t$) is hypothesized to be negatively related to export price ($XPFCB_t$), and positively related to export price of FCOJ to Canada from the USA ($XPFCS_t$), the import price of FCOJ by Canada from other countries ($MPFCOc_t$), the export price of other orange juices to Canada from the USA ($XPOCS_t$), disposable income in Canada (IC_t), and advertising expenditures of the Florida Department of Citrus in Canada (AC_t). $XPFCS_t$, $MPFCOc_t$ and $XPOCS_t$ enter the equation as competing substitute products differentiated by the supply source and/or the product characteristics. Florida's advertising in Canada (AC_t) is designed to promote orange juice from Florida. If, due to Florida's advertising, Canadian imports from the USA increase, the likely result would be a reduction in Canada's imports from other sources, assuming that other factors do not change. However, if the net effect of Florida's product advertising programs in Canada promotes orange juice in general, then it is possible that Florida advertising may have a positive effect on Canadian demand for FCOJ from other suppliers. Current and lagged advertising expenditures (AC_t and AC_{t-1}) are included to test these hypotheses. The remaining variables ($Z1_t$ through $Z5_5$ account for seasonal effects.

In the Brazilian export price equation to Canada (Equation 18), the USA FCOJ export price to Canada ($XPFCS_t$) is included because it is expected that the USA acts as price

leader. As the price changes, the Brazilian price ($XPFCB_t$) changes in the same direction. São Paulo's orange production ($PdSp_t$) and Brazil's exchange rate for the Canadian dollar ($RxBC_t$) are expected to be negatively related to $XPFCB_t$. Orange production in São Paulo enters the equation as a six-period lag ($PdSp_{t-6}$) for the same reasons as in previous discussions.

USA FCOJ Exports to Canada

Export quantity of FCOJ to Canada from the USA (Equation 19) is expected to be negatively related to its own price ($XPFCS_t$). It also has six export demand shifter variables ($XPFCB_t$, $MPFCOc_t$, $XPOCS_t$, IC_t, AC_t, AC_{t-1}) that are expected to be positively related to $XQFCS_t$. All the export demand shifter variables are expected to behave as in previous discussions. $XPFCB_t$, $MPFCOc_t$ and $XPOCS_t$ are prices of competing substitute products positively related to $XQFCS_t$. IC_t is disposable income in Canada, and AC_t and AC_{t-1} are Florida's promotional expenditures in Canada, both positively shifting the export demand.

In Equation 20, the USA FCOJ export price to Canada (XPFCS) is assumed to be positively related to Florida's domestic wholesale price of FCOJ ($WPFFl_t$) and to the import prices of FCOJ by the USA from Brazil ($MPFSB_t$) and from other countries ($MPFSOc_t$). This specification recognizes, explicitly, the role of USA imports of FCOJ in export price determination and that USA prices may be affected by competitive prices of product from other sources.

FCOJ Market Structure in Europe

The European market structure is hypothesized to be similar to the Canadian market structure. There are only two suppliers (Brazil and the USA) and the structure is formulated only for FCOJ. The structure embraces the same partial reduced form concept and the key variables are the same ($WPFFl_t$, $MPFSB_t$ and SpB_t).

The economic background on the relevant markets for orange juices presented in Chapter II stressed important differences in major European FCOJ markets. On one side the European Economic Community (EEC) countries were said to be quite important due to their market size and specific economic policies with respect to orange juice imports into those countries. On the other side, European countries not EEC members were said to be also important because of their high rate of per capita consumption of orange juices, market sophistication as far as juice quality and packing procedures are concerned, and the fact that, as non-EEC members, they do not have the same structure of protective restrictions and preferential concessions as the EEC members. In order to deal with these different economic aspects, the FCOJ demand structures in Europe are formulated for two groups of countries. The EEC7 group (West Germany, The Netherlands, the United Kingdom, Belgium, Luxembourg, Denmark and France) represents EEC members. The European non-EEC3 group (Sweden, Norway and Finland) represents other European non-EEC members.

The EEC7 and European non-EEC3 market structures are described by Equations 21 through 28.

$$XQFEB_t = f_{15}\ (XPFEB_t^-,\ XPFES_t^+,\ T_t^+,\ AE_t^+,\ Z1_t,\ Z2_t,\ Z3_t,\ Z4_t,\ Z5_t) \quad (21)$$

$$XPFEB_t = f_{16}\ (XPFES_t^+,\ PdSp_{t-6}^-,\ RxBE_t^+) \quad (22)$$

$$XQFES_t = f_{17}\ (XPFES_t^-,\ XPFEB_t^+,\ T_t^+,\ AE_t^+,\ Z1_t,\ Z2_t,\ Z3_t,\ Z4_t,\ Z5_t) \quad (23)$$

$$XPFES_t = f_{18}\ (WPFFl_t^+,\ MPFSB_t,\ MPFSOc_t^+,\ RxSE_t^+) \quad (24)$$

$$XQFNB_t = f_{19}\ (XPFNB_t^-,\ XPFNS_t^+,\ T_t^+,\ AN_t^+,\ Z1_t,\ Z2_t,\ Z3_t,\ Z4_t,\ Z5_t \quad (25)$$

$$XPFNB_t = f_{20}\ (XPFNS_t^+,\ PdSp_{t-6}^-,\ RxBN_t^+) \quad (26)$$

$$XQFNS_t = f_{21}\ (XPFNS_t^-,\ XPFNB^+,\ T_t^+,\ AN_t^+,\ Z1_t,\ Z2_t,\ Z3_t,\ Z4_t,\ Z5_t \quad (27)$$

$$XPFNS_t = f_{22}\ (WPFFl_t^+,\ MPFSB_t^+,\ MPFSOc_t^+,\ RxSN_t^+) \quad (28)$$

Eight endogenous variables are determined by the structure. Wholesale prices in Florida ($WPFFl_t$) and the USA import price from Brazil ($MPFSB_t$) are endogenous variables in the system determined in the USA market. The other variables are predetermined. A description of all variables of the FCOJ market structure in the EEC7 and the European non-EEC3 countries is presented in Table 13.

Table 13. Description of variables in the FCOJ market structures in the EEC7 and the European non-EEC3 countries

Variables[1]	Description
Endogenous variables	
$XQFEB_t$	Export quantity of FCOJ to the EEC7 from Brazil
$XPFEB_t$	Export price of FCOJ to the EEC7 from Brazil
$XQFES_t$	Export quantity of FCOJ to the EEC7 from the USA
$XPFES_t$	Export price of FCOJ to the EEC7 from the USA
$XQFNB_t$	Export quantity of FCOJ to the European non-EEC3 from Brazil
$XPFNB_t$	Export price of FCOJ to the European non-EEC3 from Brazil
$XQFNS_t$	Export quantity of FCOJ to the European non-EEC3 from the USA
$XPFNS_t$	Export price of FCOJ to the European non-EEC3 from the USA
$WPFFl_t$	Wholesale price of FCOJ in Florida
$MPFSB_t$	Import price of FCOJ by the USA from Brazil
Predetermined variables	
$MPFSOc_t$	Import price of FCOJ by the USA from other countries
$RxBE_t$	Brazil exchange rate index relative to the EEC7 countries
$RxBN_t$	Brazil exchange rate index relative to the European non-EEC3 countries

(continued)

Table 13 (continued).

Variables[1]	Description
$RxSE_t$	The USA exchange rate index relative to the EEC7 countries
$RxSN_t$	The USA exchange rate index relative to the European non-EEC3 countries, expressed in dollars per thousand persons
AN_t	Advertising expenditures of the Three-Party Program in the European non-EEC3 countries, expressed in dollars per thousand persons
$PdSp_{t-6}$	Estimates of orange production in the state of São Paulo (Brazil); lag of six periods expressed in billion boxes of 90 pounds.
T_t	Time trend variables as a proxy variable for income per capita in the EEC7 and the European non-EEC countries
$Z1_t$	Five (i=1,...,5) dummy variables to account for bimonth seasonal effects on demand. $Z1_t$ is equal to one for December-January bimonths, and zero otherwise. Similarly $Z2_t$ through $Z5_t$ is equal to one for February-March, April-May, June-July and August-September bimonths, respectively, and zero otherwise.

[1]Unless otherwise specified non-monetary variables are expressed in gallons of single strength juice equivalent per thousand persons. Monetary variables are expressed in the USA dollar in terms of 1975 prices. Price variables are expressed in USA dollars per gallon of single strength juice equivalent. A "t" subscript on a variable stands for "time period" which is from December-January bimonth of 1971/1972 to February-March bimonth of 1979. For more details see Appendix E.

Brazilian FCOJ Exports to the EEC7

Export quantity of FCOJ to the EEC7 countries from Brazil (Equation 21) is hypothesized to be negatively related to its own price ($XPFEB_t$) and positively related to the USA export price to the same market ($XPFES_t$). T_t is a time trend variable used as a proxy for disposable income in the EEC7 market, which is also expected to be positively related to demand for FCOJ from Brazil. AE_t stands for advertising expenditures in the EEC7 market and it includes only financial support of the Three-Party Program which is designed to promote Florida's citrus in Europe. Three-Party Program data are available only on a yearly basis and AE_t accounts for advertising expenditures in the seven countries of the EEC7 market. The impact of the program expenditures may be positive or negative, depending on whether the promotion of FCOJ from Florida causes a substitution of the Florida product for the Brazilian product, or creates an umbrella effect that causes orange juice from both the USA and Brazil to be purchased. $Z1_t$ through $Z5_t$ are seasonal measures of demand with the same objectives and expected behavior as in previous market demand structure specifications.

Equation 22 describes the derivation of Brazil's FCOJ export price to EEC7 ($XPFEB_t$). $XPFEB_t$ is expected to be positively related to the USA export price of FCOJ to the same market. Orange production in São Paulo enters the equation under the same specification as in the previous case ($PdSp_{t-6}$) and with the same negative expected relationship.

Exchange rate in this case is summarized as an index value of the Brazilian cruzeiro against currencies of EEC7 countries.[19] Its effect on the export price from Brazil to EEC7 ($XPFEB_t$) is expected to be positive, since the index is an inverse function of the exchange rate values of individual countries. For example, if exchange rates associated with individual countries increase (devaluations), then the index is expected to decrease as would the corresponding export price.

USA FCOJ Exports to the EEC7

The USA export quantity of FCOJ to the EEC7 ($XQFES_t$), as specified by Equation 23, has the same logical formulation as discussed in the Brazilian case, with the only difference being that AE_t now is expected to have a positive effect on the USA FCOJ export demand to the EEC7 market.

USA export price to the EEC7 (Equation 24) is hypothesized to be positively related to Florida's FCOJ wholesale prices ($WPFFl_t$), to the import prices of FCOJ by the USA from Brazil and from other countries ($MPFSB_t$ and $MPFSOc_t$), and to the USA exchange rate index for the EEC7 countries ($RxSE_t$). Florida's FCOJ wholesale price ($WPFFl_t$) has, as already discussed, a direct and an indirect role in the derivation of export prices. Directly, since an increase in the wholesale price is likely to lead to an increase in export

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[19]For more details on the construction of the exchange rate index see Appendix D.

prices, and indirectly through price spreads in the derivation of FCOJ imports into the USA that may be used to average down export prices. This last rationale also explains the role of FCOJ import prices by the USA in the export price equation.

Brazilian and USA FCOJ Exports to the European non-EEC3

The formulation of the European non-EEC3 market structure for FCOJ from Brazil and USA is conceptually the same as in the case of the EEC7 market. Equations 25 through 28 are the same as 21 through 24 except that N in these formulations means the European non-EEC3 countries.

Estimation

This section provides a brief discussion[20] of a system of simultaneous linear equations and of its major elements, the procedure used to estimate the empirical model, and a test of model validation.

From previous discussions in this chapter with regard to the theoretical setting and model formulation the simultaneous nature of the economic model of this study is quite clear. Most equations in the system include more than one endogenous[21] variable. This condition introduces a

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[20]Most of this discussion is organized from Goldberger, 1964; Kennedy, 1979; Kmenta, 1971; and Maddala, 1977.

[21]In the economic model there are 28 endogenous variables as defined by equations 1 through 28 (left hand side variables) and, among the explanatory variables (right hand side variables), 41 are predetermined variables (the ones that are explanatory, but not current endogenous variables).

violation in the set of assumptions of the classical linear regression model. If endogenous variables are used as explanatory variables it can be proved (Goldberger, 1974, p. 305-306) that they are contemporaneously correlated with the error term in all other equations in the system. As a result, the ordinary least squares (OLS) estimator would be biased, even asymptotically, and, consequently, an alternative estimator should be used.

By adding an error term to each behavioral equation of the system formulated in the previous section (called economic model), the econometric model of this study is formally specified in the so-called structural form. In matrix notation, the whole structure can be written as:

$$\beta Y(t) + \Gamma X(t) = U(t) \tag{29}$$

where β is the M by M matrix of coefficients of the endogenous variables; Y(t) is the M by 1 row vector of the tth observation on the endogenous variables; Γ is the M by K matrix of coefficient of the predetermined variables; X(t) is the K by 1 row vector of the tth observation on the predetermined variables; and U(t) is the M by 1 row vector of the tth (unobserved) values of the error terms.

Each error term should satisfy the assumptions of the classical linear regression model, that is, in matrix notation,

$$U(t) = N(0,\Phi), \tag{30}$$

$$E[U(t)U'(s)] = 0, \ t \neq s \tag{31}$$

and, $E[U(t)U'(s)] = \Phi$, $t=s$ (32)

where Φ is the M by M variance-covariance matrix (non-negative definite)[22] of the structural error term. The underlying assumptions imply that each structural error vector (a) is normally distributed with mean zero and constant (homoskedastic) unknown variance and (b) is nonautoregressive, implying that error terms are contemporaneously uncorrelated.

If the structural-form of the system (Equation 29) is solved for the endogenous variables, that is, by expressing endogenous variables in terms of predetermined variables and error terms, the result is the so-called reduced-form of the system (Equation 33 or 34).[23]

$$Y(t) = -\beta^{-1}\Gamma X(t) + \beta^{-1}U(t) \tag{33}$$

$$Y(t) = \Pi X(t) + V(t) \tag{34}$$

Equations 33 and 34 are called, respectively, restricted and unrestricted versions of reduced-form equations of the system. If structural-form estimates are used to derive the reduced-form (Equation 33), restrictions imposed on the structural-form formulation are accounted for through the estimates of β and Γ. The same is not necessarily true if

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[22] In the case of existence of identities, Φ refers only to the equations that are not identities.

[23] In solving for reduced form, the matrix β in Equation 29 is implicitly assumed to be a nonsingular matrix.

the reduced-form parameters are estimated directly on the predetermined variables (Equation 34). From a direct comparison of these two equations, if follows that:

$$\Pi = -\beta^{-1} \tag{35}$$

and

$$V(t) = \beta^{-1}U(t) \tag{36}$$

where Π is the M by K matrix of reduced-form coefficients of predetermined variables, and V(t) is the M by 1 row vector of the tth (unobserved) values of the reduced-form error terms.

The variance-covariance matrix (Ψ) of the reduced-form error terms can be proved to be given by

$$\Psi = \beta^{-1}\Phi(\beta^{-1})' \tag{37}$$

It should be pointed out that in the reduced-form system each endogenous variable is expressed in terms of only predetermined variables and an error term, after accounting for the interdependence among current endogenous variables. Thus, a given reduced-form coefficient indicates the total effect of a change in its respective predetermined variable on the corresponding endogenous variable, assuming that other variables are held constant. These reduced-form coefficients are called long-run multipliers associated with the model (Kennedy 1979, p. 107). In contrast, a structural-form coefficient indicates only its variable partial direct

effect on the respective dependent endogenous variable. However, estimates of the structural-form coefficients are quite important for identifying the underlying economic hypotheses used as major support in developing the model. Thus, depending on a study's objectives, different strategies can be used to estimate reduced-forms--directly from values of predetermined variables as in Equation 34, or deriving it, as in Equation 33, by first estimating structural-form parameters. Associated with these strategies is the identification problem in simultaneous equation systems. It is a mathematical problem of going from estimates of the reduced-form structure back to meaningful estimates of the structural-form parameters. An equation can be said to be overidentified, or exactly identified, or underidentified by zero restrictions on certain parameters, if there are more than enough, or exactly enough, or less than enough predetermined variables excluded from the given equation to act as instruments of endogenous explanatory variables used in that equation. By applying the usual tests for identification (rank and order conditions), the structural-form equations of this study were found to be overidentified.

Various procedures are suggested in the literature to estimate a system of simultaneous equations. Based on the objectives of this study, the problems associated with the

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[24] A summary of these procedures is presented by Kennedy, 1979, p. 112-126.

formulation of its model,[25] the nature of the model identification problem, and major characteristics of available procedures, the two-stage least squares (2SLS) procedure was chosen to estimate the parameters of the over-identified structural-form equations of the system. This procedure not only gives consistent estimators of the structural parameters, but studies have also shown it to have small-sample properties superior on most criteria to all other estimators, in addition to being quite robust (Kennedy 1979, p. 115). However, 2SLS estimators are not invariant with respect to the endogenous variable which is normalized. One would like this property in a simultaneous equation estimator. Basically, the 2SLS procedure requires that, in the first stage, each endogenous variable acting as explanatory variable be regressed on all the predetermined variables of the system (estimation of the reduced-form version) and their estimated values are calculated. In the second stage these estimated values (called instrumental variables) of endogenous variables and the included exogenous variables are used in an OLS regression.

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[25]There are some errors of specification in the formulation of the structural form version of the model, especially in the case of Canadian and European market structures, where lack of systematic data for retail and wholesale sectors forced the formulation of only import equations. Available retail and/or wholesale variables were used as explanatory variables of import equations. Single-equation estimation procedures are said to keep these misspecification problems within their source in the system, rather than to incorporate them in the estimates of all the structural parameters as in the case of systems methods procedures (Kennedy, p. 116).

For testing how well values predicted by the model conform to observed data, a test based on the ratio of the root mean square error to the respective observed mean value of endogenous variables for different periods within the data range is used. For a given endogenous variable and the ith time period, the ratio (RM_i) is given by

$$RM_i = \left[\frac{\sum_{t=1}^{N_i} (P_t - A_t)^2}{N_i} \right]^{\frac{1}{2}} / M_i \tag{38}$$

Where, P_t and A_t stand, respectively, for predicted (forecasted) and actual (observed) values; N_i is the number of observations in the ith time period; and M_i is the corresponding observed mean value of the endogenous variable. This ratio will give an idea of the magnitude of the forecast error relative to the respective actual mean value for the endogenous variable in consideration.

CHAPTER IV

EMPIRICAL RESULTS AND IMPLICATIONS

This chapter is organized in two major parts with the common goal of discussing the empirical results and implications of estimates of the statistical model. In the first section, 2SLS estimates of the structural-form equations are presented and discussed. In the second section, estimates of the derived reduced-form equations are presented and discussed. Validation tests of the model in its derived reduced-form version are also presented and discussed in the second section.

Estimates of the Structural-Form Equations

In this section, the structural-form estimates of the model are presented and discussed for each of the four markets in this study. Special emphasis is given to the implications of these results within a given market context and to the market supply sources. Economic analysis in this section is intended to evaluate the underlying theoretical framework of the model, as well as particular implications of the results. Comparisons with other findings are also made, whenever possible.

Explanatory variables are listed in the tables as the respective structure where theoretically specified in the

model. This, however, does not necessarily mean that all of those variables are included in the final estimates of the equation.

The USA Market

Most of the structural-form equations were estimated as stated in the theoretical formulation in Chapter III. However, some variables were deleted from specific equations due to multicolinearity,[1] plausibility of the respective signs, and/or the magnitude of a given estimate relative to its standard error. In this particular market, only the equations concerning FCOJ imports from Brazil (Equations 8 and 9), and the equations for the wholesale level of other orange juices in Florida (Equations 13 and 14) deviate from the theoretical specification. Practically, all signs of the estimated coefficients were as theoretically hypothesized.[2] Most of the estimated coefficients are considerably larger than their estimated standard errors.

Retail FCOJ

Structural-form estimates for retail FCOJ demand ($RQFS_t$) and the price ($RPFS_t$) equations are presented in Tables 14 and 15. Except for $RPOS_t$ in the FCOJ retail demand equation,

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[1]Multicolinearity was detected based on the estimates of the correlation matrices of the parameters. Only extremely high levels of multicolinearity were regarded as major problems, given that 2SLS has been shown to be quite insensitive to this problem (Kennedy 1979, p. 115).

[2]Means, standard deviations and coefficients of variation for variables used in the model are presented in Appendix F.

Table 14. Structural-form estimates of the FCOJ retail demand equation in the USA market ($RQFS_t$, Equation 1)

Explanatory variables[a]	Coefficient	Standard error
Intercept	204.6033	238.2164
Endogenous variables		
$RPFS_t^-$	-98.6950	68.8457
$RPOS_t^+$	-112.2447	59.4951
Predetermined variables		
$RPShS_t^+$	128.9164	73.3681
IS_t^+	62.1050	28.7421
AS_t^+	1.4025	1.1662
AS_{t-1}^+	.8982	.8695
$Z1_t$	17.5453	8.4340
$Z2_t$	14.2254	8.2063
$Z3_t$	-10.2295	7.4022
$Z4_t$	-20.6681	8.3289
$Z5_t$	-10.9591	7.3398

[1]Variable superscript indicates the a priori expected sign.

Table 15. Structural-form estimates of the FCOJ retail price equation in the USA market ($RPFS_t$, Equation 2)

Explanatory variables[1]	Coefficient	Standard error
Intercept	.4532	.0801
Engodenous variables		
$WPFF1_t^+$	.8201	.1780
Predetermined variables		
$WPFF1_{t-1}^+$	.2638	.1759

[1]Variable superscript indicates the a priori expected sign.

all other coefficients were consistent with expectations. The negative effect of prices of other orange juices ($RPOS_t$) on retail FCOJ demand (Table 14) does not necessarily imply a departure from the theoretical setting where a positive response was expected. Similar problems of consistency in orange juice demand estimates were reported by Tilley (1979), Ward and Tilley (1980), and Malick (1980). A common agreement of these studies is that no statistical substitution evidences were found between FCOJ and chilled orange juice (COJ). Tilley, and Ward and Tilley also found that canned single strength orange juice (CSSOJ) was negatively related to FCOJ demand.[3] The net effect of a change in the price of any commodity (P_j) on the quantity demand of any other good (Qi) can be decomposed into a substitution effect and an income effect (Phlips, 1974, p. 40-47).[4] Since the income effect of price changes is not necessarily symmetric and that it will be larger for a commodity which takes a larger proportion of total expenditures (Tomek & Robinson, 1981, p. 56), then the negative effect of $RPOS_t$ on the demand for FCOJ does not necessarily invalidate the expected substitute characteristic between the two products. This result should also be

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[3]It should be recalled that in this study orange juices are grouped as frozen concentrated (FCOJ) and other orange juices. The latter includes all other forms of orange juices but FCOJ. At retail level, other orange juices group is basically chilled and canned single strength (COJ and CSSOJ).

[4]In terms of partial derivatives such decomposition can be written as $Qi/\partial Pj = Kij - Qj\ (\partial Qi/\partial Y)$, where Kij is the substitution effect and $Qj\ (\partial Qi/\partial Y)$ is the income effect. Note that $Qj\ (\partial Qi/\partial Y)$ is not necessarily equal to $Qi\ (\partial Qj/\partial Y)$.

independent of secondary reasons leading consumers to purchase the two products.[5] To rationalize such results, it is necessary to have a larger absolute value of the income effect relative to the substitution effect and that the FCOJ share of total expenditures be relatively larger than the share of other orange juices, which seems to be the case.

Among the other explanatory variables of retail FCOJ demand in the USA, income (IS_t) and seasonality ($Z1_t$ through $Z5_t$) seem to be quite important. The estimated income coefficient is more than twice its standard error, suggesting that FCOJ consumption is quite sensitive to changes in real income per capita. Seasonal estimates suggest that FCOJ consumption increases during relatively colder months (October to March) and declines during those months that are relatively warmer (April to September). Estimated coefficients for advertising variables (AS_t and AS_{t-1}), even though positive are only slightly greater than their respective standard errors. Price of frozen orange-flavored synthetics and drinks ($RPShS_t$) was found to be positively related to $RQFS_t$, as expected, suggesting a substitution relation between the two products. Retail price of FCOJ (Table 15) was found to be highly sensitive to current and lagged wholesale prices of FCOJ in Florida ($WPFFl_t$ and $WPFFl_{t-1}$).

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[5]Ward and Tilley (1980, p. 10) argued that the failure of their estimates to show substitution between FCOJ and COJ is likely to be related to consumer convenience (by purchasing COJ) versus storability (by purchasing FCOJ).

Estimated elasticities and flexibilities evaluated at the means of the variables from the structural-form estimates of the model are presented in Appendix G. It should be emphasized, however, that these structural-form elasticity and flexibility estimates are partial, in the sense that they indicate only the respective direct effect within a given equation. Total effects of changing predetermined variables on endogenous variables and the consequent effects among endogenous variables will be presented in the discussion of the estimates of the derived reduced-form equations.

The value of the own-price elasticity is estimated to be -.4180 and the income estimate is .8948. In the derivation of retail prices ($RPFS_t$), changes in current and lagged FCOJ wholesale prices in Florida ($WPFFl_t$ and $WPFFl_{t-1}$) are quite important with current and lagged price transmission elasticities estimated to be .5328 and .2642.

Wholesale FCOJ

Tables 16 and 17 present the estimated coefficients of the wholesale FCOJ structure in Florida. All estimates have signs consistent with the conceptual formulation and most of them are large relative to their respective standard errors.

Among the major determinants of wholesale FCOJ demand in Florida (Table 16), retail consumption of other orange juices ($RQOS_t$) seems to play a significant role, given that the estimated coefficient is almost four times larger than

Table 16. Structural-form estimates of the FCOJ wholesale demand equation in Florida ($WQFFl_t$, Equation 3)

Explanatory variables[1]	Coefficient	Standard error
Intercept	136.0881	323.6901
Endogenous variables		
$WPFFl_t^-$	-358.6431	171.2662
$WPOFl_t^+$	245.0809	117.8307
$RQFS_t^+$	.5817	.6550
$RQOS_t^+$	1.4439	.4033
Predetermined variables		
$Z1_t$	60.1773	27.9097
$Z2_t$	41.7583	28.7496
$Z3_t$	-11.8118	25.9771
$Z4_t$	18.1411	29.7190
$Z5_t$	32.2708	29.1060

[1]Variable superscript indicates the a priori expected sign.

Table 17. Structural-form estimates of the FCOJ wholesale price equation in Florida ($WPFFl_t$, Equation 4)

Explanatory variables[1]	Coefficient	Standard error
Intercept	2.3476	.1845
Endogenous variables		
$WSkFS_t^-$	-.0138	.0165
Predetermined variables		
$WSkFS_{t-1}^-$	-.0275	.0168
PdS_t^-	-3.4918	1.2589
PdS_{t-1}^-	1.8793	1.2442
D_t^+	.2874	.0560
T_t^-	-.0050	.0020

[1]Variables superscript indicates the a priori expected sign.

its standard error. As retail sales of other orange juices increase the wholesale demand for FCOJ also increases, since wholesale FCOJ in this formulation includes the product in bulk form that can be reconstituted into chilled and canned single strength orange juices. The poor response of Florida's wholesale FCOJ sales to changes in current FCOJ retail consumption reflects the relative stability of FCOJ consumption rate in the USA and the ability of retailers to sell from accumulated inventory. Seasonal variations in Florida's wholesale FCOJ demand are quite consistent with the retail market where greater sales are in colder bimonths (December-January and February-March).

All of Florida's wholesale FCOJ price function variables (Table 17) had coefficients more than 1.5 times their respective standard errors, except current stocks ($WSkFS_t$). Orange production forecasts seem to have a major role in the determination of Florida's wholesale FCOJ prices. Current and previous crop estimates (PdS_t and PdS_{t-1}) have a strong effect on Florida's wholesale FCOJ prices, showing that processors anticipate future orange supplies. The effects of the freeze on Florida's wholesale FCOJ price as measured by the estimated coefficient of the dummy variable D_t are quite significant. The result indicates that after a freeze, $WPFFl_t$ is likely to increase by 29 cents per single strength equivalent gallon, assuming that all other price determinants do not change. The linear time trend variable (T_t) accounting for time-related changes in the wholesale FCOJ

price had a negative estimated coefficient, meaning a net decrease in the $WPFFl_t$ over time.

Structural-form elasticity and flexibility estimates for Florida's wholesale FCOJ sector are in Appendix G. The wholesale FCOJ own-price elasticity estimate is -.6618 which is relatively more elastic than the corresponding elasticity at retail level (-.4180). Ward's (1976a) estimate of Florida's wholesale FCOJ domestic demand elasticity (-.5230) is not greatly different from the estimate in this study. The cross-price elasticity with respect to wholesale price of other orange juices in Florida ($WPOFl_t$) is estimated to be .6141, indicating that if processors raised $WPOFl_t$ by 1 percent, FCOJ wholesale movement is likely to increase by a little more than .5 percent. FCOJ and other orange juices retail price transmission elasticities are similar in magnitudes (.3901 and .3621, respectively).

Wholesale FCOJ prices in Florida are practically insensitive to changes in current and lagged FCOJ stocks in the USA ($WSkFS_t$ and $WSkFS_{t-1}$) as measured by the respective values of stock flexibilities (-.0374 and -.0742). Orange production forecast flexibilities indicate that a one percent increase (decrease) in current and previous crop estimates (PdS_t and PdS_{t-1}) will be associated with a .7959 and .4276 percent decline (increase) in the wholesale price of FCOJ.

FCOJ Imports from Brazil

In the structural-form equations (Tables 18 and 19) for the USA FCOJ Brazilian import (quantity and price), most of the variables have estimated coefficients larger than their associated standard errors. Stock variables ($WSkFS_t$, $WSkOS_t$ and lags) were deleted from the final estimates due to their persistent sign inconsistencies and multicolinearity with other variables in the model. Price spread (SpB_t) carries in its definition ($WPFFl_t$ - $MPFSB_t$) the effects of FCOJ stocks on imports through the derivation of the wholesale FCOJ price in Florida ($WPFFl_t$). Wholesale demanded quantity of other orange juices ($WQOFl_t$) includes the effects of the respective level of stocks on FCOJ imports through the specification of wholesale price of other orange juices. The FCOJ import price for the USA from other countries ($MPFSOc_t$) was excluded, given its high correlation with the import price from Brazil ($MPFSB_t$) already included in the formulation of the price spread (SpB_t). Current and lagged wholesale price of other orange juices in Florida ($WPOFl_t$ and $WPOFl_{t-1}$) were deleted from the USA FCOJ import equation (Table 19) due to their very low coefficients relative to the corresponding standard errors.

The price spread (SpB_t) coefficient in the structural-form import equation indicates that a 10 cent increase in the difference between Florida's wholesale FCOJ price ($WPFFl_t$) and the import price from Brazil ($MPFSB_t$) is likely to increase FCOJ imports from Brazil by practically 11 single strength juice equivalent gallons per thousand persons.

Table 18. Structural-form estimates of the USA FCOJ import demand equation from Brazil ($MQFSB_t$, Equation 7)

Explanatory variables[1]	Coefficient	Standard error
Intercept	-188.1535	52.7638
Endogenous variable		
SpB_t^+	107.4650	61.1746
$WQOFl_t^+$	1.2070	.3265
$WSkFS_t^-$	--	--
$WSkOS_t^-$	--	--
Predetermined variables		
$WSkFS_{t-1}^-$	--	--
$WSkOS_{t-1}^-$	--	--
$MPFSOc_t^+$	--	--
$Z1_t$	11.7234	21.5108
$Z2_t$	-16.3451	21.6607
$Z3_t$	-21.5905	20.8051
$Z4_t$	-29.9382	21.0097
$Z5_t$	-22.6145	21.0708

[1]Variable superscript indicates the a priori expected sign.

Table 19. Structural-form estimates of the USA FCOJ import price equation from Brazil ($MPFSB_t$, Equation 9)

Explanatory variables[1]	Coefficient	Standard error
Intercept	-.1058	.4830
Endogenous variables		
$WPFFl_t^+$	.2332	.1715
$WPOFl_t^+$	--	--
Predetermined variables		
$WPFFl_{t-1}^+$	.4637	.1683
$WPOFl_{t-1}^+$	--	--
$PdSp_{t-6}^-$	-.7697	.5799
$RxBS_t^-$	-.0095	.0579

[1]Variable superscript indicates the a priori expected sign.

Widening the price spread for a given import tariff, or reducing the tariff level for a given price spread would result in an increase in FCOJ imports into the USA. Thus the effects of price spread changes are equivalent to the effects of changing tariff on imports. However, since a change of tariff has associated with it some change in the structure of exports related to a given duty drawback provision, then the effects of changing tariff may differ from the effects of changing price spreads (Ward, 1976a). Estimated coefficients for seasonal variables do not seem to have significant impact on FCOJ imports from Brazil.

Import price equation coefficient estimates (Table 19) support the conceptual hypotheses that the USA FCOJ import price from Brazil is determined by Florida's wholesale price and São Paulo state orange production. If other factors are kept constant, a 10 cent change in Florida's current wholesale price for FCOJ ($WPFFl_t$) is likely to result in a 2.3 cent increase in the import price ($MPFSB_t$). Likewise, a 10 cent increase in Florida's previous wholesale price ($WPFFl_{t-1}$) will result in a 4.6 cent increase in $MPFSB_t$. Thus, the combined current and lagged effect coefficients indicate that approximately 7 cents of any 10 cent change in Florida prices will be reflected in a change in the Brazilian price. So, given a change in $WPFFl_t$, Brazilian exporters do not fully readjust their prices immediately. Orange production in the state of São Paulo in the previous year ($PdSp_{t-6}$) had an estimated coefficient of -.7697.

Brazilian exchange rate policy appears to have no significant impact on FCOJ import price in the USA, given the absolute magnitude of the estimated coefficient for $RxBS_t$ (cruzeiros per USA dollar) and its size relative to its standard error. However, as was pointed out in the model formulation, such results were likely to come about, since exchange rates are directly controlled by the government in Brazil. Current rates of cruzeiros per dollar are set almost every month so as to keep this relation at some constant value.

Structural-form elasticity and flexibility results are shown in Appendix G. A price spread elasticity[6] of 1.6607 indicates that for each 1 percent increase in the spread of imports into the USA from Brazil should increase by nearly 1.7 percent. Wholesale other orange juice transmission elasticity is 5.0697 indicating that a 1 percent increase in $WQOF1_t$ will increase USA FCOJ imports from Brazil by more than 5 percent.

Current and lagged FCOJ wholesale price transmission elasticities (.5123 and 1.0201) indicated that current import price adjustment due to changes in $WPFF1_{t-1}$ is almost twice as large as adjustment relative to changes in current wholesale prices in Florida ($WPFF1_t$). That is, a 1 percent increase in $WPFF1_t$ in the current bimonth will result in

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[6]Ward's (1976a) study using double-log forms for a system of simultaneous equations and quarterly data estimated the price spread elasticity for Florida's FCOJ imports from Brazil as 2.6986.

nearly .5 percent increase in $MPFSB_t$, while the same change in Florida's FCOJ wholesale price in the previous bimonth will result in more than a 1 percent increase in current import price from Brazil. Exchange rate transmission elasticities (-.1642) indicate that for each 1 percent increase in rate of cruzeiros per dollar, the USA import price from Brazil will decrease by less than .2 percent. Likewise, an increase in orange production in the state of São Paulo in the previous year is likely to reduce $MPFSB_t$ by only .1 percent.

Retail and Wholesale Other Orange Juices

Structural-form estimates for other orange juices at retail level in the USA and at wholesale level in Florida are presented in Tables 20 through 23. Most of the variables in the final estimated structures are large relative to their respective standard errors. Wholesale FCOJ price was excluded from Equation 13 (Table 22) and lagged wholesale stock of other orange juices was excluded from Equation 14 (Table 23), due to their small coefficient values relative to their respective standard errors.

As expected from the conceptual formulation , retail FCOJ prices are positively related to retail quantity of other orange juices indicating that FCOJ is a substitute for other orange juices (Table 20). This result supports the argument developed in the discussion of retail FCOJ demand estimates in the sense that other orange juices are expected to take a relatively small share of total expenditures and

Table 20. Structural-form estimates of the other orange juices retail demand equation in the USA market ($RQOS_t$, Equation 10)

Explanatory variables[1]	Coefficient	Standard error
Intercept	-425.7334	190.1408
Endogenous variables		
$RPOS_t^-$	-136.6758	47.4881
$RPFS_t^+$	101.2446	54.9516
Predetermined variables		
$RPShS_t^+$	140.3181	58.5613
IS_t^+	89.8842	22.9415
AS_t^+	.2961	.9308
AS_{t-1}^+	.3790	.6941
$Z1_t$	-2.1561	6.7319
$Z2_t$	-2.8706	6.5502
$Z3_t$	-7.7425	5.9083
$Z4_t$	-1.6839	6.6480
$Z5_t$	4.0167	5.8585

[1]Variable superscript indicates a priori expected sign.

Table 21. Structural-form estimates of the other orange juices retail price equation in the USA market ($RPOS_t$, Equation 11)

Explanatory variables[1]	Coefficient	Standard error
Intercept	.8159	.1128
Endogenous variables		
$WPOFl_t^+$	.1447	.2267
$RpOS_t^-$	-.2241	.1163
Predetermined variables		
$WPOFl_{t-1}^+$	.8336	.2134

[1]Variable superscript indicates the a priori expected sign.

Table 22. Structural-form estimates of the other orange juices wholesale demand equation in Florida ($WQOF1_t$, Equation 13)

Explanatory variables[1]	Coefficient	Standard error
Intercept	91.9673	9.4146
Endogenous variables		
$WPOF1_t^-$	-24.9021	6.7257
$WPFF1_t^+$	--	--
$RQOS_t^+$	.5831	.0303
Predetermined variables		
$Z1_t$	15.3357	3.2232
$Z2_t$	14.4719	3.2403
$Z3_t$	6.7412	3.2245
$Z4_t$	13.0681	3.2259
$Z5_t$	12.1645	3.2198

[1]Variables superscript indicates the a priori expected sign.

Table 23. Structural-form estimates of other orange juices wholesale price equation in Florida ($WPOFl_t$, Equation 14)

Explanatory variables[1]	Coefficient	Standard error
Intercept	2.3323	.1961
Endogenous variables		
$WSkOS_t^-$	-.0209	.0334
Predetermined variables		
$WSkOS_{t-1}^-$	--	--
PdS_t^-	.3179	1.3543
PdS_{t-1}^-	-4.4162	1.3513
D_t^+	.3163	.0549
T_t^-	-.0056	.0023

[1]Variable superscript indicates the a priori expected sign.

consequently the income effect should be smaller in absolute value. Thus, the net cross-price effect on $RQOS_t$ from changes on $RPFS_t$ is positive. Similar results were found by Tilley (1979), and Ward and Tilley (1980). Other orange juices retail demand in the USA ($RQOS_t$) is quite sensitive to income changes and quite insensitive to advertising expenditures. Seasonality seems to have no practical effects on the consumption of other orange juices as measured by the $Z1_t$ through $Z5_t$ estimated coefficients and respective standard errors.

Lagged wholesale prices in Florida ($WPOF1_{t-1}$) and the proportion of other orange juices sold in cardboard containers ($RpOS_t$) are quite important determinants of the retail price of other orange juices (Table 21). A 10 cent increase on $WPOF1_{t-1}$ is likely to increase current retail prices ($RPOS_t$) by more than 8.3 cents per gallon.

All coefficients for the variables included in the estimates of other orange juices' wholesale movement in Florida (Table 22) are large relative to their respective standard errors. Seasonal variable ($Z1_t$ to $Z5_t$) estimates indicate that other orange juice movement is practically uniform during the season. Only during the bimonth of April and May ($Z3_t$) does the movement of other orange juice increase by nearly half of the increments in the other bimonths.

Empirical estimates for the other orange juice wholesale price equation (Table 23) indicate that the

lagged orange production forecast in the USA (PdS_{t-1}), freeze effects (D_t), and time-related changes in prices (T_t) are important factors determining price. The effect of freeze seems to be very relevant since its occurrence is likely to increase $WPOFl_t$ by approximately 31 cents per gallon in real terms. Other orange juice stocks in the USA ($WSkOS_t$) do not have important effects on Florida's wholesale prices ($WPOFl_t$), as indicated by the coefficient value relative to its standard error.

Structural-form elasticity and flexibility estimates for retail and wholesale other orange juices are presented in Appendix G. Most of the explanatory variables of consumption of other orange juices in the USA ($RQOS_t$) have elastic responses. Consumption of other orange juices is expected to increase by 3.4629, 1.5593 and 1.1466 percent for each 1 percent increase in income, in price of orange-flavored synthetics and drinks, and in retail FCOJ prices, respectively. Retail and other orange juices own-price elasticity is estimated to be -2.0587, indicating that consumption of other orange juices exhibits elastic responses to changes in price ($RPOS_t$).

Lagged other orange juices wholesale price ($WPOFl_{t-1}$) transmission elasticity (.5561) indicates that $RPOS_t$ increase by more than .5 percent for each 1 percent increase in Florida's wholesale prices. The flexibility estimated for the retail proportion of other orange juices in cardboard containers (-.0521) suggest a quite small reduction on $RPOS_t$ for each 1 percent increase in the proportion.

The own-price elasticity ($WPOFl_t$) for Florida's movement of other orange juices is estimated to be -.2284. Other orange juices retail transmission elasticity (.5352) indicates that a 1 percent increase in the consumption of this product in the USA ($RQOS_t$) is likely to cause an increase of nearly .5 percent in Florida's wholesale movement of the product.

Among the estimated flexibilities for Florida's wholesale prices ($WPOFl_t$) only the flexibility relative to lagged orange production forecast (-.7400) suggests that each 1 percent increase in previous crop forecast is likely to result in a reduction of current Florida's wholesale price of other orange juices by approximately .7 percent. Adjustments in wholesale orange juice prices to changes in crop forecasts by Florida processors are different, depending on the product. The previous discussion indicated that Florida's FCOJ prices are relatively more affected by changes in current orange production forecasts. The results presented for other orange juices, however, indicated that Florida's wholesale prices for this product respond more slowly to changes in the crop forecast.

The Canadian Market

Canadian structural-form equations for FCOJ exports from Brazil and the USA were estimated in a form almost identical to the conceptual structure developed in Chapter III. Only two variables were deleted from the formulation.

Canadian import prices of FCOJ from other countries ($MPFCOc_t$) were excluded from the quantity equations, given extremely high levels of multicolinearity with FCOJ prices from the USA and Brazil. In the USA export price equation to Canada ($XPFCS_t$) import price from other countries ($MPFSOc_t$) was also excluded, given its high level of multicolinearity with import prices from Brazil ($MPFSB_t$).

Most of the parameters have estimated coefficients with signs consistent with expectations. However, in the USA FCOJ export equation to Canada, the unexpected signs of the estimatd coefficients for Brazil's export prices ($XPFCB_t$) and current Florida's advertising expenditures (AC_t) do not appear to create any serious problem for the model, since the estimate relative to $XPFCB_t$ is not large relative to its standard error, and the cumulative impact of advertising (current and lagged) is still consistent with expectations.

Brazilian FCOJ Exports to Canada

Parameter estimates for most of the variables included in the structural-form equations of Brazil's FCOJ exports to Canada are large relative to their respective standard errors (Tables 24 and 25). Brazilian FCOJ exports to Canada (Table 24) were found to be negatively related to Brazil's price ($XPFCB_t$) and positively related to the USA FCOJ and other orange juices export prices to Canada ($XPFCS_t$ and $XPOCS_t$). This last relationship shows that, for each 10 cents per gallon increase in the prices of FCOJ and other

Table 24. Structural-form estimates of Brazil FCOJ export demand equation to Canada ($XQFCB_t$, Equation 17)

Explanatory variables[1]	Coefficient	Standard error
Intercept	-1390.2600	375.9153
Endogenous variables		
$XPFCB_t^-$	-405.7944	253.2894
$XPFCS_t^+$	412.5790	292.5199
Predetermined variables		
$MPFCOc_t^+$	--	--
$XPOCS_t^+$	505.7004	176.0427
IC_t^+	134.4298	58.9665
AC_t^+	6.4238	13.6043
AC_{t-1}^+	3.0683	15.1706
$Z1_t$	-32.2467	67.6270
$Z2_t$	7.6037	83.9818
$Z3_t$	-7.4476	89.0928
$Z4_t$	-62.2866	63.8325
$Z5_t$	-8.6692	59.2104

[1]Variable superscript indicates the a priori expected sign.

Table 25. Structural-form estimates of Brazil FCOJ export price equation to Canada ($XPFCB_t$, Equation 18)

Explanatory variables[1]	Coefficient	Standard error
Intercept	-.0124	.4093
Endogenous variables		
$XPFCS_t^+$	.7089	.0738
Predetermined variables		
$PdSp_{t-6}^-$	-.2872	.5156
$RxBC_t^-$	--	--
$RxBS_t^-$	-.0347	.0498

[1]Variable superscript indicates the a priori expected sign.

orange juices exports from the USA to Canada, Brazilian FCOJ exports to the same market will increase by approximately 41 and 51 gallons per thousand persons, respectively. Thus, the Brazilian product seems to be quite sensitive to changes in price policies of the USA products in Canada. The Tilley and Lee (1981) study on Canadian FCOJ imports also emphasized that the USA exerts a strong competitive impact on Brazil's ability to export to Canada. Income changes in Canada were found to affect Brazil's FCOJ exports to the Canadians. However, Florida's advertising programs in Canada appear to have no practical effects on export demand of the Brazilian product, since advertising parameters estimates (AC_t and AC_{t-1}) are quite small relative to their corresponding standard errors. This indicates that Brazilian exports to Canada do not benefit from Florida's FCOJ promotional programs in that market. Seasonal coefficients estimates ($Z1_t$ to $Z5_t$) indicate that there is no important seasonal variation.

The Brazilian export price of FCOJ to Canada (Table 25) is determined by the USA price to the same market ($XPFCS_t$). For each 10 cent change in the USA price per gallon, the price of FCOJ from Brazil increases approximately 7 cents. The estimated coefficients is almost ten times its standard error. These results conform with previous hypotheses that the USA prices have an extremely important role in the derivation of Brazil's FCOJ export price to Canada. Other variables in equation 18 ($PdSp_{t-6}$ and $RxBS_t$) do not appear

to have significant effects on the price determination. Both estimated coefficients are small relative to their estimated standard errors, even though their signs conform with a priori expectation. As anticipated, given the government policy, the exchange rate variable relating cruzeiros per USA dollar ($RxBS_t$) had an estimated coefficient with the right sign, but it was small relative to its standard error.

Estimates of structural-form elasticities and flexibilities (Appendix G) summarize the previous discussion of Brazilian FCOJ export structures in Canada. FCOJ exports were found to be responsive to own-price, to the price of alternative products and to income. Each 1 percent change in XPFCB, is associated with more than 1 percent change in the opposite direction in Brazil's FCOJ exports to Canada (-1.1884). Likewise changes in alternative product prices ($XPFCS_t$ and $XPOCS_t$) cause a change in Brazilian FCOJ exports to Canada in the same direction by almost 3 percent in the case of the USA FCOJ prices (2.8003) or 4 percent in the case of the USA prices of other orange juices (3.9404). The income elasticity (3.8719) indicates that Brazilian exports of FCOJ to Canada will increase by approximately 4 percent for each 1 percent increase in income per capita in Canada. Florida's advertising elasticities (.1368 and .0659) indicate that Canadian demand for FCOJ from Brazil is relatively insensitive to current and lagged promotional expenditures on Florida's products in Canada.

The export price transmission elasticity (1.6429) relative to FCOJ from the USA gives another measure of the importance of this variable in the derivation of Brazil's export price to Canada. For each 1 percent increase in $XPFCS_t$, the $XPFCB_t$ is likely to increase by more than 1.6 percent. The estimated flexibility for lagged orange production in the state of São Paulo (-.0475) supports the previous conclusion that crop changes have no major effects on future export prices to Canada.

USA FCOJ Exports to Canada

Tables 26 and 27 present the structural-form estimates for the USA FCOJ Canadian market equations. The export demand equation (Table 26) has some estimated coefficients that are not greater than their respective standard errors and/or signs that do not conform with a priori expectation. Even though exports are negatively related to export price ($XPFCS_t$) as conceptually formulated the estimated coefficient is small relative to its standard error. Tilley and Lee (1981) also found a negative relation. Products expected to behave as substitutes for FCOJ from the USA in this market appear to have no significant effect on the demand for the USA product. The Brazilian FCOJ price ($XPFCB_t$) coefficient is negative and quite small relative to its standard error. A positive relation exists between USA FCOJ export and $XPOCS_t$, suggesting some degree of substitution even though the coefficient is small relative

Table 26. Structural-form estimates of the USA FCOJ export demand equation to Canada ($XQFCS_t$, Equation 19)

Explanatory variables[1]	Coefficient	Standard error
Intercept	-183.3615	139.4842
Endogenous variables		
$XPFCS_t^-$	-80.0033	108.5401
$XPFCB_t^+$	-16.3897	93.9835
Predetermined variables		
$MPFCOc_t^+$	--	--
$XPOCS_t^+$	65.0389	65.3210
IC_t^+	83.1731	21.8796
AC_t^+	-6.2466	5.0479
AC_{t-1}^+	8.9006	5.6291
$Z1_t$	-15.6414	25.0932
$Z2_t$	8.2555	31.1616
$Z3_t$	-36.4766	33.0581
$Z4_t$	-15.6500	23.6852
$Z5_t$	-8.3631	21.9701

[1]Variable superscript indicates the a priori expected sign.

Table 27. Structural-form estimates of the USA FCOJ export price equation to Canada ($XPFCS_t$, Equation 20)

Explanatory variables[1]	Coefficient	Standard error
Intercept	.9912	.1297
Endogenous variables		
$WPFFl_t^+$	.4962	.0713
$MPFSB_t^+$	.4534	.0869
Predetermined variables		
$MPFSOc_t^+$	--	--
$RxSC_t^-$	-.0058	.0011

[1]Variable superscript indicates the a priori expected sign.

to its standard error. Most of USA exports to Canada are in consumer size packages, while practically all FCOJ exports from Brazil are in 55 gallon drums of 65° brix concentrate that require further reprocessing. The different characteristics of FCOJ from these two sources may explain the results of this study. The USA product is quite differentianted so that its market is relatively independent of potential substitutes. However, FCOJ from Brazil is quite sensitive to changes in the price of the USA products (FCOJ and other orange juices) as discussed previously. Brazil exerts little, if any, competitive impact on the USA ability to export FCOJ to Canada. The USA FCOJ exports to Canada are quite sensitive to income per capita; i.e., one dollar increase in income is likely to increase imports from the USA by more than 83 gallons per thousand persons. Florida's orange juice advertising efforts in Canada do not seem to have been successful. The coefficient for current advertising (AC_t) is negative but smaller than the positive coefficient for prior period advertising. Tilley and Lee (1981) found advertising results that were similar. The USA product does not exhibit a seasonal pattern.

All variables included in the final estimates of the USA FCOJ export price equation have coefficient that conform with a priori expectations and are large relative to their respective standard errors. The Brazilian product imported into the USA appears to have an important role in deriving

$XPFCS_t$. Its impact on price is almost the same as the impact of Florida's wholesale prices. Each 1 cent change in one of these prices will change the USA FCOJ export price to Canada ($XPFCS_t$) by practically .5 cent. This finding is quite important since it gives support to the hypothesis that Brazilian FCOJ imported by the USA is a major factor in the export program. Because duty drawback is available on exports in the USA, imports can be used to average down FCOJ exports prices and/or as a way to make FCOJ imports profitable.

The estimates of the coefficient for the USA exchange rate relative to the Canadian dollar indicate that, for each cent increase in that rate the export price is likely to decrease by .6 cent. In the data period used in this study the exchange rate has decreased, especially in the recent three years (Table D.3. - Appendix D). Thus, the expected result was an increase in the export price to Canada and consequently a decrease in FCOJ exports, which is consistent with observed exports. This result supports the role of exchange rate in the derivation of export prices stressed by Schuh (1974) and Kost (1976), not only qualitatively, but also in terms of magnitude. In the case of FCOJ exports to Canada, variation in the rate of exchange between the two currencies has had substantial effects on USA export prices to that market.

Except in the case of the income elasticity, all other structural-form elasticity estimates for the USA FCOJ export

structure in Canada are inelastic (Appendix G). Even though relatively less responsive than in the case of the Brazilian product, USA FCOJ exports to Canada are expected to increase more than 2 percent for each 1 percent increase in income. The own-price elasticity relative to FCOJ exports to Canada (-.4616) indicates that quantity sold in Canada is less responsive than Florida's wholesale domestic movement (own-price elasticity equal to -.6618), and of Brazilian FCOJ export price to Canada (-1.1884).

In the price equation all price transmission elasticities are quite important. For each 1 percent increase in Florida's wholesale price ($WPFFl_t$) the USA export price to Canada ($XPFCS_t$) is expected to increase by almost .4 percent (.4465). Likewise change in the USA import price of FCOJ from Brazil is expected to increase $XPFCS_t$ by nearly .2 percent (.1857). On a relative basis, the impact of Brazilian FCOJ price to the USA in the determination of $XPFCS_t$ is still almost half of the impact of Florida's wholesale prices. The estimate of exchange rate transmission elasticity (-.5287) indicates that 1 percent increase in the rate of the USA dollar per Canadian dollar is associated to a price decline for FCOJ exports from the USA to Canada by more than .5 percent.

Own-price elasticity estimate in this study referent to USA FCOJ export to Canada (-.4616) is not far away from that of Tilley and Lee (-.64), considering the differences in both studies. However, cross-price elasticities relative

to price of FCOJ from Brazil, are quite different. These different results are likely to be associated with the ways that the USA FCOJ exports to Canada are treated. While Tilley and Lee differentiated between FCOJ retail size and bulk shipments, in the present study they are not treated differently.

The European Markets

Structural-form equations for FCOJ exports from Brazil and the USA to the two groups of European countries (the EEC7 and the European non-EEC3) were estimated as suggested by their respective conceptual formulation, except for two minor changes in the price equations. High levels of multicolinearity were found within the exchange rate indices ($RxBE_t$, $RxBN_t$, $RxSE_t$, and $RxSN_t$). Since the USA dollar is the basic currency in FCOJ trade, the exchange rates of cruzeiros per USA dollar were used in the Brazilian equations. Import prices of FCOJ to the USA from other countries ($MPFSOc_t$) were deleted from the USA export price equations for the European markets since this variable was colinear with import prices from Brazil ($MPFSB_t$).

With few exceptions, most of the coefficient estimates have signs that conform to a priori expectations. Substitution relationships are difficult to verify in either the USA or Brazilian export demand relationships. These results seem to reinforce the idea that differentiation of FCOJ from the USA has resulted in export flows to European markets that are

quite independent of price changes by potential competitors. The other unexpected sign is the negative effect of changing values of the indices of the USA exchange rate to the EEC7 country currencies on the USA FCOJ export price to these countries. Since the index is an inverse function of individual country exchange rates, changes in the index should have an effect on export prices in an opposite direction from that of changing individual exchange rates. Individually, an exchange rate increase (devaluation) is expected to decrease export prices. So the index of exchange rates should be positively related to export price if all exchange rates included in the index are simultaneously devalued. These and other specific results relative to the estimates of the Brazilian and the USA FCOJ export equations for these two markets, will be the major topics in the following discussion.

Brazilian FCOJ Exports to the EEC7

Brazilian exports to the EEC7 countries are found to be negatively related to own-price ($XPFEB_t$) and positively associated with time-related changes (T_t) on exports (mainly income) and to Florida's product advertising expenditures in those countries (AE_t) (Table 28). These results show that $XQFEB_t$ is sensitive to changes on its own-price and, that, over time, there is evidence to indicate an increasing trend in Brazil's exports of FCOJ to this market, even though in absolute terms it is small. Three-Party Program efforts intended to promote Florida's orange products in this region (AE_t) seem to increase Brazilian FCOJ sales as

Table 28. Structural-form estimates of Brazil FCOJ export demand equation to the EEC7 countries ($XQFEB_t$, Equation 21)

Explanatory variables[1]	Coefficient	Standard error
Intercept	87.1555	47.1473
Endogenous variables		
$XPFEB_t^-$	-147.8751	80.7974
$XPFES_t^+$	-9.2872	34.8037
Predetermined variables		
T_t^+	3.1557	.9424
AE_t^+	17.9493	11.9529
$Z1_t$	-4.8740	16.1997
$Z2_t$	-51.7059	16.5576
$Z3_t$	-81.4971	16.3508
$Z4_t$	-68.0360	16.2112
$Z5_t$	-23.2469	16.2125

[1]Variable superscript indicates the a priori expected sign.

well. Estimates for the seasonal variables ($Z2_t$ to $Z5_t$) indicate that, in relation to the October-November bimonth, Brazil's FCOJ exports to the EEC7 countries decrease substantially until the April-May bimonth and then continue to decrease by small quantities until recovering to the base period level of exports in October-November.

Practically all estimates of the export price equation coefficients (Table 29) for FCOJ from Brazil ($XPFEB_t$) are large relative to their respective standard errors. The USA price to the same market ($XPFES_t$) is an important determinant of Brazil's FCOJ export price to the EEC7. The coefficient for $XPFES_t$ is almost seven times greater than its standard error. Its numerical value indicates that a 10 cent increase in the USA price translates into almost a 3.5 cent increase Brazilian FCOJ price to this market. Devaluation of the cruzeiro relative to the USA dollar by one unit is likely to reduce $XPFEB_t$ by 13 cents per gallon. Thus, Brazilian FCOJ exports to the EEC7 countries would be expected to increase considerably with devaluations of the cruzeiro relative to the USA dollar.

Most of the previous results are reexpressed by elasticity estimates (Appendix G). Each 1 percent increase in current Florida's advertising expenditures (AE_t) through the Three-Party Program represents more than .5 percent increase in Brazil's exports of FCOJ to the EEC7 market (.5292). Likewise, change in the USA export price of FCOJ to this market ($XPFES_t$) is expected to increase Brazilian export price of FCOJ to the EEC7 countries by almost .6

Table 29. Structural-form estimates of Brazil FCOJ export price equation to the EEC7 countries ($XPFEB_t$, Equation 22)

Explanatory variables[1]	Coefficient	Standard error
Intercept	1.2336	.4033
Endogenous variables		
$XPFES_t$	.3473	.0507
Predetermined variables		
$PdSp^-_{t-6}$	-.5505	.5404
$RxBE^+_t$	--	--
$RxBS^-_t$	-.1252	.0512

[1]Variable superscript indicates the a priori expected sign.

percent (.5610). Exchange rate transmission elasticity (-2.0659) is quite high, suggesting a strong response of the Brazilian export price ($XPFEB_t$) to changes in the exchange rate of cruzeiros per USA dollar.

USA FCOJ Exports to the EEC7

Tables 30 and 31 show the estimates of the structural-form parameters of the USA FCOJ export structure in the EEC7 countries. Most of the major variables have estimated coefficients that are large relative to their standard errors. In the export demand equation (Table 30) the coefficient for the price of FCOJ ($XPFES_t$) indicates that FCOJ exports to this market from the USA are quite sensitive to changes in $XPFES_t$. For each 10 cent per gallon increase in $XPFES_t$, FCOJ exports decrease by more than 2.4 gallons per thousand persons. The estimated coefficient for Brazilian FCOJ price ($XPFEB_t$) does not support the hypothesis of substitution for the USA product. The estimated relation has a negative sign but is small relative to its standard error. This result means that the USA exports of FCOJ to the EEC7 countries are independent of changes in the Brazilian FCOJ prices in the same market. A similar conclusion was obtained in the case of Brazil's FCOJ exports to the EEC7 countries relative to changes in the USA prices of FCOJ.

These results are consistent with the fact that the Brazilian product is exported in bulk drums of 65° brix concentrate that requires reprocessing while FCOJ from the USA is already in consumer packages that are ready for

Table 30. Structural-form estimates of the USA FCOJ export demand equation to the EEC7 countries ($XQFES_t$, Equation 23)

Explanatory variables[1]	Coefficient	Standard error
Intercept	11.3701	7.563
Endogenous variables		
$XPFES_t^-$	-24.0565	5.5861
$XPFEB_t^+$	-1.9782	12.9682
Predetermined variables		
T_t^+	.3514	.1513
AE_t^+	1.8695	1.9185
$Z1_t$	-.0536	2.6001
$Z2_t$	3.8950	2.6575
$Z3_t$	6.6364	2.6244
$Z4_t$	7.0104	2.6019
$Z5_t$	1.6055	2.6022

[1]Variables superscript indicates the a priori expected sign.

Table 31. Structural-form estimates of the USA FCOJ export price equation to the EEC7 countries ($XPFES_t$, Equation 24)

Explanatory variables[1]	Coefficient	Standard error
Intercept	1.2518	.4838
Endogenous variables		
$WPFFl_t^+$	.2540	.2293
$MPFSB_t^+$	.7380	.2791
Predetermined variables		
$MPFSOc_t$	--	--
$RxSE_t^+$	-.0109	.0040

[1]Variable superscript indicates the a priori expected sign.

immediate consumption. The fact that the Brazilian product has a quite constant high share in the market (Table 9, Chapter II) and is valued substantially below the USA product (Table 8, Chapter II) may explain the small sensitivity of Brazil's FCOJ exports to changes in the USA FCOJ prices. The USA FCOJ exports to the EEC7 countries are also growing over time as reflected by the coefficient for T_t, the time trend. The Three-Party Program in promoting Florida's product (AE_t) seems to have no impact on the USA FCOJ exports to this market. Specific studies on the effectiveness of the Three-Party Program (Lee, 1977,1978; and Lee et al. 1978) have reached quite favorable conclusions for the program.

Seasonal variable estimates for February-March through June-July ($Z2_t$ through $Z4_t$) indicate that exports to the EEC7 market increase significantly from the base period (October-November). The peak of the USA exports to the EEC7 coincide with the smallest rate of Brazilian exports of FCOJ to the same market. These results suggest some seasonal complementarity between the two sources in supplying FCOJ to the EEC7 countries which may explain the lack of substitution between the two products.

Estimates of the price equation parameters (Table 31) indicate that the USA import price of FCOJ from Brazil ($MPFSB_t$) plays a major role in the derivation of the export price of FCOJ from the USA to the EEC7 market. For each 10 cent per gallon increase in $MPFSB_t$, $XPFES_t$ is

expected to increase $XPFES_t$ by 7.4 cents. An increase in Florida's wholesale price ($WPFFl_t$) is estimated to result in an increase of only 2.5 cents. Similar estimates on the Canadian market (Table 27) give these variables almost the same impact on the USA export prices to Canada, with Florida's wholesale price having relatively more impact. Together, these results suggest that the Brazilian prices to the USA market are relatively more important in deriving the USA export price to the EEC7 countries than to Canada, with Florida's wholesale price having relatively more impact. This inference is quite consistent, given that it should be much easier to maintain the EEC7 export price lower relative to the USA domestic price than to offer similar discounts in Canada. Thus, a two-price system (domestic prices higher than export prices), using imports from Brazil to average down the export price, is more likely to be associated with USA exports to the EEC7 countries than exports to Canada.

As already mentioned in the introductory discussion of this sub-section, the negative sign of the USA exchange rate index ($RxSE_t$) was not expected. Given the number of currencies (seven) involved in the derivation of the index, and that the USA dollar has not had a systematic pattern of behavior[7]

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[7]A devaluation of the USA dollar to the deutsche mark (West Germany) does not necessarily imply a devaluation of the dollar relative to the franc in France or to the pound in the United Kingdom.

toward all of them during the period of time considered in this study, then the index estimate turns out to be an average measure of devaluations and increased valuations at the same time. Thus, the results should not necessarily conform with the conceptual expectation.

Elasticity estimates derived from the structural-form equations (Appendix G) reinforce most of the previous inferences regarding the USA FCOJ export structure to the EEC7 market. Own-price elasticity results indicated that compared with the USA domestic and the Canadian market, exports to the EEC7 countries tend to be relatively much more responsive to price changes. A 1 percent cut in FCOJ price is likely to increase Florida's domestic movement by approximately .7 percent and exports to Canada by nearly .5 percent. However, the same changes in the export prices to the EEC7 market are expected to increase exports to this region by almost 2 percent. Similar relations among these elasticities were found by Ward (1976a) relative to the FCOJ from Florida. These results then support Ward's conclusion that discounting the exporting price to the EEC7 market is desirable.

Elasticity estimate of current expenditures of the Three-Party Program indicates that 1 percent increase in AE_t will increase the USA FCOJ exports to the EEC7 countries by approximately .5 percent. The umbrella effect on Brazilian exports of FCOJ to the same market from this advertising effort to promote Florida's product is slightly more than the

corresponding effect on FCOJ exports from the USA as measured by the respective advertising elasticities (.5292 and .5029). Price transmission elasticity reinforces the idea that the USA import price from Brazil ($MPFSB_t$) plays a major role in the derivation of the USA export price to the EEC7 countries ($XPFES_t$). The impact on $XPFES_t$ for each 1 percent change in $MPFSB_t$ is relatively higher (.4362) than the impact on $XPFES_t$ for the same change in Florida's wholesale price (.3298). However, the effect on $XPFES_t$ from changing the values of the dollar relative to the EEC7 country currencies ($RxES_t$), as measured by the exchange rate transmission elasticity (-1.3934), is more than sufficient to offset the combined effect of changing $MPFSB_t$ and $WPFFl_t$. These results may explain the recent downward trend of the USA FCOJ exports to the EEC7 market. The strengthening of the dollar relative to major currencies in Europe has offset any effort by the same agents to increase exports to this region through price reductions and/or promotional programs.

Brazilian FCOJ Exports to the European Non-EEC3

Structural-form equation estimates relative to Brazil's FCOJ exports to the European non-EEC3 countries are shown in Tables 32 and 33. Most of the estimated coefficients for export demand (Table 32) are not substantially greater than their associated standard errors. Based on these results it appears that Brazilian FCOJ exporting to this market is largely a seasonal phenomenon as identified by the seasonal

Table 32. Structural-form estimates of Brazil FCOJ export demand equation to the European non-EEC3 countries ($XQFNB_t$, Equation 25)

Explanatory variables[1]	Coefficient	Standard error
Intercept	510.9708	531.7365
Endogenous variables		
$XPFNB_t^-$	-182.6938	281.7113
$XPFNS_t^+$	-26.6495	199.7314
Predetermined variables		
T_t^+	.5505	8.3220
AN_t^+	-5.9842	6.9020
$Z1_t$	133.7020	62.0089
$Z2_t$	58.9341	62.5844
$Z3_t$	12.6402	63.0043
$Z4_t$	53.3214	62.6468
$Z5_t$	224.2376	64.0905

[1]Variable superscript indicates the a priori expected sign.

Table 33. Structural-form estimates of Brazil FCOJ export price equation to the European non-EEC3 countries ($XPFNB_t$, Equation 26)

Explanatory variables[1]	Coefficient	Standard error
Intercept	.7131	.4231
Endogenous variables		
$XPFNS_t^+$	.4177	.0951
Predetermined variables		
$PdSp_{t-6}^-$	.4009	.5638
$RxBN_t^+$	--	--
$RxBS_t^-$	-.0829	.0517

[1]Variable superscript indicates the a priori expected sign.

variables ($Z1_t$ to $Z5_t$). Most of the estimates have signs consistent with expectations. FCOJ exports are negatively related to own-price ($XPFNB_t$) and, again, the results do not support the assumption that the USA product is a potential substitute to FCOJ from Brazil. Time-related changes, as measured by the coefficient of T_t, seem to have no significant effect on $XQFNB_t$. The effect of Three-Party Program promotion of Florida's FCOJ on Brazil's exports to the European non-EEC3 countries conforms with expectation. Seasonal variability estimates seem to indicate that most of the Brazilian exports of FCOJ to these countries are seasonally related, especially during the bimonths of August-September through December-January when Brazil's sales to this market increase considerably. These results may suggest that Brazil's exports of FCOJ to these countries are also complementary to other sources.

The price equation estimates (Table 33) are quite similar to effects of the same variables in the derivation of Brazil's FCOJ export price to the Canadian and the EEC7 markets. The results indicate that a quite high proportion of variations in Brazil's FCOJ export price to this market ($XPFNB_t$) can be explained by changes in the USA export price of FCOJ to the same market ($XPFNS_t$) and by the exchange rate of the cruzeiro against the USA dollar ($RxBS_t$). For each 10 cents per gallon that is added to $XPFNS_t$, the Brazilian product price ($XPFNB_t$) is expected to increase by 4.2 cents per gallon.

Elasticity and flexibility estimates relative to structural-form equations (Appendix G) reinforce the previous related discussion, even though most of the export demand estimates have estimated coefficients smaller than the respective standard errors. However, two of the price equation estimates are relatively important to the analysis. The USA FCOJ price transmission elasticities relative to the derivation of Brazil's FCOJ export price indicate that the estimate for this market (.7969 percent) is the second largest response of Brazilian export prices to variation of the respective export price from the USA. As indicated by the estimated exchange rate transmission elasticity (-1.3911), for each 1 percent devaluation of the Brazilian cruzeiro relative to the USA dollar more than a 1 percent reduction in $XPFNB_t$ is expected.

USA FCOJ Exports to the European Non-EEC3

Tables 34 and 35 display the structural-form estimates for the USA FCOJ export equations to the European non-EEC3 countries. In the export demand equation (Table 34), export quantity of FCOJ to this region from the USA ($XQFNS_t$) is quite sensitive to variation in its own-price ($XPFNS_t$). For each 10 cent per gallon reduction in $XPFNS_t$, USA exports to this market are expected to increase by more 23.2 gallons per thousand persons. Estimate of the effect of Brazilian FCOJ price to the same market ($XPFNB_t$) indicates that the Brazilian product behaves like a substitute for FCOJ from

Table 34. Structural-form estimates of the USA FCOJ export demand equation to the European non-EEC countries ($XQFNS_t$, Equation 27)

Explanatory variables[1]	Coefficient	Standard error
Intercept	111.9906	133.7687
Endogenous variables		
$XPFNS_t^-$	-232.2003	50.2464
$XPFNB_t^+$	67.3028	70.8700
Predetermined variables		
T_t^+	1.4686	2.0935
AN_t^+	2.5567	1.7363
$Z1_t$	38.0835	15.5995
$Z2_t$	4.0872	15.7443
$Z3_t$	16.4419	15.8500
$Z4_t$	-1.3898	15.7600
$Z5_t$	-.3866	16.1232

[1]Variable superscript indicates the a priori expected sign.

Table 35. Structural-form estimates of the USA FCOJ export price equation to the European non-EEC3 countries ($XPFNS_t$, Equation 28)

Explanatory variables[1]	Coefficient	Standard error
Intercept	-.3826	.3273
Endogenous variables		
$WPFFl_t^+$	.3890	.1452
$MPFSB_t^+$	.2225	.1763
Predetermined variables		
$MPFSOc_t^+$	--	--
$RxSN_t^+$	.0080	.0030

[1]Variable superscript indicates the a priori expected sign.

USA even though the parameter is small relative to its standard error. The time variable (T_t) coefficient estimate does not give strong support that $XQFNS_t$ is increasing over time, which is consistent with the characteristics of the market previously discussed. Even though the estimated parameter is not large relative to its standard errors, the Three-Party Program parameter estimate indicates that each dollar increase in the program expenditures is likely to increase FCOJ exports from the USA by more than two and a half gallons per thousand persons.

All price equation estimates (Table 35) are consistent with a priori expectations and the nature of this market concerning orange juice consumption patterns. Estimates of the USA import price of FCOJ from Brazil ($MPFSB_t$) do not strongly indicate that the Brazilian product plays the same role in the derivation of FCOJ export prices from the USA as it does for other markets. To these countries, the major role is played by Florida's wholesale price ($WPFFl_t$).

The estimated coefficient of the exchange rate index ($RxSN_t$) is almost three times its standard error (.0030), even though it is relatively small in absolute terms (.0080). Each one unit reduction in the index, which is likely to be associated with devaluation of the dollar relative to all individual currencies, is expected to reduce the $XPFNS_t$ by less than 1 cent per gallon.

Structural-form elasticity estimates (Appendix G) reinforce the previous inferences on the USA FCOJ exports

to the European non-EEC3 countries. Export quantities were found to be quite responsive to changes in the own-price of FCOJ from the USA ($XPFNS_t$), as measured by the own-price elasticity of demand for exports (-2.4662). Promotion of Florida's FCOJ through the Three-Party Program was found to be relatively effective, since each 1 percent increase in the program expenditures is expected to be associated with more than 1 percent increase in FCOJ exports from the USA to this market. In relative terms this is the highest response of FCOJ sales to advertising efforts. This better response to advertising could be associated with the weight placed on orange juice quality in these countries and the ability of the USA product to fulfill these requirements since most of the FCOJ exports from the USA are in final consumer containers where quality is more easily controlled.

Price transmission elasticities are very consistent with previous discussions relative to the implications of the price equation estimated coefficients. For each 1 percent increase in the price per gallon of Florida's wholesale FCOJ prices ($WPFFl_t$) or of the USA import price of FCOJ from Brazil ($MPFSB_t$), $XPFNS_t$ is expected to increase by .4 and .1 percent, respectively. These results show that the Brazilian product does not have a significant role in the derivation of the $XPFNS_t$ as compared with the role of Florida's FCOJ price. The exchange rate price transmission elasticity estimate (.8779) is quite large. The relative impact on $XPFNS_t$ of changing exchange rates (.8779) is more

than twice the effect of variations in the Florida wholesale price (.4349.

Estimates of the Derived Reduced-Form Equations

This section contains a discussion of the derivation of the reduced-form estimates of the model, and of major implications of these estimates for the orange juice trade; also included are the results of model validation tests which give some insight into the performance of the estimated model.

The reduced-form estimates are a restricted reduced-form version of the system of simultaneous equations (Equation 31, Chapter III). The matrix of the derived reduced-form estimates of predetermined variables ($\hat{\Pi}$) was obtained by solving the following equation

$$\hat{\Pi} = -\hat{\beta}^{-1}\hat{\Gamma} \tag{37}$$

where $\hat{\beta}$ and $\hat{\Gamma}$ are matrices of the structural-form coefficients of endogenous and predetermined variables estimated by the 2SLS procedure. Equation 37 is simply the estimated version of Equation 33 in Chapter III. In order to carry out the matrix operation in equation 37, nonlinear relations in the structural formulation of the model (Chapter III), defined by the identities for orange juice stocks (Equations 5, 6, 15, and 16) and for retail proportion of other orange juices in cardboard containers (Equation 12), were linearized as follows. Population means were used in the population ratios of Equations 6

and 16 in the definitions of wholesale quantity per thousand persons of FCOJ and of other orange juices in stock in the USA ($WQkFS_t$ and $WQkOS_t$). The other nonlinear relations involving ratios of major varialbes of the model (Equations 5, 12 and 15) were linearly approximated by first-order terms of the Taylor's Series expansion about the variable means (Womack & Matthews, 1972). As summarized by them, the other procedures[8] used to handle this problem require initial values for all predetermined variables making them complex and quite expensive for large models. Taylor's Series expansions have been shown to be very convenient (Womack and Matthews). Thus, the identities defined by Equations 5, 12 and 15, in Chapter III, were approximated by the following linear expressions[9], evaluated about the means of the respective variables.

$$WS\hat{k}FS_t = 2.63843 + .00185\ WQkFS_t - .00489\ (WQFFl_t \quad (38)$$

$$Rp\hat{O}S_t = .49691 + .00738\ RQObS_t - .00367\ RQOS_t \quad (39)$$

$$WS\hat{k}OS_t = 1.14481 + .00678\ WQkOS_t - .0076\ WQOFl_t \quad (40)$$

With these transformations the reduced-form estimates were derived through the matrix operation in Equation 37.

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[8]Newtonian numerical analytic techniques and Gauss-Siedel numerical method.

[9]The linear approximation of an x/y ratio by the first-order terms of the Taylor's Series expansion, evaluated about the means of the variables, can be simplified as follows:

$$\hat{x/y} = \bar{x}/\bar{y} + (1/\bar{y})x - (\bar{x}/\bar{y}^2)y$$

where, $\bar{x}$ and $\bar{y}$ are mean values of the respective variables.

Table 36 displays the derived reduced-form estimates which show the effect of predetermined variables on the endogenous variables in the model. These estimates are called long-run multipliers (Kennedy, 1979, p. 107) or simply multipliers (Goldberger 1964, p. 369), since a particular reduced-form coefficient indicates the total effect on the corresponding endogenous variable of a one-unit change in its respective predetermined variable, assuming that other exogenous variables in the equation are fixed. It is a total effect in the sense that it accounts for the interdependent relationships among other current endogenous variables. The discussion in this section covers the impact of a selected group of multipliers on some endogenous variables. The first sub-group includes lagged wholesale prices of orange juices in Florida ($WPFFl_{t-1}$ and $WPOFl_{t-1}$), export price of other orange juices to Canada from the USA ($XPOCS_t$), retail price of frozen orange-flavored synthetics and drinks in the USA ($RPShS_t$), and income in the USA and in Canada (IS_t and IC_t). The second sub-group includes exchange rates, orange production, and freeze. Except for freeze, discussion of which is based on the magnitude of the respective estimates in Table 36, the multiplier impact relative to all other predetermined variables is discussed using the derived reduced-form elasticity and flexibility estimates (Table 37) evaluated about the means of the respective variables. The results relative to the last sub-group of predetermined variables will be discussed as separate topics in this sub-section.

Table 36. Estimates of the derived reduced-form equations[1]

Endogenous Variables	Intercept	Predetermined Variables										
		$WPFFI_{t-1}$	$WQkFS_{t-1}$	$WSkFS_{t-1}$	$WPOFI_{t-1}$	$WQkOS_{t-1}$	$MQFSOc_t$	$XQFOcS_t$	$XQOCS_t$	$XPOCS_t$	$WQsFFI_t$	$WQsOFI_t$
$RQFS_t$	-110.9390	-28.5133	.0022	2.3459	-82.4137	.0023	.0022	-.0020	-.0002	-.0151	.0022	.0023
$RPFS_t$	2.3035	.2657	.0000	-.0219	-.0134	.0000	.0000	.0000	.0000	.0001	.0000	.0000
$WQFFI_t$	-615.2930	18.4420	.0074	7.9742	-195.7170	-.0287	.0074	-.0068	.0031	-.0512	.0074	-.0287
$WPFFI_t$	2.2562	.0023	.0000	-.0267	-.0163	.0000	.0000	.0000	.0000	.0002	.0000	.0000
$MQFSB_t$	-159.0500	-32.8080	-.0033	-3.5814	-73.5118	.0056	-.0033	.0031	-.0006	.0230	-.0033	.0056
$MPFSB_t$	.4203	.4642	.0000	-.0062	-.0038	.0000	.0000	.0000	.0000	.0000	.0000	.0000
$RQOS_t$	-299.9130	24.1034	-.0018	-1.9831	-103.3150	.0023	-.0018	.0017	-.0002	.0127	-.0018	.0023
$RPOS_t$	.7858	.0204	.0000	-.0017	.7460	.0000	.0000	.0000	.0000	.0000	.0000	.0000
$WQOFI_t$	-139.3410	13.9491	-.0011	-1.1477	-59.7905	.0048	-.0011	.0010	.0005	.0074	-.0011	.0048
$WPOFI_t$	2.2660	.0042	.0000	-.0003	-.0182	-.0001	.0000	.0000	.0000	.0000	.0000	-.0001
$XQFCB_t$	-1097.7700	26.4321	-.0019	-2.0039	-1.2269	-.0002	-.0019	.0017	.0000	505.7130	-.0019	-.0002
$XPFCB_t$	1.6190	.1500	.0000	-.0114	-.0070	.0000	.0000	.0000	.0000	.0001	.0000	.0000
$XQFCS_t$	-394.0080	-19.3879	.0014	1.4698	.8999	.0002	.0014	-.0013	.0000	65.0295	.0014	.0002
$XPFCS_t$	2.3013	.2116	.0000	-.0160	-.0098	.0000	.0000	.0000	.0000	.0001	.0000	.0000
$XQFEB_t$	-224.7440	-20.8117	.0006	.6887	.4217	.0001	.0006	-.0006	.0000	-.0044	.0006	.0001
$XPFEB_t$	1.9751	.1192	.0000	-.0039	-.0024	.0000	.0000	.0000	.0000	.0000	.0000	.0000
$XQFES_t$	-36.0853	-8.0199	.0002	.2654	.1625	.0000	.0002	-.0002	.0000	-.0017	.0002	.0000
$XPFES_t$	2.1351	.3432	.0000	-.0114	-.0070	.0000	.0000	.0000	.0000	.0000	.0000	.0000
$XQFNB_t$	320.0910	-10.7258	.0011	1.2098	.7407	.0001	.0011	-.0010	.0000	-.0078	.0011	.0001
$XPFNB_t$	.9589	.0436	.0000	-.0049	-.0030	.0000	.0000	.0000	.0000	.0000	.0000	.0000
$XQFNS_t$	39.8620	-21.2605	.0022	2.3981	1.4683	.0003	.0022	-.0021	.0000	-.0154	.0022	.0003
$XPFNS_t$	.5886	.1042	.0000	-.0118	-.0072	.0000	.0000	.0000	.0000	.0001	.0000	.0000
$WQkFS_t$	528.2810	-40.1080	.9887	-12.1463	121.8440	.0343	.9887	-.9125	-.0036	-6.8357	.9887	.0343
SpB_t	1.8358	-.4620	.0000	-.0204	-.0125	.0000	.0000	.0000	.0000	.0001	.0000	.0000
$WQkOS_t$	139.3410	-13.9491	.0011	1.1477	59.7905	.9952	.0011	-.0010	-.1058	-.0074	.0011	.9952
$RpOS_t$	1.5976	-.0885	.0000	.0073	.3792	.0000	.0000	.0000	.0000	.0000	.0000	.0000
$WSkFS_t$	6.6245	-.1644	.0018	-.0615	1.1825	.0002	.0018	-.0017	.0000	-.0124	.0018	.0002
$WSkOS_t$	3.1708	-.2028	.0000	.0167	.8694	.0067	.0000	.0000	-.0001	-.0001	.0000	.0067

(continued)

[1] In order to derive these estimates the identity equations (ratios) for $WSkFS_t$ (Equation 5), $RpOS_t$ (Equation 12) and $WSkOS_t$ (Equation 15) were linearly approximated by Taylor's Series expansion evaluated about the means of the respective variables.

Table 36 (continued).

Endogenous Variables	Predetermined Variables											
	$RPShS_t$	$RQObS_t$	IS_t	IC_t	AS_t	AS_{t-1}	AC_t	AC_{t-1}	AE_t	AN_t	PdS_t	PdS_{t-1}
$RQFS_t$	115.1170	.1635	53.3599	-.0193	1.3682	.8584	.0014	-.0021	-.0038	-.0004	292.7250	231.8290
$RPFS_t$	.0171	.0000	.0101	.0002	.0001	.0001	.0000	.0000	.0000	.0000	-2.7701	-1.5656
$WQFFI_t$	248.7860	.3883	147.7760	-.0655	1.1648	.9833	.0049	-.0070	-.0128	-.0015	1076.9800	-350.3990
$WPFFI_t$	.0208	.0000	.0123	.0002	.0001	.0001	.0000	.0000	.0000	.0000	-3.3778	-1.9090
$MQFSB_t$	90.6325	.1458	57.9126	.0294	.1992	.2487	-.0022	.0031	.0057	.0007	-467.2940	-70.5299
$MPFSB_t$	.0049	.0000	.0029	.0000	.0000	.0000	.0000	.0000	.0000	.0000	-.7877	-.4452
$RQOS_t$	127.2950	.2050	81.4618	.0163	.2730	.3460	-.0012	.0017	.0032	.0004	-256.9260	-64.3643
$RPOS_t$	.1079	-.0015	.0691	.0000	.0002	.0003	.0000	.0000	.0000	.0000	-.1722	-.6888
$WQOFI_t$	73.6680	.1186	47.1436	.0094	.1580	.2002	-.0007	.0010	.0018	.0002	-156.5450	71.8977
$WPOFI_t$	.0224	.0000	.0143	.0000	.0000	.0001	.0000	.0000	.0000	.0000	.2703	-4.3943
$XQFCB_t$	1.5650	.0024	.9218	134.4460	.0078	.0064	6.4224	3.0701	.0032	.0004	-253.9700	-143.5350
$XPFCB_t$	.0089	.0000	.0053	.0001	.0000	.0000	.0000	.0000	.0000	.0000	-1.4413	-.8146
$XQFCS_t$	-1.1479	-.0018	-.6761	83.1610	-.0057	-.0047	-6.2457	8.8993	-.0024	-.0003	186.2860	105.2820
$XPFCS_t$	.0125	.0000	.0074	.0001	.0001	.0000	.0000	.0000	.0000	.0000	-2.0332	-1.1491
$XQFEB_t$	-.5379	-.0008	-.3168	-.0057	-.0027	-.0022	.0004	-.0006	17.9482	-.0001	87.2841	49.3300
$XPFEB_t$	.0031	.0000	.0018	.0000	.0000	.0000	.0000	.0000	.0000	.0000	-.4999	-.2825
$XQFES_t$	-.2073	-.0003	-.1221	-.0022	-.0010	-.0008	.0002	-.0002	1.8691	.0000	33.6352	19.0095
$XPFES_t$	.0089	.0000	.0052	.0000	.0000	.0000	.0000	.0000	.0000	.0000	-1.4393	-.8134
$XQFNB_t$	-.9449	-.0015	-.5565	-.0099	-.0047	-.0039	.0007	-.0011	-.0019	-5.9844	153.3311	86.6577
$XPFNB_t$	.0038	.0000	.0023	.0000	.0000	.0000	.0000	.0000	.0000	.0000	-.6220	-.3516
$XQFNS_t$	-1.8729	-.0029	-1.1031	-.0197	-.0093	-.0077	.0015	-.0021	-.0038	2.5562	303.9320	171.7720
$XPFNS_t$	.0092	.0000	.0054	.0001	.0000	.0000	.0000	.0000	.0000	.0000	-1.4892	-.8417
$WQkFS_t$	-157.6920	-.2417	-89.5921	-8.7416	-.9633	-.7327	.6565	-.9355	-1.7059	-.1997	-1619.1200	237.5640
SpB_t	.0160	.0000	.0094	.0002	.0001	.0001	.0000	.0000	.0000	.0000	-2.5900	-1.4638
$WQkOS_t$	-73.6680	-.1186	-47.1436	-.0094	-.1580	-.2002	.0007	-.0010	-.0018	-.0002	156.5450	-71.8977
$RpOS_t$	-.4672	.0066	-.2990	-.0001	-.0010	-.0013	.0000	.0000	.0000	.0000	.9429	.2362
$WSkFS_t$	-1.5083	-.0023	-.8884	-.0159	-.0075	-.0062	.0012	-.0017	-.0031	-.0004	-8.2618	2.1529
$WSkOS_t$	-1.0711	-.0017	-.6855	-.0001	-.0023	-.0029	.0000	.0000	.0000	.0000	2.2762	-1.0454

(continued)

Table 36 (continued).

Endogenous Variables	Predetermined Variables											
	$PdSp_{t-6}$	$RxBS_t$	$RxSC_t$	$RxSE_t$	$RxSN_t$	D_t	T_t	$Z1_t$	$Z2_t$	$Z3_t$	$Z4_t$	$Z5_t$
$RQFS_t$	.1365	.0031	-.0001	-.0005	.0003	-29.6390	.5163	17.1773	14.0193	-9.4302	-20.6636	-11.6209
$RPFS_t$	-.0013	.0000	.0000	.0000	.0000	.2336	-.0041	.0045	.0036	-.0016	.0008	.0025
$WQFFI_t$	.4640	.0104	-.0004	-.0017	.0010	-19.2111	.3113	66.9426	45.9514	-26.6951	4.5090	30.9170
$WPFFI_t$	-.0016	.0000	.0000	.0000	.0000	.2848	-.0049	.0055	.0044	-.0019	.0009	.0030
$MQFSB_t$	82.5074	1.0163	.0002	.0008	-.0004	24.9513	-.4288	29.4274	-.2683	-18.6441	-15.2616	-5.1674
$MPFSB_t$	-.7701	-.0095	.0000	.0000	.0000	.0664	-.0012	.0013	.0010	-.0004	.0002	.0007
$RQOS_t$	-.1154	-.0026	.0001	.0004	-.0002	15.6287	-.2695	-1.6045	-2.3224	-7.1170	-1.5098	3.7593
$RPOS_t$	-.0001	.0000	.0000	.0000	.0000	.0587	-.0010	-.0007	-.0013	-.0057	-.0007	.0037
$WQOFI_t$	-.0668	-.0015	.0001	.0003	-.0001	1.2273	-.0176	14.2919	13.0192	2.5718	12.0962	14.2487
$WPOFI_t$	.0000	.0000	.0000	.0000	.0000	.3167	-.0056	.0043	.0040	.0008	.0037	.0043
$XQFCB_t$	72.8357	13.5404	-.7244	.0004	-.0002	21.4147	-.3719	-31.8328	7.9346	-7.5916	-62.2168	-8.4421
$XPFCB_t$	-.5353	-.0378	-.0041	.0000	.0000	.1215	-.0021	.0023	.0019	-.0008	.0004	.0013
$XQFCS_t$	36.7671	.9653	.5313	-.0003	.0002	-15.7076	.2728	-15.9450	8.0127	-36.3710	-15.7012	-8.5297
$XPFCS_t$	-.3499	-.0043	-.0058	.0000	.0000	.1714	-.0030	.0033	.0026	-.0012	.0006	.0018
$XQFEB_t$	115.8940	18.9400	.0000	.6609	.0001	-7.3598	3.2835	-5.0163	-51.8196	-81.4476	-68.0600	-23.3249
$XPFEB_t$	-.7480	-.1276	.0000	-.0038	.0000	.0421	-.0007	.0008	.0007	-.0003	.0001	.0004
$XQFES_t$	12.2012	-.0835	.0000	.2547	.0000	-2.8361	.4007	-.1084	3.8512	6.6555	7.0012	1.5754
$XPFES_t$	-.5687	-.0070	.0000	-.0109	.0000	.1214	-.0021	.0023	.0019	-.0008	.0004	.0013
$XQFNB_t$	-55.5387	15.3645	-.0001	-.0003	-.8235	-12.9289	.7750	133.4520	58.7343	12.7271	52.2793	224.1000
$XPFNB_t$	.3291	-.0838	.0000	.0000	.0033	.0525	-.0009	.0010	.0008	-.0004	.0002	.0006
$XQFNS_t$	62.0730	-5.1449	-.0001	-.0005	-1.6324	-25.6276	1.9136	37.5881	3.6912	16.6142	-1.4733	-.6584
$XPFNS_t$	-.1719	-.0021	.0000	.0000	.0080	.1256	-.0022	.0024	.0019	-.0008	.0004	.0013
$WQkFS_t$	61.9708	1.3867	-.0559	-.2324	.1275	50.4741	-1.2900	-38.6896	-50.9173	4.4623	-24.4465	-36.5797
SpB_t	.7685	.0095	.0000	.0000	.0000	.2184	-.0038	.0042	.0034	-.0015	.0007	.0023
$WQkOS_t$	.0668	.0015	-.0001	-.0003	.0001	-1.2273	.0176	-14.2919	-13.0192	-2.5718	-12.0962	-14.2487
$RpOS_t$	.0004	.0000	.0000	.0000	.0000	-.0574	.0010	.0059	.0085	.0261	.0055	-.0138
$WSkFS_t$	.1124	.0025	-.0001	-.0004	.0002	.1873	-.0039	-.3989	-.3189	.1388	-.0673	-.2189
$WSkOS_t$	.0010	.0000	.0000	.0000	.0000	-.0178	.0003	-.2078	-.1893	-.0374	-.1759	-.2072

Table 37. Derived reduced-form elasticity and flexibility estimates for selected predetermined variables evaluated at the means of the respective variables.[1]

Endogenous Variables	Elasticity (percent)									
	$WPFFI_{t-1}$	$WPOFI_{t-1}$	$XPOCS_t$	$RPShS_t$	IS_t	IC_t	AS_t	AS_{t-1}	AC_t	AC_{t-1}
$RQFS_t$	-.0786	-.3097	-.0001	.4784	.7688	-.0003	.0351	.0223	.0000	.0000
$RPFS_t$	.1729	-.0119	.0001	.0168	.0344	.0006	.0006	.0006	.0000	.0000
$WQFFI_t$	.0341	-.4932	-.0001	.6934	1.4278	-.0006	.0200	.0172	.0000	.0000
$WPFFI_t$	.0023	-.0223	.0003	.0314	.0644	.0009	.0009	.0009	.0000	.0000
$MQFSB_t$	-.9320	-2.8475	.0008	3.8827	8.6015	.0039	.0526	.0667	-.0002	.0003
$MPFSB_t$	1.0212	-.0114	.0000	.0163	.0334	.0000	.0000	.0000	.0000	.0000
$RQOS_t$	.1776	-1.0381	.0001	1.4146	3.1384	.0006	.0187	.0241	.0000	.0000
$RPOS_t$	.0100	.4976	.0000	.0796	.1767	.0000	.0009	.0014	.0000	.0000
$WQOFI_t$	.0943	-.5514	.0001	.7514	1.6670	.0003	.0099	.0128	.0000	.0000
$WPOFI_t$	.0031	-.0183	.0000	.0249	.0557	.0000	.0000	.0007	.0000	.0000
$XQFCB_t$	.1617	-.0102	3.9405	.0144	.0295	3.8724	.0004	.0004	.1368	.0660
$XPFCB_t$	.3133	-.0199	.0003	.0280	.0519	.0010	.0000	.0000	.0000	.0000
$XQFCS_t$	-.1008	.0064	.4308	-.0090	-.0184	2.0362	-.0003	-.0002	-.1131	.1625
$XPFCS_t$	.1907	-.0120	.0001	.0170	.0349	.0004	.0008	.0000	.0000	.0000
$XQFEB_t$	-.2139	.0059	-.0001	-.0083	-.0170	-.0003	-.0003	-.0002	.0000	.0000
$XPFEB_t$	.2504	-.0069	.0000	.0098	.0198	.0000	.0000	.0000	.0000	.0000
$XQFES_t$	-.7522	.0208	-.0002	-.0293	-.0599	.0010	.0009	.0007	.0001	-.0001
$XPFES_t$	.4463	-.0124	.0000	.0175	.0354	.0000	.0000	.0000	.0000	.0000
$XQFNB_t$	-.0423	.0040	.0000	-.0056	-.0115	-.0002	-.0002	-.0001	.0000	.0000
$XPFNB_t$	.0931	-.0087	.0000	.0122	.0257	.0000	.0000	.0000	.0000	.0000
$XQFNS_t$	.2528	.0238	-.0002	-.0336	-.0686	-.0011	-.0010	-.0009	.0001	-.0001
$XPFNS_t$	.1167	-.0110	.0001	.0155	.0316	.0000	.0000	.0000	.0000	.0000
$WQkFS_t$	-.0281	.1164	-.0061	-.1666	-.3281	-.0288	-.0063	-.0048	.0016	-.0023
SpB_t	-.8494	-.0313	.0002	.0444	.0903	.0017	.0017	.0017	.0000	.0000
$WQkOS_t$	-.0824	.4816	-.0001	-.6563	-1.4562	-.0003	-.0087	-.0112	.0000	.0000
$RpOS_t$	-.1863	1.0885	.0000	-1.4832	-3.2910	-.0010	-.0196	-.0258	.0000	.0000
$WSkFS_t$	-.0607	.5954	-.0058	-.8400	-1.7153	-.0277	-.0258	-.0216	.0015	-.0022
$WSkOS_t$	-.1744	1.0196	-.0001	-1.3892	-3.0825	-.0004	-.0184	-.0236	.0000	.0000

[1] See Appendix F for means of the variables used in the model.

(continued)

Table 37 (continued).

Endogenous Variables	Elasticity (percent)						Flexibility (percent)		
	AE_t	AN_t	$RxBS_t$	$RxSC_t$	$RxSE_t$	$RxSN_t$	PdS_t	PdS_{t-1}	$PdSp_{t-6}$
$RQFS_t$	.0000	.0000	.0001	.0000	-.0001	.0001	.1836	.1451	.0000
$RPFS_t$	.0000	.0000	.0000	.0000	.0000	.0000	-.4102	-.2314	-.0001
$WQFFI_t$	-.0001	-.0001	.0002	-.0001	-.0003	.0002	.4530	-.1471	.0001
$WPFFI_t$	.0000	.0000	.0000	.0000	.0000	.0000	-.7699	-.4343	-.0001
$MQFSB_t$	.0005	.0008	.2268	.0006	.0022	-.0011	-3.0212	-.4552	.1856
$MPFSB_t$	.0000	.0000	-.1642	.0000	.0000	.0000	-.3944	-.2225	-.1341
$RQOS_t$	.0001	.0001	-.0002	.0001	.0003	-.0001	-.4309	-.1078	-.0001
$RPOS_t$	.0000	.0000	.0000	.0000	.0000	.0000	-.0192	-.0766	.0000
$WQOFI_t$	.0000	.0001	-.0001	.0001	.0002	-.0001	-.2410	.1105	.0000
$WPOFI_t$	.0000	.0000	.0000	.0000	.0000	.0000	.0454	-.7363	.0000
$XQFCB_t$	.0001	.0001	.6507	-.4482	.0002	-.0001	-.3535	-.1995	.0353
$XPFCB_t$	.0000	.0000	-.6202	-.8662	.0000	.0000	-.6851	-.3865	-.0885
$XQFCS_t$	.0000	.0001	.0394	.4473	-.0002	-.0002	.3187	.1990	.0242
$XPFCS_t$	.0000	.0000	-.0304	-.5287	.0000	.0000	-.4170	-.2353	-.0250
$XQFEB_t$	.5292	.0000	1.5296	.0000	.6679	.0001	.2042	.1152	.0943
$XPFEB_t$	.0000	.0000	-2.1055	.0000	-.7847	.0000	-.2390	-.1348	-.1244
$XQFES_t$	.5028	.0000	-.0615	.0000	2.3485	.0000	.7179	.4050	.0906
$XPFES_t$	.0000	.0000	-.0715	.0000	-1.3934	.0000	-.4259	-.2403	-.0585
$XQFNB_t$	.0000	-.9574	.4762	.0000	-.0001	.3184	.1377	.0777	-.0173
$XPFNB_t$	.0000	.0000	-1.4062	.0000	.0000	.6909	.3023	-.1706	.0556
$XQFNS_t$	-.0001	1.2326	-.4806	-.0001	-.0006	-1.9026	.7349	.4640	.0584
$XPFNS_t$	.0000	.0000	-.0185	.0000	.0000	.8779	-.3794	-.1908	-.0152
$WQkFS_t$	-.0034	-.0057	.0076	-.0040	-.0160	.0088	-.2581	.0378	.0034
SpB_t	.0000	.0000	.1372	.0000	.0000	.0000	-1.0836	-.6114	.1894
$WQkOS_t$	.0000	.0000	.0001	-.0001	-.0002	.0001	.2410	-.1105	.0000
$RpOS_t$	.0000	.0000	.0000	.0000	.0000	.0000	.4518	.1130	.0001
$WSkFS_t$	-.0033	-.0045	.0073	-.0037	-.0145	.0072	-.6944	.1806	.0033
$WSkOS_t$	.0000	.0000	.0000	.0000	.0000	.0000	.4455	-.2043	.0001

The most important effects of lagged wholesale price of FCOJ in Florida ($WPFFl_{t-1}$) are on the USA imports of FCOJ from Brazil, the USA exports, especially to the EEC7 countries, and Brazilian exports to Canada and to the EEC7 countries. Low previous period prices ($WPFFl_{t-1}$) results in a more than proportional decrease in the current USA import price of FCOJ from Brazil ($MPFSB_t$). However, the impact on Florida's current wholesale price ($WPFFl_t$ and $WPOFl_t$) is practically zero. The net effect is an increase in the price spread (SpB_t) and more imports from Brazil are brought into the USA. The extended effects on FCOJ exports to Europe and Canada from the USA and Brazil are directly related to the effects on the USA imports from Brazil. USA FCOJ export prices are affected by the current Florida wholesale price ($WPFFl_t$) and the import price from Brazil ($MPFSB_t$). Since $WPFFl_t$ is relatively unaffected, the impact on export prices of $WPFFl_{t-1}$ is through the reduction on $MPFSB_t$. As this price declines, USA export prices also decline, as indicated by the transmission elasticities in Table 37 (column one). Given lower export prices due to cheaper imports, USA exports to the EEC7 countries and to Canada increase as expected. However, USA exports to the European non-EEC3 countries declined, even though the respective export price also declined. This means that the substitution effect of the lower Brazilian price offsets the effect of the lower USA price. In addition, it is possible that some imports within this period are contractually related to prior

period prices. Brazil's FCOJ exports to the European and Canadian markets are expected to be affected by low previous wholesale prices in Florida in two different ways. The first effect is a reduction of the Brazilian prices to these markets, since the corresponding prices from the USA declined and Brazilian prices are positively related to USA prices. Thus, more exports of FCOJ from Brazil are expected to Europe and Canada. The second effect is that lower prices of FCOJ from the USA in those countries should reduce Brazilian FCOJ exports to the same markets, since some degree of substitution is expected to exist between the two FCOJ sources. The elasticity estimates in Table 37 express the net effect of these opposite forces. In Canada, the net result is a reduction in Brazilian exports (-.1617 percent) implying that the substitution effect is greater than the price effect. In Europe the net effect is positive suggesting that the volume of Brazil's exports to the EEC7 and the European non-EEC3 countries increase. The magnitude of these effects are quite different. To the EEC7 countries, a 1 percent decrease in $WPFFl_{t-1}$ will increase exports from Brazil by nearly .2 percent. However, to the European non-EEC3 countries, the effect on Brazil's FCOJ exports is very small (-.0423 percent).

Reduced-form elasticity estimates relative to the lagged wholesale price of other orange juices in Florida (Table 37, column two) suggests major impacts on the USA imports of FCOJ from Brazil (-2.8475 percent) and on the

retail domestic market for other orange juices. One percent reduction of $WPOFl_{t-1}$ is likely to increase retail consumption of other orange juices in the USA by more than 1 percent and increase FCOJ imports from Brazil by almost 3 percent. These results suggest that imports in the USA domestic market have increased as a result of other orange juices' demand growth (chilled and canned single strength).

In the Canadian market, estimates of the effects of the USA export price of other orange juices (Table 37, column three) relative to FCOJ exports from Brazil and the USA ($XQFCB_t$ and $XQFCS_t$) indicate that the Brazilian product exhibits an elastic (3.9405 percent) response while the USA product exhibits a relatively inelastic (.4308 percent) response. If $XPOCS_t$ increases by 1 percent, exports of FCOJ from Brazil increase by almost 4 percent while the USA exports increase by less than .5 percent. These results support the idea that differentiation of the USA FCOJ has resulted in a very efficient protective barrier to competition from other sources.

Derived reduced-form coefficient estimates of retail price of frozen orange-flavored synthetics and drinks in the USA ($RPShS_t$) seem to indicate strong substitute relationships in the USA demand for FCOJ imports from Brazil ($MQFSB_t$) and in the retail domestic market for other orange juices ($RQOS_t$). Both cross-price elasticities (Table 37, column four) are elastic, but imports of FCOJ from Brazil are relatively more responsive to changes in

$RPShS_t$ (3.8827 percent) than retail consumption of other orange juices (1.4146 percent). Some effects are also translated to the USA domestic market for FCOJ ($RQFS_t$ and $WQFFl_t$). This analysis suggests that imports brought into the USA are related to increases in consumption of orange juices other than FCOJ.

Imports of FCOJ from Brazil ($MQFSB_t$) and other orange juices ($RQOS_t$ and $WQOFl_t$) are positively related to income. Reduced-form estimates of income elasticities (Table 37, column five) indicate that for each 1 percent increase in income per capita in the USA (IS_t) the results of a chain reaction would be an increase of almost 9 percent in FCOJ imports from Brazil (8.6015 percent), of more than 3 percent in retail consumption of other orange juices (3.1384 percent), and of almost 2 percent in the corresponding wholesale sales in Florida (1.6670 percent). FCOJ domestic sales are likely to increase by practically .8 percent at the retail level (.7688 percent) and by more than 1 percent at the wholesale level in Florida (1.4278 percent).

In Canada, income effects are relatively strong for both sources of supply. As the estimates of income elasticities (Table 37, column six) indicate, a 1 percent increase in per capita income in Canada is expected to increase Brazilian FCOJ exports ($XQFCB_t$) by almost 4 percent and USA exports ($XQFCS_t$) by more than 2 percent. This relatively favorable response for the Brazilian product may suggest that Canadian consumers that use orange juice of

higher quality (assumed to be the USA product) do not increase consumption at the same rate as the other consumers or that new consumers are more likely to be using the Brazilian product.

Impact of Exchange Rate

The impact on endogenous variables of changing the rate of the Brazilian cruzeiro relative to the USA dollar, and the rates of the USA dollar relative to the Canadian dollar and to European currencies, expressed in terms of 1975 prices, are presented in Table 37 (columns thirteen to sixteen), as reduced-form elasticities. As expected the impacts of changing exchange rates are stronger on prices than on export quantities.

Larger structural-form estimate of the rate of USA dollar per Canadian dollar ($RxSC_t$) relative to the associated standard error (Table 27), makes the respective reduced-form elasticity estimates (Table 37, column fourteen) quite relevant. One percent devaluation of the USA dollar relative to Canadian currency is likely to decrease USA FCOJ export prices to Canada ($XPFCS_t$) by more than .5 percent and consequently exports of FCOJ increase almost by the same percentage. The extended effect reduced Brazil's export price to Canada ($XPFCB_t$) by almost .9 percent and export quantity ($XQFCB_t$) by more than .4 percent. This last result is the net effect of the impact of lower export prices of Brazilian FCOJ which is directly related to the USA price ($XPFCS_t$), thus reducing exports of FCOJ from Brazil. The

implications for FCOJ exports to the Canadian market are important, since devaluation of the USA dollar against the Canadian dollar is likely to increase exports of the USA product and to decrease sales of the Brazilian FCOJ. Increased valuations of the dollar, which occurred during the time period of this study, is likely to improve Brazil's exports and to reduce USA exports to this market.

Estimates of the indices used to capture the effects of variation in the rate of the dollar relative to European currencies on USA exports of FCOJ are different for the two groups of countries. Decreasing the indices (devaluation of dollar relative to all currencies for a given group of countries) is expected to reduce prices and consequently to increase exports. Increasing the indices is expected to have the opposite effect which would result in higher export prices and consequently less FCOJ exported.

Reduced-form elasticity estimates (Table 37, columns fifteen and sixteen) conform with the expectations only in the case of the European non-EEC3 countries. If the index decreases by 1 percent the USA export price of FCOJ ($XQFNS_t$) is likely to decrease by almost .9 percent and exports are expected to increase by practically 2 percent. The extended effects on exports from Brazil are also consistent with the expectations, but the elasticities are relatively small. The estimates relative to the EEC7 countries are only partially consistent with that rationale. Based on the elasticity estimates, a reduction of the index by 1 percent

will increase the USA export price by more than 1 percent and will reduce exports by more than 2 percent. Extended effects on Brazilian exports to this market have the same directional impact on prices and quantities exported. The relationships between export prices and export quantities are consistent in both cases. However, reduction of the index in this market is associated with higher export prices. This apparent inconsistency is related to the fact that the rates of the dollar relative to a group of foreign currencies do not necessarily change in the same direction, even though the derived index of these exchange rates may suggest a net devaluation or increased valuation. In these cases the effects on FCOJ exports (price and quantity) will not be related to the direction of the index itself but on the relative impact of variation in individual exchange rates on exports to the respective countries. Thus, it is possible that a given value of the index may not indicate that all individual exchange rates used in its derivation have changed in the same direction, and that export price and quantity may change differently as in the case of same directional change of all exchange rates.

Impact of Orange Production

The effects of variation in orange production in the USA and in São Paulo (Brazil) on trade of orange juice are analyzed through the estimates of the flexibilities in Table 37 (columns eighteen to nineteen). It should be

recalled that crop estimate variables refer to the average bimonthly forecasts of annual production in the case of the USA and to yearly estimates of production in the state of São Paulo in the case of Brazil.

Current and lagged reduced-form estimates of flexibilities for orange production in the USA (PdS_t and PdS_{t-1}) have important implications for the orange juice trade. The impacts on USA FCOJ imports are quite strong. For example, if the current crop estimate (PdS_t) decreases, import prices from Brazil ($MPFSB_t$) increase since Florida's wholesale price for FCOJ increases and the Brazilian price is a direct fucntion of Florida's price ($WPFFl_t$). However, the FOCJ import price from Brazil increases relatively less than the wholesale price in Florida. Thus, 1 percent decrease in PdS_t is expected to increase the price spread ($WPFFl_t$ - $MPFSB_t$) by more than 1 percent and imports from Brazil by more than 3 percent. It is important to emphasize the highly elastic response of the USA imports from Brazil to changes in current estimates of ornage production (PdS_t).

In Canada, Brazil's FCOJ exports ($XQFCB_t$) also increase even though export prices increase. Brazil ultimately exports more because the substitution effect associated with a higher export price from the USA is more than sufficient to offset the price effect associated with a higher export price of the Brazilian FCOJ.

In Europe the two products seem to be quite independent of each other and as price increases exported quantity is

likely to decrease. In the EEC7 market for FCOJ exports from Brazil and the USA the result of reduction of current orange production forecasts in the USA is higher prices and consequently smaller quantities exported from both suppliers. There is an exception in the case of Brazil's exports to the European non-EEC3 countries. As current crop estimates indicate, a decrease in orange production in the USA leads to a decrease of both export price and quantity of FCOJ from Brazil.

The reduced-form flexibility estimates relative to variations in yearly orange production in São Paulo (Brazil) indicate that their impacts on the orange juice trade are small and perhaps not very meaningful, given that some of the structural-form estimates involved in the derivation are small relative to their associated standard errors (Tables 19, 25, 29 and 33).

Impact of Freeze

The analysis relative to the impact of freeze in the USA, or more specifically in Florida (D_t), as formulated in the structural-form of the model, will be based on the derived reduced-form estimates presented in Table 36.

The occurrence of freezes in Florida is likely to add more than 28 cents per gallon to the wholesale price of Florida's FCOJ ($WPFFl_t$) and practically 32 cents per gallon to the wholesale price of Florida's other orange juice prices ($WPOFl_t$). Even though the effects on prices are relatively higher on other orange juices, the consequent

impacts on wholesale orange juice movements are quite different. As prices increase Florida's FCOJ movement decreases by almost 20 gallons per thousand persons and other orange juice movement increases by nearly one gallon per thousand persons. Associated with these changes there is a substantial increase in FCOJ stocks and a small reduction on other juices' stocks, which is practically equal to the change in $WQOFl_t$. In order to rationalize these results it is necessary to look at the extended effects on the USA imports from Brazil, exports to other markets and domestic consumption. Import price of FCOJ from Brazil is expected to have a small increase of nearly 6 cents per gallon that, associated with the variation in Florida's wholesale price ($WPFFl_t$), results in increase in the spread (SpB_t) of almost 22 cents per gallon. As the spread widens, imports of FCOJ from Brazil increase by approximately 25 gallons per thousand persons. At retail level in the USA, higher FCOJ prices decrease consumption substantially. However, other orange juice prices increase only slightly and consumption increases by more than 15 gallons per thousand persons. A strong substitution effect toward chilled and canned single strength is quite evident.

The impact on reduction of the USA exports of FCOJ is relatively high in the European non-EEC3 countries, and smaller in Canada and the EEC7 countries. The occurrence of a freeze in Florida also affects Brazilian exports of FCOJ to these markets. In European markets higher prices of

the Brazilian product result in less exports for the EEC7 and the European non-EEC3 countries. Higher prices for the USA product have no significant substitution effect toward the Brazilian product. In Canada, however, the estimates suggest that the effects of high prices on Brazilian FCOJ are more than offset by the substitution effect caused by high prices of the USA FCOJ to that market. These results again suggest that some substitution of Brazilian FCOJ for the USA FCOJ in Canada occurs. In the European markets the results indicate that these products are quite independent of each other.

Tests on Performance of the Estimated Model

In this sub-section some insights on how well the estimated model forecasts conform to observed data are presented and discussed based on the derived reduced-form. Estimated and observed values of endogenous variables are compared through the results of formal tests as well as through a set of graphs which give quantitative and visual indications on the "goodness of fit" of the estimated model.

As described in Chapter III, ratios of the root mean square error to the respective observed mean value of endogenous variables for six different periods within the data range were computed (Table 38) to give some quantitative idea of the performance of individual equations of the estimated model. It is interesting to observe that more than 80 percent (136 out of 168) of the computed ratios are less than 10 percent of the respective observed mean value.

Table 38. Ratios of the root mean square error to observed mean value for comparing actual and derived reduced-form estimated values of endogenous variables for specific periods within the data range used in the study

Endogenous variables	Jun-Jul 1972 to Oct-Nov 1973	Dec-Jan 1973-74 to Oct-Nov 1974	Dec-Jan 1974-75 to Oct-Nov 1975	Dec-Jan 1975-76 to Oct-Nov 1976	Dec-Jan 1976-77 to Oct-Nov 1977	Dec-Jan 1977-78 to Oct-Nov 1978
$RQFS_t$	.0141	.0175	.0081	.0100	.0271	.0177
$RPFS_t$	.0156	.0279	.0108	.0089	.0197	.0225
$WQFFl_t$	.3047	.0330	.0274	.0438	.0651	.0219
$WPFFl_t$	.2016	.0430	.0256	.0261	.0474	.0134
$MQFSB_t$	.6146	.4156	.3731	.4571	.6963	.2047
$MPFSB_t$	.0561	.0594	.4082	.0681	.0855	.0363
$RQOS_t$	.0522	.0457	.0210	.0422	.0341	.0130
$RPOS_t$	.0070	.0080	.0055	.0140	.0156	.0126
$WQOFl_t$	.0276	.0218	.0069	.0229	.0237	.0145
$WPOFl_t$	.0190	.0418	.0100	.2072	.0235	.0186
$XQFCB_t$	.1927	.4804	.1332	.2436	.1811	.0792
$XPFCB_t$	.0223	.0394	.0393	.0356	.1301	.0361
$XQFCS_t$	.0352	.0399	.0705	.0629	.0661	.0289
$XPFCS_t$	.0119	.0202	.0113	.0131	.0362	.0181

(continued)

Table 38 (continued).

Endogenous variables	Jun-Jul 1972 to Oct-Nov 1973	Dec-Jan 1973-74 to Oct-Nov 1974	Dec-Jan 1974-75 to Oct-Nov 1975	Dec-Jan 1975-76 to Oct-Nov 1976	Dec-Jan 1976-77 to Oct-Nov 1977	Dec-Jan 1977-78 to Oct-Nov 1978
$XQFEB_t$	.0881	.2538	.0877	.0819	.1117	.1035
$XPFEB_t$	.0291	.0586	.0545	.0895	.1068	.0289
$XQFES_t$	.1216	.3707	.3760	.1052	.1991	.1780
$XPFES_t$	.0641	.0886	.0800	.0830	.0954	.0464
$XQFNB_t$	.2122	.1337	.1144	.1861	.1619	.1060
$XPFNB_t$	.0247	.0329	.0511	.0935	.0968	.0290
$XQFNS_t$	.1001	.2568	.0897	.0841	.0981	.1871
$XPFNS_t$	.0300	.0746	.0427	.0226	.0514	.0275
$WQkFS_t$	.0115	.0096	.0102	.0126	.0429	.0205
$WSkFS_t$	.0433	.0340	.0396	.0604	.0762	.0425
$WQkOS_t$	.0322	.0421	.0347	.0482	.0171	.0420
$WSkOS_t$	.0601	.0421	.0345	.0668	.0323	.0597
SpB_t	.0635	.1032	.0610	.0690	.0989	.0294
$RpOS_t$	.0474	.0345	.0204	.0455	.0462	.0303

Most of the ratios that are greater than 10 percent are from equations for the USA FCOJ imports from Brazil and exports to the EEC7 countries, and Brazilian exports of FCOJ to Canada and to the European non-EEC3 countries.

The final test on performance of the estimated model is given by the set of graphs (Figures 1 to 28) in Appendix II, where actual and reduced-form estimated values of endogenous variables are plotted over time. Together with previous tests and with statistical results of the structural-form estimates, this set of graphs gives some indication of the "goodness of fit" of the model.

CHAPTER V

SUMMARY AND CONCLUSIONS

This chapter includes a brief review of major points addressed in the preceding chapters, concluding remarks associated with the study objectives, and suggestions with respect to improvement of future studies.

Summary

In recent years, trade of orange juices became an important economic issue for a large number of countries. On one side, for the leading producer and exporting countries like Brazil and the USA, orange juice and particularly frozen concentrated orange juice (FCOJ) exports have been significant as sources of foreign revenues as well as important to the economic survival of many internal industries, especially in Brazil. On the other side, for the importing (or producer-importer-exporter) countries like the EEC7 (seven countries of the European Economic Community), the European non-EEC3 (three European, non-EEC countries), Canada and the USA, FCOJ imports have also been quite important in fulfilling demand for orange juice. For the USA, as a producer, the foreign trade sector also adds substantial economic activity that may not have occurred otherwise.

The major trade models addressing the orange juice issues with an international perspective (Ward, 1976a; Moretti, 1978; Tilley & Lee, 1981) have concentrated on one sector or on one country or region. In the present study, the economic model for orange juices encompasses the international linkage among the two leading producing countries and leading importing regions. Special emphasis is placed on the role of the foreign trade segment on the domestic orange juice industry.

The objectives of this study are:

1. to identify major factors affecting trade of orange juice;

2. to evaluate the extend to which changes in domestic and foreign demands for the USA orange juice affect the USA FCOJ exports and imports;

3. to evaluate whether foreign and domestic promotion programs for the USA (Florida) orange juice provide an "umbrella" for market expansion of similar products from other producing-exporting countries; and

4. to determine the impact of pricing strategies and price changes on exports and imports of orange juice among producing-exporting and importing countries.

A simultaneous equation econometric model was developed for major countries involved in orange juice trade. The analytical scenario consists of two orange juice products (frozen concentrated and other orange juices), two major producing and exporting countries (the USA and

Brazil) and four major importing countries or groups of countries (Canada, the USA, the EEC7 and the European non-EEC3 countries). The EEC7 countries are West Germany, The Netherlands, the United Kingdom, Belgium, Luxembourg, Denmark and France. The European non-EEC3 countries are Sweden, Norway and Finland.

The conceptual framework consists of a system of simultaneous demand and price equations for FCOJ and other orange juices for the USA retail, wholesale (Florida) and import (FCOJ from Brazil) markets, and Brazilian and USA FCOJ export markets in Canada, the EEC7 and the European non-EEC3. Price equations stem from the simultaneous nature of the model and measure price transmission effects within different levels of a given market and across markets. Brazilian and USA orange juice supplies are assumed to be predetermined, given the nature of orange production and the time unit of the study (bimonth).

Only the USA domestic retail market is included in the model, given its magnitude, as well as its linkages with export and import markets. The Brazilian domestic market is excluded because it is small and systematic data are not available. In the other markets (Canadian and European) trade of orange juice was simplified to include only the FCOJ export sector to these markets from Brazil and from the USA. The domestic orange juice producing sector in Canada and Europe is small or non-existent and it is reasonable to assume that all domestic demand forces

can be captured by international trade demand and price equations. Brazil and the USA are by far the major suppliers of orange juice to these markets, and FCOJ is the most important traded product.

The conceptual formulation of the economic model resulted in a system of simultaneous equations with 28 endogenous variables (22 behavioral and 6 identities) and 41 predetermined (6 lagged endogenous and 35 exogenous) variables. Two-stage least squares (2SLS) was used to estimate the over-identified structural-form equations of the system.

Major Conclusions

Two groups of factors are relevant to trade of orange juices (FCOJ and other orange juices) within different markets and across markets. One set of factors affects orange juice trade indirectly through prices in the system. The other set includes factors that have a major impact on quantity of orange juice traded. In the first group of factors, the analyses of this study are quite consistent in stressing the significant roles of Florida's wholesale prices, of orange production forecasts in the USA, of the USA import and export prices, of exchange rates and of Florida's freeze. Besides their important role in the derivation of the respective retail prices of orange juices in the USA, Florida's wholesale prices, especially of FCOJ, were found to be relevant in the simultaneous determination

of the USA import price of Brazilian FCOJ and consequently in determining the price spread as well as in the derivation of the USA export prices of FCOJ.

Current and previous wholesale prices of FCOJ in Florida are of major importance for Brazilian exporters to the USA. The current FCOJ wholesale price in Florida and import price from Brazil define the price spread which is an important variable in the simultaneous determination of the USA FCOJ imports from Brazil. These same prices are also of major importance in the simultaneous determination of the USA FCOJ export prices to Europe and Canada.

The direct effects of orange production forecasts in the USA and Florida's freeze on orange juice prices are through the formulation of Florida wholesale prices. The extended effects on other prices and to traded quantities are estimated with the derived reduced-form estimates. These orange forecasts significantly affect Florida wholesale prices (especially of FCOJ) and the USA import price of FCOJ from Brazil. Since the impact on the import price was found to be relatively less than on Florida's price, then the price spread changed by the respective differential resulted in a significant impact on the USA imports of FCOJ from Brazil. A 1 percent reduction of current USA orange production is likely to cause an increase of .8 percent in Florida's FCOJ wholesale price of nearly .4 percent in the import price of FCOJ from Brazil, of more than 1 percent on the price spread and consequently of more than 3 percent on

FCOJ imports by the USA from Brazil. Thus, changes in USA imports from Brazil are relatively elastic with respect to the price spread, given some reduction in the current USA orange production forecast. Higher wholesale prices of FCOJ in Florida and of prices of Brazilian FCOJ imports are likely to result in higher export prices for FCOJ from the USA and from Brazil. Higher export prices are likely at first to reduce exports of FCOJ to major consuming regions. The net effect on quantity of each supplier to each importing market will depend on the degree of substitution between the two products in each market. Derived reduced-form flexibilities indicate that, in the USA and Canadian markets, Brazil's FCOJ exports had a net increase, even though the corresponding export price also increased. These results suggested a relatively larger substitution effect on Brazil's exports to Canada and a relatively larger price effect on the USA exports to the same market. Brazilian and USA exports to Europe were found to be relatively independent of each other.

The occurrence of a freeze in Florida is estimated to add approximately 30 cents per gallon to Florida's wholesale price of FCOJ and of other orange juices. Extended effect on USA import prices of FCOJ from Brazil was estimated at nearly 6 cents per gallon, which results in a substantial increase in the spread and consequently more FCOJ imports from Brazil and the USA. The extended effects to other export markets of FCOJ from Brazil and from the USA are translated as higher prices and the net effect on quantities

indicate that, again, only Brazil's FCOJ net exports to Canada increased. All other relations indicate that price effects are sufficiently large to offset substitution effects, and exports of FCOJ from the USA and Brazil are reduced in Europe. USA exports to Canada are reduced and Brazil's FCOJ exports to Canada increase.

Reduced-form estimates of exchange rate impacts indicate that devaluations of the Brazilian cruzeiro relative to the USA dollar are likely to result in more exports of Brazilian FCOJ to European markets, especially to the EEC7 countries, through the primary effects of reducing export prices. If the rate of cruzeiros per dollar increases by 1 percent, the Brazilian FCOJ export price to the EEC7 market would decrease by more than 2 percent and consequently exports would increase by nearly 1.5 percent.

Exchange rate estimates for the USA dollar relative to the Canadian dollar are important in explaining variation in USA exports of FCOJ to Canada. The analyses indicated that, as the USA dollar increases in value relative to the Canadian dollar by 1 percent, the USA export price increases by nearly .5 percent and exports decrease by approximately .4 percent. The extended effects also increase the Brazilian FCOJ export price to Canada by almost .9 percent but the larger substitution effect, given high USA prices, cause Brazilian exports to Canada to increase by almost .4 percent.

In the European markets the estimates of the indices of exchange rates relative to the USA dollar are important to

USA export prices and quantities. However, given a problem of consistency of the index (devaluation relative to a given currency does not necessarily mean devaluation to any other currency in the index), only the estimats for the European non-EEC3 countries agree with unilateral changes relative to the dollar. As the index decreases, which is associated with devaluation of the dollar, the USA FCOJ export price also decreases and exports increase. One percent decrease in the index is related to almost .9 percent decrease in export price and nearly 2 percent increase in USA FCOJ exports to the European non-EEC3 countries. The extension to Brazil's FCOJ exports to the same market results in higher prices and in a reduction in exports of a relatively insignificant magnitude. The results for the EEC7 countries indicate that, as the index decreases, the USA export price to this market increases by 1.13934 percent) and exports decrease by 2.3485 percent. Since the possibility exists that individual exchange rates in the index change in different directions, there was not a unique way to relate these changes to devaluation or increased valuation of the dollar. Even though smaller in magnitude, the extended effects upon Brazil's exports of FCOJ to the EEC7 countries were similar to the effects on USA exports.

Major factors affecting the quantity of orange juice traded are own-prices, prices of substitute products, income, and seasonal variations. Most of the structural-form estimates relative to own-price variables are larger

than the associated standard errors so that the corresponding numerical values can be viewed with some confidence. Structural-form elasticity estimates indicate that FCOJ demand is elastic for the USA imports from Brazil with respect to the price spread (1.6607 percent), for Brazilian exports to Canada with respect to own-price (-1.1884 percent), the USA exports to the EEC7 (-1.7351 percent), and to the European non-EEC3 countries (-2.4662 percent) with respect ot own-price. Brazilian own-price elasticities for FCOJ exports to the European markets were found to be inelastic in both cases, -.7273 percent to the EEC7 and -.3374 percent to the European non-EEC3. The USA own-price elasticity of FCOJ exports to Canada was also found to be inelastic (-.4616 percent).

Estimates of income elasticities are 8.6015 percent for USA imports of FCOJ from Brazil, 3.1384 percent for retail consumption of other orange juices in the USA, and 3.8724 and 2.0362 for Brazilian and USA FCOJ exports to Canada.

Most estimates of advertising coefficients were small relative to their respective standard errors. In the European markets the results, in general, indicate positive impact on USA FCOJ exports, especially to the European non-EEC3 countries. In this market the estimates support the effectiveness of the program and the extended effect on Brazil's exports of FCOJ to this market is negative. In the EEC7 market the program results are both positive and of same approximated relative magnitude for the USA and Brazilian

exports of FCOJ. Even through there is no clear-cut evidence to fully support the statement that foreign and domestic programs of the USA (Florida) orange juice products provide an "umbrella" for market expansion for the same products from other suppliers (Brazil), the analysis does not conclusively reject that hypothesis.

Analyses of seasonal variation suggest that in the USA market, demand for orange juices increases during relatively colder months (October to March) and decreases during those months that are relatively warmer (April to September). This pattern is also quite similar to the one for imports of FCOJ from Brazil. In Canada, Brazil and the USA FCOJ exports follow the same seasonal pattern. In the EEC7 market these two suppliers of FCOJ appear to have opposite seasonal tendencies. October-November bimonths appear to be the peak for Brazilian exports and the lowest for USA exports. April-May bimonths are the lowest USA exports. April-May bimonths are the lowest for Brazil and the peak for the USA.

Suggestions for Future Studies

Improvements in the actual data base should be oriented to correct deficiencies in the Brazilian trade with the USA (USA imports or Brazil exports), in Brazil's exports to the European countries, especially to the European non-EEC3 countries (Sweden, Norway and Finland), and in the USA trade with Canada (USA exports or Canadian

imports). Data on per capita income in Europe, instead of a time proxy as used in this study, would be useful.

Expansion of the model in future studies should give endogenous treatment to the USA exports of other orange juices to Canada and should include Israeli exports to Europe.

Some variables did not respond as expected to the specification used in this model such as advertising, exchange rate index and stock variables. Alternative formulations (other than linear functional form) should be considered, as well as distributed lag structures in the case of advertising variables. The exchange rate indices developed to measure the effects on prices from variations of individual exchange rates for the European markets did not perform consistently to indicate devaluation or increased valuation of the currency considered. Alternative ways to measure these changes may also improve the overall performance of the model. Estimates of the lag structure, such as for Florida's wholesale prices of FCOJ and orange production forecasts in the USA, suggested that the respective dependent variables (prices in these examples) may have given better results if a longer lag structure is used.

The final set of suggestions deals with further analyses based on the estimates of this study. For example, more accuracy of the reduced-form estimates is obtainable, as pointed out by Womack and Matthews (1972, p. 98), if evaluation at some point other than the mean values (say

previous period values or last values of the data series) is used to linearize the ratios of the equations for FCOJ stock, retail proportion of other orange juices in cardboard containers, and other orange juices' stocks by Taylor's Series expansions.

APPENDIX A

EXPORTS OF ORANGE JUICE

Table A.1. Leading orange juice exporting countries, 1969-1978

Year	Brazil[a]	USA[b]	Mexico[c]	Israel[d]	Spain[e]	South Africa[e]
	----------1,000 gallons of single strength juice equivalent----------					
1969	29,528	28,805	381	23,779	14,228	12,322
1970	42,513	42,278	1,016	23,162	23,120	9,782
1971	98,238	46,199	2,287	42,458	23,882	8,765
1972	110,719	50,205	8,384	43.192	26,931	10,671
1973	153,710	62,522	13,212	43,406	24,518	19,055
1974	137,782	64,106	13,974	49,078	23,120	11,433
1975	229,802	70,140	4,446	42,764	20,834	6,987
1976	266,568	85,418	10,798	71,705	45,224	8,257
1977	271,248	86,539	30,361	38,242	21,596	5,208
1978	423,865	58,037	29,853	42,859	24,518	5,717
Total	1,763,973	594,249	114,712	390,645	247,971	98,197
Percent	44.49	14.99	2.89	9.85	6.25	2.48

(continued)

Table A.1. (continued)

Year	Greece[f]	Morocco[e]	Italy[e]	Belize[e]	Argentina[e]	Other countries[e,1]	Total
	1,000 gallons of single strength juice equivalent						
1969	9,909[2]	23,247	30,107	7,113	635	17,530	197,584
1970	3,811	29,091	32,647	5,589	1,143	17,149	231,301
1971	6,352	14,863	29,090	7,495	7,876	16,641	304,146
1972	12,703	20,452	30,488	7,113	6,605	15,244	342,707
1973	12,703	22-866	24,898	7,367	4,065	15,752	404,074
1974	12,703	15,752	21,087	7,340	3,049	24,644	383,968
1975	12,703	10,671	16,641	5,716	2,286	11,941	434,931
1976	10,671[2]	13,466	5,970	5,208	3,430	17,022	513,737
1977	9,146[2]	13,466	8,765	4,700	3,430	14,100	506,801
1978	12,830[2]	13,466	11,814	4,954	3,557	14,608	646,078
Total	103,531	177,340	211,507	62,495	36,076	164,631	3,965,327
Percent	2.61	4.47	5.33	1.58	.91	4.15	100.00

[1]Includes Algeria, Cyprus, Ghana, Jamaica, and Trinidad-Tobago. [2]Estimates.

Sources: Computed from [a]Brazil, Serviço de Estatística Econômica Financeira, Ministério da Fazenda, 1970-1979; [b]United States Department of Commerce, Bureau of the Census, 1969-1979a; [c]Mexico, Secretaría de Industria y Comercio, 1972-1979; [d]Israel, Central Bureau of Statistics, 1970-1980; [e]Food and Agriculture Organization of the United Nations, 1980; and [f]Morais and Medeiros, 1978.

Table A.2. Brazilian exports of orange juice by country of destination, 1969-1979

Year	West Germany	United Kingdom	The Netherlands	Belgium & Luxembourg	Denmark	France	EEC total	Sweden
	1,000 gallons of single strength juice equivalent							
1969	12,172	608	4,454	113	330	00	17,677	1,059
1970	24,200	739	5,212	366	241	00	30,758	1,322
1971	35,584	987	11,201	1,062	880	683	50,397	3,156
1972	39,870	920	18,550	2,017	899	783	63,039	8,345
1973	70,238	579	33,110	1,679	1,059	884	107,549	13,200
1974	43,034	752	26,243	2,066	673	305	73,073	19,495
1975	56,041	5,358	54,472	2,721	1,371	254	120,217	20,491
1976	55,256	6,870	85,453	5,567	5,440	305	158,891	23,203
1977	39,873	9,798	67,614	2,726	7,354	51	127,416	24,593
1978	37,419	17,030	57,947	2,292	5,724	00	120,412	24,190
1979	50,068	19,510	73,962	4,936	6,988	00	155,464	22,338
Total	463,755	63,151	438,218	25,545	30,959	3,265	1,024,893	161,392
Percent	21.72	2.96	20.52	1.20	1.45	.15	48.00	7.56

(continued)

Table A.2. (continued)

Year	Norway	Finland	Other European non-EEC[1]	European non-EEC total	Canada	USA	Israel	Other countries[2]	Total
	1,000 gallons of single strength juice equivalent								
1969	111	19	230	1,419	5,940	3,587	699	206	29,528
1970	192	13	193	1.720	5,448	1,277	2,505	805	42,513
1971	555	133	127	3,971	13,242	29,720	318	590	98,238
1972	503	514	597	9,959	13,547	22,428	1,551	195	110,719
1973	503	1,380	2,051	17,134	11,170	13,952	3,393	512	153,710
1974	849	1,180	1,623	23,147	9,459	29,360	1,397	1,346	137,782
1975	1,538	3,875	11,529	37,433	26,828	26,180	11,329	7,815	229,802
1976	1,931	7,622	9,971	42,727	20,117	21,183	18,426	5,224	266,568
1977	2,177	6,302	10,516	43,588	26,281	59,461	7,167	7,335	271,248
1978	2,722	10,135	5,133	42,180	43,021	187,389	11,829	19,034	423,865
1979	3,844	13,317	8,853	48,352	36,634	92,805	13,128	25,019	371,402
Total	14,925	44,490	50,823	271,630	211,687	487,342	71,742	68,081	2,135,375
Percent	.70	2.08	2.38	12.72	9.91	22.82	3.36	3.19	100.00

[1] Includes Austria, East Germany, Poland, Portugal, Spain, Switzerland and Yugoslavia.
[2] Includes Argentina, Australia, Bolivia, Chile, Japan, Mozambique, Netherlands Antilles, New Zealand, Paraguay, Senegal, South Africa and Venezuela.

Source: Computed from Brazil, Serviço do Estatística Econômica e Financeira, Ministério de Fazenda, 1970-1979.

Table A.3. The United States of America exports of orange juice by country of destination, 1969-1979

Year	West Germany	United Kingdom	The Netherlands	Belgium & Luxembourg	Denmark	France	Other EEC[1]	EEC total
	1,000 gallons of single strength juice equivalent							
1969	2,162	1,347	1,246	463	264	1,278	188	6,948
1970	4,075	2,188	2,854	703	496	1,231	201	11,748
1971	3,735	2,105	2,502	661	192	1,278	130	10,603
1972	4,867	1,659	4,888	553	72	1,225	240	13,504
1973	5,060	2,594	7,361	575	400	1,721	285	17,996
1974	3,421	2,085	4,397	516	442	1,534	132	12,527
1975	3,602	2,517	6,907	512	321	2,177	307	16,343
1976	8,104	3,651	10,681	1,699	661	2,478	300	27,574
1977	5,226	4,009	9,222	418	701	2,641	551	22,768
1978	2,587	1,666	3,074	391	442	2,453	342	10,955
1979	2,786	1,965	4,092	394	66	4,409	320	14,032
Total	45,625	25,786	57,224	6,885	4,057	22,425	2,996	164,998
Percent	6.91	3.91	8.67	1.04	.61	3.40	.45	24.99

(continued)

Table A.3. (continued)

Year	Sweden	Norway	Finland	Other European non-EEC[2]	European non-EEC total	Canada	Other countries[3]	Total
	1,000 gallons of single strength juice equivalent							
1969	2,448	65	00	1,260	3,773	15,982	2,102	28,805
1970	5,177	115	23	1,608	6,923	20,487	3,120	42,278
1971	10,155	549	105	1,420	12,229	21,034	2,333	46,199
1972	6,125	811	513	1,425	8,874	23,400	4,427	50,205
1973	8,640	1,440	513	2,600	13,193	27,019	4,314	62,522
1974	7,729	1,687	865	2,545	12,826	31,598	7,155	64,106
1975	8,157	1,619	351	1,835	11,962	34,988	6,847	70,140
1976	8,018	1,407	348	2,084	11,857	37,853	8,134	85,418
1977	8,415	1,744	145	2,745	13,049	38,432	12,290	86,539
1978	3,788	384	106	1,394	5,672	31,589	9,821	58,037
1979	3,522	478	00	1,433	5,433	34,510	12,003	65,978
Total	72,174	10,299	2,969	20,349	105,791	316,892	72,546	660,227
Percent	10.93	1.56	.45	3.08	16.02	48.00	10.99	100.00

[1]Includes Italy and Ireland. [2]Includes Austria, Bulgaria, East Germany, Iceland, Poland, Spain and Switzerland. [3]Includes Australia, Hong Kong, Japan, Malaysia and forty other countries.

Source: Computed from United States Department of Commerce, Bureau of the Census, 1969-1979a.

Table A.4. The United States of America exports of FCOJ and other orange juices by major regions and countries of destination, 1972-1979

	FCOJ				Other orange juices				Total
	EEC7[1]	Euroepan non-EEC3[2]	Canada	All other countries[3]	EEC7[1]	European non-EEC3[2]	Canada	All other countries[3]	
	1,000 gallons of single strength juice equivalent								
1972	8,027	6,996	18,037	1,531	5,243	453	5,903	4,021	50,205
1973	12,898	10,240	21,139	2,878	4,813	353	5,880	4,321	62,522
1974	7,794	9,905	25,665	5,791	4,601	376	5,933	4,041	64,106
1975	11,925	9,962	29,024	5,239	4,111	165	5,964	3,750	70,140
1976	21,678	9,567	31,508	6,343	5,596	206	6,345	4,175	85,418
1977	17,268	10,081	31,545	10,593	4,950	223	6,887	4,993	86,539
1978	7,165	4,152	24,924	6,187	3,448	126	6,664	5,371	58,037
1979	8,938	3,876	28,230	7,495	4,775	125	6,280	6,259	65,978
Total	95,686	64,779	210,072	46,057	37,537	2,027	49,856	36,931	542,945
Percent	17.63	11.93	38.69	8.48	6.92	.37	9.18	6.80	100.00

[1]Includes West Germany, The Netherlands, the United Kingdom, Belgium, Luxembourg, Denmark and France. [2]Includes Sweden, Norway and Finland. [3]Includes Australia, Hong Kong, Japan, Malaysia and forty other countries.

Source: Computed from United States Department of Commerce, Bureau of the Census, 1969-1979a.

APPENDIX B

IMPORTS OF ORANGE JUICE

Table B.1. Leading orange juice importers, 1969-1978

Year	West Germany[a]	The Netherlands[a]	United Kingdom[a]	Belgium & Luxembourg[a]	France[a]	Denmark[a]	Other EEC countries[a,1]	EEC total
	1,000 gallons of single strength juice equivalent							
1969	67,455	18,420	111,536	8,257	27,566	7,749	2,668	243,651
1970	89,813	21,850	104,295	8,638	36,332	10,290	7,749	278,967
1971	132,624	26,042	137,705	13,593	38,999	9,146	17,531	375,640
1972	161,587	30,869	141,897	16,133	43,319	11,433	16,006	421,244
1973	204,017	48,400	76,660	18,420	68,598	16,133	8,384	440,612
1974	144,057	61,357	83,841	19,944	67,963	16,769	6,860	400,791
1975	185,470	62,755	75,840	28,964	56,657	18,293	2,922	430,901
1976	186,232	57,546	79,451	35,951	61,612	21,342	1,397	443,531
1977	159,047	95,657	78,380	38,110	58,436	23,755	1,270	454,655
1978	126,828	71,266	77,745	37,094	60,849	13,974	2,160	389,916
Total	1,457,130	494,162	967,350	225,104	520,331	148,884	66,947	3,879,908
Percent	24.10	8.18	16.00	3.72	8.61	2.46	1.11	64.18

(continued)

Table B.1. (continued)

Year	Sweden[a]	Norway[a]	Finland[a]	Other European non-EEC[a,2]	European non-EEC total	Canada[b]	USA[c]	Other countries[a,3]	Total
	1,000 gallons of single strength juice equivalent								
1969	25,915	4,573	3,684	38,872	73,044	31,886	7,133	2,022	358,636
1970	38,872	4,700	3,938	42,430	89,940	29,091	2,633	5.971	406,602
1971	36,205	5,335	5,462	42,430	89,432	36,458	18,943	6,987	527,460
1972	33,283	6,479	7,368	48,908	96,038	39,610	44,495	6,606	607,993
1973	38,364	7,622	8,384	51,322	105,692	48,957	28,624	9,909	633,794
1974	41,921	7,114	7,622	64,533	121,190	49,450	21,005	20,961	613,397
1975	36,586	7,622	11,814	63,517	119,539	65,326	33,046	39,254	688,066
1976	47,257	7,876	16,133	63,517	134,783	65,079	34,878	49,035	727,306
1977	43,319	9,655	14,101	65,423	132,498	68,799	49,713	30,361	736,026
1978	35,188	8,257	12,703	57,038	113,186	84,845	141,181	16,896	746,024
Total	376,910	69,233	91,209	537,990	1,075,342	519,501	381,651	188,902	6,045,304
Percent	6.23	1.15	1.51	8.90	17.79	8.59	6.31	3.13	100.00

[1]Includes Italy and Ireland. [2]Includes Austria, Bulgaria, East Germany, Iceland, Spain and Yugoslavia. [3]Includes Antigua, Australia, Barbados, Jamaica, South Africa, and Trinidad-Tobago.

Sources: Computed from [a]Food and Agriculture Organization of the United Nations, 1980; [b]Statistics Canada, 1969-1979; and [c]United States Department of Commerce, Bureau of the Census, 1969-1979b.

Table B.2. The United States of America imports of orange juice by country of origin, 1969-1979

Year	Brazil	Mexico	Belize	Other countries[1]	Total
	----------1,000 gallons of single strength juice equivalent----------				
1969	3,802	697	1,711	923	7,133
1970	1,308	577	746	2	2,633
1971	15,413	1,230	1,415	885	18,943
1972	34,534	5,726	1,196	3,309	44,495
1973	13,327	5,848	1,349	8,100	28,624
1974	14,115	5,160	364	1,366	21,005
1975	28,214	3,315	00	1,517	33,046
1976	31,091	1,473	00	2,314	34,878
1977	33,749	13,790	182	1,992	49,713
1978	129,891	9,860	00	1,430	141,181
1979	148,703	7,376	00	332	156,411
Total	454,147	55,052	6,963	21,900	538,062
Percent	84.41	10.23	1.29	4.07	100.00

[1]Includes Argentina, Israel, Italy, Japan, Spain, South Africa and eleven other countries.

Source: United States Department of Commerce, Bureau of the Census, 1969-1979b.

Table B.3. Canadian imports of orange juice by country of origin, 1969-1979

Year	USA	Brazil	Mexico	Belize	Other countries[1]	Total
	----------1,000 gallons of single strength juice equivalent----------					
1969	16,092	7,571	3,677	368	3,178	31,886
1970	19,560	5,189	3,565	237	540	29,091
1971	19,826	11,352	3,628	494	1,158	36,458
1972	22,299	12,336	2,321	1,174	1,480	39,610
1973	25,751	16,761	4,018	1,087	1,340	48,957
1974	32,577	7,479	5,358	2,076	1,960	49,450
1975	35,798	26,302	1,230	1,243	753	65,326
1976	39,394	22,160	1,673	1,835	17	65,079
1977	38,256	23,215	6,004	540	784	68,799
1978	35,270	45,869	3,406	00	300	84,845
1979	40,296	44,651	2,712	00	128	87,787
Total	325,119	222,885	38,592	9,054	11,638	607,288
Percent	53.54	36.70	6.35	1.49	1.92	100.00

[1]Includes Argentina, Jamaica, Israel, South Africa and nineteen other countries.

Source: Computed from Statistics Canada, 1969-1979.

Table B.3.1. Canadian imports of FCOJ and other orange juices by countries of origin; 1972-1979

Year	FCOJ				Other orange juices			Total
	USA	Brazil	All other countries[1]	Total	USA	All other countries[2]	Total	
	1,000 gallons of single strength juice equivalent							
1972	17,136	12,296	4,135	33,567	5,162	881	6,043	39,610
1973	20,103	16,732	5,934	42,769	5,649	539	6,188	48,957
1974	23,339	7,417	7,913	38,669	9,238	1,543	10,781	49,450
1975	25,235	25,835	2,825	53,895	10,562	869	11,431	65,326
1976	30,673	21,919	3,316	55,908	8,720	451	9,170	65,079
1977	28,144	22,415	6,512	57,071	10,112	1,616	11,728	68,790
1978	25,479	45,585	3,581	74,645	9,790	410	10,200	84,845
1979	31,498	44,273	2,776	78,547	8,798	442	9,240	87,787
Total	201,607	196,472	36,992	435,071	68,031	6,754	74,782	509,853
Percent	29.54	38.53	7.26	85.33	13.34	1.33	14.67	100.00

[1]Includes Argentina, Belize, Israel, Jamaica, Mexico and nineteen other countries. [2]Includes same countries as in footnote 1 and small amount of juice recorded as from Brazil.

Source: Computed from Statistics Canada, 1969-1979.

Table B.4. EEC imports of orange juice from Brazil and the United States of America, 1969-1979

EEC	EEC7[1]			Other EEC[2]			EEC		
	Brazil	USA	Total	Brazil	USA	Total	Brazil	USA	Total
	1,000 gallons of single strength juice equivalent								
1969	17,677	6,760	24,437	00	188	188	17,677	6,948	24,625
1970	30,758	11,547	42,305	00	201	201	30,758	11,748	42,506
1971	50,397	10,473	60,870	00	130	130	50,397	10,603	61,000
1972	63,039	13,264	76,303	00	240	240	63,039	13,504	76,543
1973	107,549	17,711	125,260	00	285	285	107,549	17,996	125,545
1974	73,073	12,395	85,468	00	132	132	73,073	12,527	85,600
1975	120,217	16,036	136,253	00	307	307	120,217	16,343	136,560
1976	158,891	27,274	186,165	00	300	300	158,891	27,574	186,465
1977	127,416	22,217	149,633	00	551	551	127,416	22,768	150,184
1978	120,412	10,613	131,025	00	342	342	120,412	10,955	131,367
1979	155,464	13,712	169,176	00	320	320	155,464	14,032	169,496
Total	1,024,893	162,002	1,186,895	00	2,996	2,996	1,024,893	164,998	1,189,891
Percent	86.13	13.62	99.75	00	.25	.25	86.13	13.87	100.00

[1]EEC7 as defined in this study includes West Germany, the United Kingdom, The Netherlands, Belgium, Luxembourg, Denmark and France. [2]Includes Italy and Ireland.

Source: Computed from Tables A.2. and A.3., Appendix A.

Table B.5. European non-EEC imports of orange juice from Brazil and the United States of America, 1969-1979

Year	European non-EEC3[1]			Other European non-EEC[2]			European non-EEC		
	Brazil	USA	Total	Brazil	USA	Total	Brazil	USA	Total
	1,000 gallons of single strength juice equivalent								
1969	1,189	2,513	3,702	230	1,260	1,490	1,419	3,773	5,192
1970	1,527	5,315	6,842	193	1,608	1,801	1,720	6,923	8,643
1971	3,844	10,809	14,653	127	1,420	1,547	3,971	12,229	16,200
1972	9,362	7,449	16,811	597	1,425	2,022	9,959	8,874	18,833
1973	15,083	10,593	25,676	2,051	2,600	4,651	17,134	13,193	30,327
1974	21,524	10,281	31,805	1,623	2,545	4,168	23,147	12,826	35,973
1975	25,904	10,127	36,031	11,529	1,835	13,364	34,433	11,962	49,395
1976	32,756	9,773	42,529	9,971	2,084	12,055	42,727	11,857	54,584
1977	33,072	10,304	43,376	10,516	2,745	13,261	43,588	13,049	56,637
1978	37,047	4,278	41,325	5,133	1,394	6,527	42,180	5,672	47,852
1979	39,499	4,000	43,499	8,853	1,433	10,286	48,352	5,433	53,785
Total	220,807	85,442	306,249	50,823	20,349	71,172	271,630	105,791	377,421
Percent	58.50	22.64	81.14	13.47	5.39	18.86	71.97	28.03	100.00

[1]European non-EEC3 as defined in this study includes Sweden, Norway and Finland. [2]Includes Austria, Bulgaria, East Germany, Iceland, Poland, Spain, Switzerland and Yugoslavia.

Source: Computed from Tables A.2. and A.3., Appendix A.

APPENDIX C

FLORIDA'S ORANGE JUICE

Table C.1. Florida's frozen concentrated orange juice supply and demand, 1972-1979

Year	Beginning stocks	Domestic supply	Imports	Total supply	Domestic demand	Exports	Total demand	Ending stocks
	----------1,000 gallons of single strength juice equivalent----------							
1972	98,155	564,541	22,939	685,635	530,468	29,126	559,594	126,041
1973	126,041	729,582	12,323	867,946	604,249	39,724	643,973	223,973
1974	223,973	696,370	10,216	930,559	664,446	41,621	706,067	224,492
1975	224,492	766,090	19,721	1,010,303	700,014	45,560	745,574	264,729
1976	264,729	758,537	26,194	1,049,460	790,932	50,476	841,408	208,052
1977	208,052	687,881	52,397	948,330	769,278	47,386	816,664	131,666
1978	131,666	697,740	123,221	952,627	747,395	37,083	784,478	168,149
1979	168,149	770,929	99,933	1,039,011	800,311	45,787	846,098	192,913
Total	1,445,257	5,671,670	366,944	7,483,871	5,607,093	336,763	5,943,856	1,540,015
Percent	19.31	75.79	4.90	100.00	74.92	4.50	79.42	20.58

Source: Computed from Florida Canners Association, 1971-1980.

Table C.2. Florida's other orange juice (canned and chilled) supply and demand, 1972-1979

Year	Beginning stocks	Domestic supply	Total supply	Domestic demand	Exports	Total demand	Ending stocks
	----------1,000 gallons of single strength juice equivalent----------						
1972	12,878	154,344	167,222	145,124	6,765	151,889	15,333
1973	15,333	176,885	192,218	167,190	6,676	173,866	18,352
1974	18,352	174,081	192,433	169,285	7,449	176,734	15,699
1975	15,699	201,497	217,196	189,896	7,819	197,715	19,481
1976	19,481	210,078	229,559	203,346	8,243	211,589	17,970
1977	17,970	210,043	228,013	207,586	8,279	215,865	12,148
1978	12,148	234,731	246,879	226,217	7,937	234,154	12,725
1979	12,725	263,675	276,400	246,127	8,552	254,679	21,721
Total	124,586	1,625,334	1,749,920	1,554,771	61,720	1,616,491	133,429
Percent	7.12	92.88	100.00	88.85	3.53	92.38	7.62

Source: Computed from Florida Canners Association, 1971-1980.

Table C.3. Florida's total orange juice supply and demand, 1972-1979

Year	Beginning stocks	Domestic supply	Imports	Total supply	Domestic demand	Exports	Total demand	Ending stocks
	1,000 gallons of single strength juice equivalent							
1972	111,033	718,885	22,939	852,857	675,592	35,891	711,483	141,374
1973	141,374	906,467	12,323	1,060,164	771,439	46,400	817,839	242,325
1974	242,325	870,451	10,216	1,122,992	833,731	49,070	882,801	240,191
1975	240,191	967,587	19,721	1,227,499	889,910	53,379	943,289	284,210
1976	284,210	968,615	26,194	1,279,019	994,278	58,719	1,052,997	226,022
1977	226,022	897,924	52,397	1,176,343	976,864	55,665	1,032,529	143,814
1978	143,814	932,471	123,221	1,199,506	973,612	45,020	1,018,632	180,874
1979	180,874	1,034,604	99,933	1,315,411	1,046,438	54,339	1,100,777	214,634
Total	1,569,843	7,297,004	366,944	9,233,791	7,161,864	398,483	7,560,347	1,673,444
Percent	17.00	79.03	3.97	100.00	77.56	4.32	81.88	18.12

Source: Computed from Tables C.1. and C.2.

APPENDIX D

REAL EXCHANGE RATE VALUES AND INDICES

Real Exchange Rate Values and Indices

Exchange rate is assumed to be an exogenous variable explaining variations in the import-export orange juice demand relations. This appendix describes the method of calculation for bimonthly indices of real exchange rate values of the USA dollar and the Brazilian cruzeiro against two groups of major European country currencies (EEC7 and European non-EEC3).

The procedure is the same one used by United States Board of Governors of the Federal Reserve System described in the Federal Reserve Bulletin, volume 64, August 1978, page 700.

Real exchange rate values were obtained by deflating the corresponding nominal values by available price indices (1975=100); i.e., the wholesale price indices in the case of the USA and Brazil, and the consumer price indices in the case of the other countries. Export and import data, as well as the consumer price indices for Canada, EEC7 and European non-EEC3 countries, are those reported by the International Monetary Fund, 1970-1980. Nominal exchange rate values and wholesale price indices for the USA and Brazil are from the United States Board of Governors of the Federal Reserve System (1972-1980) (the USA exchange rates), United States Department of Commerce, Bureau of Economic Analysis (1975-1980) (the USA wholesale price index), the Fundação Getúlio Vargas (1972-1980) (Brazil exchange rate (cruzeiros per USA dollar), and Brazil wholesale price index).

A real exchange rate value index is defined, in general, as

$$100 \prod_{i=1}^{n} R_{it}^{w_i} \text{ where,}$$

R_{it} is the base period (February-March of 1973) exchange rate value of the ith country currency at time t, and w_i is the weight of the ith country. The USA exchange rate values are expressed in cents per unit of foreign currency. Brazil's exchange rate values are expressed in cruzeiros per unit of foreign currency and, except the rate of cruzeiros per USA dollar which is reported by Fundação Getúlio Vargas, all other relations were derived from the series of the USA exchange rate values and Brazil's exchange rate values against the USA dollar. Weights and base period exchange rate values and indices of exchange rates in the case of the two groups of European countries are shown in Tables D.2. through D.8. for Brazil and the U.S.A.

Table D.1. Real exchange rate values for the base period (February-March of 1973) and weight by country

Country-currency name	Base period		Weight[3]
	USA[1]	Brazil[2]	
EEC7 countries			1.00000
West Germany-deutsche mark	40.62320	3.122420	.32256
The Netherlands-guilder	36.94900	2.840110	.13402
The United Kingdom-pound	225.68700	17.348000	.18619
Belgium/Luxembourg-franc	2.65551	.204114	.11780
Denmark-krone	16.24170	1.248390	.03644
France-franc	22.44340	1.725090	.20299
European non-EEC3 countries			1.00000
Sweden-krona	24.94670	1.917570	.54226
Norway-krone	17.86910	1.373480	.25873
Finland-markka	23.84450	1.832810	.19901

[1]Cents per unit of foreign currency. [2]Cruzeiros per unit of foreign currency. [3]Weights are average trade value shares (the USA dollar value of exports and imports over total value trade) of each country in the group for five years (1972-1976).

Table D.2. Bimonthly real exchange rate values of the Brazilian cruzeiro against the USA dollar, 1972-1979

Years	Dec./Jan.	Feb./Mar.	Apr./May	June/July	Aug./Sept.	Oct./Nov.
	cruzeiros per USA dollar					
1971/72	--	7.83404	7.81361	7.78804	7.66094	7.63494
1972/73	7.80436	7.68680	7.75189	7.82969	7.99783	7.70315
1973/74	7.77196	7.86933	7.41221	7.65313	8.19957	8.34040
1974/75	8.25952	8.13836	8.25035	8.17524	8.05437	8.02680
1975/76	8.01980	7.83889	8.05101	7.97060	7.60091	7.61769
1976/77	7.69496	7.63197	7.48677	7.64978	7.82986	7.79201
1977/78	7.85064	7.77026	7.70497	7.67583	7.66363	7.63256
1978/79	7.92505	8.03409	--	--	--	--

Sources: Computed from Fundação Getúlio Vargas, 1972-1980 (nominal exchange rate values and wholesale price index in Brazil); and United States Department of Commerce, Bureau of Economic Analysis, 1975-1980 (wholesale price index in the USA).

Table D.3. Bimonthly real exchange rate values of the USA dollar against the Canadian dollar, 1972-1979

Years	Dec./Jan.	Feb./Mar.	Apr./May	June/July	Aug./Sept.	Oct./Nov.
	cents per Canadian dollar					
1971/72	--	110.560	111.870	112.643	113.487	113.453
1972/73	110.293	107.670	105.845	104.889	102.074	105.171
1973/74	103.585	103.389	104.207	102.890	97.991	97.353
1974/75	98.041	98.796	97.109	97.617	97.760	99.591
1975/76	101.078	103.749	104.413	105.242	105.196	105.716
1976/77	101.829	99.402	97.971	98.593	98.265	96.243
1977/78	96.633	94.410	92.943	94.362	92.009	89.655
1978/79	88.515	87.705	--	--	--	--

Source: Computed from United States Board of Governors of the Federal Reserve System, 1972-1980 (nominal exchange rates); United States Department of Commerce, Bureau of Economic Analysis, 1975-1980 (wholesale price index in the USA); and International Monetary Fund, 1970-1980 (consumer price index in Canada).

Table D.4. Bimonthly real exchange rate values of the Brazilian cruzeiro against the Canadian dollar, 1972-1979

Years	Dec./Jan.	Feb./Mar.	Apr./May	June/July	Aug./Sept.	Oct./Nov.
	cruzeiros per Canadian dollar					
1971/72	--	8.66123	8.74111	8.77264	8.69420	8.66198
1972/73	8.60768	8.27663	8.20443	8.21140	8.16269	8.10111
1973/74	8.05012	8.13592	7.72380	7.86957	8.03483	8.11953
1974/75	8.09774	8.04035	8.01179	7.98042	7.87394	7.99405
1975/76	8.10607	8.13260	8.40620	8.38847	7.99571	8.05287
1976/77	7.83560	7.58719	7.33482	7.54236	7.69405	7.49939
1977/78	7.58639	7.33605	7.16132	7.24307	7.05113	6.84284
1978/79	7.01443	7.04579	--	--	--	--

Source: Derived from Tables D.2. ($RxBS_t$) and D.3. ($RxSC_t$).

Table D.5. Bimonthly real exchange rate value index (February-March of 1973=100 of the Brazilian cruzeiro against the EEC7[1] country currencies, 1972-1979

Years	Dec./Jan.	Feb./Mar.	Apr./May	June/July	Aug./Sept.	Oct./Nov.
	percent					
1971/72	--	101.731	101.452	102.360	104.543	104.518
1972/73	104.201	100.000	97.888	90.050	91.976	93.962
1973/74	103.716	102.944	104.148	102.851	102.248	98.463
1974/75	93.455	89.192	87.335	89.467	97.967	97.919
1975/76	98.087	98.997	97.736	100.989	104.041	102.049
1976/77	99.280	100.482	101.610	97.270	94.637	93.321
1977/78	88.792	88.127	90.312	90.456	87.095	84.695
1978/79	81.952	81.691	--	--	--	--

[1]Includes West Germany, The Netherlands, the United Kingdom, Belgium, Luxembourg, Denmark and France.

Source: Derived from United States Board of Governors of the Federal Reserve System, 1972-1980 (the USA nominal exchange rate values); United States Department of Commerce, Bureau of Economic Analysis, 1975-1980 (wholesale price index in the USA); International Monetary Fund (consumer price index and population of European countries used to derive weighted average consumer price index for the EEC7), Table D.2. ($RxBS_t$) and Table D.1. (base period values and weight).

Table D.6. Bimonthly real exchange rate value index (February-March of 1973=100) of the Brazilian cruzeiro against the European non-EEC3[1] country currencies, 1972-1979

Years	Dec./Jan.	Feb./Mar.	Apr./May	June/July	Aug./Sept.	Oct./Nov.
	Percent					
1971/72	--	102.764	101.938	101.240	102.743	103.485
1972/73	102.468	100.000	99.614	92.223	93.924	96.186
1973/74	104.125	102.662	104.775	103.925	102.489	98.081
1974/75	92.534	88.629	87.258	89.078	97.416	96.879
1975/76	95.741	96.133	93.287	94.765	97.274	93.552
1976/77	91.246	92.353	96.530	92.370	92.963	95.216
1977/78	91.915	92.456	95.324	95.688	92.567	90.813
1978/79	88.818	89.117	--	--	--	--

[1]Includes Sweden, Norway and Finland.

Sources: Derived from United States Board of Governors of the Federal Reserve System, 1972-1980 (the USA nominal exchange rate values); United States Department of Commerce, Bureau of Economic Analysis, 1975-1980 (wholesale price index in the USA); and International Monetary Fund, 1970-1980 (consumer price index and population of European countries used to derive a weighted average consumer price index for the European non-EEC3); Table D.2. ($RxBS_t$); and Table D.1. (base period values and weights).

Table D.7. Bimonthly real exchange rate value index (February-March of 1973=100) of the USA dollar against the EEC7[1] country currencies, 1972-1979

Years	Dec./Jan.	Feb./Mar.	Apr./May	June/July	Aug./Sept.	Oct./Nov.
	Percent					
1971/72	--	103.682	103.130	103.716	104.196	103.817
1972/73	105.799	100.000	98.723	91.686	95.688	94.180
1973/74	104.841	105.378	100.426	102.364	109.074	106.847
1974/75	100.417	94.435	93.742	95.146	102.658	102.255
1975/76	102.338	100.962	102.373	104.727	102.881	101.138
1976/77	99.389	99.769	98.970	96.814	96.402	94.600
1977/78	90.686	89.086	90.528	90.331	86.836	84.105
1978/79	84.499	85.387	--	--	--	--

[1]Includes West Germany, The Netherlands, the United Kingdom, Belgium, Luxembourg, Denmark and France.

Sources: Derived from United States Board of Governors of the Federal Reserve System 1972-1980, (the USA nominal exchange rate values); United States Department of Commerce, Bureau of Economic Analysis, 1975-1980 (wholesale price index in the USA); and International Monetary Fund (consumer price index and population of European countries used to derive a weighted average consumer price index for the EEC7); and Table D.1. (base period values and weights).

Table D.8. Bimonthly real exchange rate value index (February-March of 1973=100) of the USA dollar against the European non-EEC3[1] country currencies, 1972-1979

Years	Dec./Jan.	Feb./Mar.	Apr./May	June/July	Aug./Sept.	Oct./Nov.
	Percent					
1971/72	--	104.735	103.625	102.577	102.401	102.790
1972/73	104.039	100.000	100.461	93.904	97.718	96.396
1973/74	105.252	105.088	101.034	103.424	109.329	106.432
1974/75	99.427	93.838	93.733	95.101	102.597	102.139
1975/76	102.074	100.645	101.865	104.019	102.145	100.204
1976/77	98.498	98.875	98.430	96.282	96.217	94.803
1977/78	91.021	89.543	91.051	90.874	92.292	90.178
1978/79	91.577	93.149	--	--	--	--

[1] Includes Sweden, Norway and Finland.

Source: Derived from United States Board of Governors of the Federal Reserve System 1972-1980, (the USA nominal exchange rate values); United States Department of Commerce, Bureau of Economic Analysis, 1975-1980 (wholesale price index in the USA); and International Monetary Fund, 1970-1980 (consumer price index and population of European countries used to construct a weighted average consumer price index for the European non-EEC3); and Table D.1. (base period values and weights).

APPENDIX E

VARIABLE DEFINITIONS AND DATA SOURCES

Variable Definitions and Data Sources

Endogenous variables are listed according to their equational ordering formulation in the model. Predetermined variables are listed according to the number of capital letters (five through one) and type of transaction or type of variable (import, export, retail, wholesale exchange rate, advertising, disposable income, and orange production). Unless otherwise specified, non-monetary variables are expressed in single strength or reconstituted juice equivalent gallons per thousand persons. Monetary variables are expressed in the USA dollar in terms of 1975 prices. Prices are expressed in dollars per single strength or reconstituted juice equivalent gallon. Exchange rates are expressed in units of the exporting country currency (Brazilian cruzeiros or cents) per unit of foreign currency, or as an index. Advertising variables are expressed in dollars per thousand persons. Disposable income variables are expressed in thousand dollars per capita.

The variable subscript t stands for time period (December-January bimonth of 1971/72 to February-March bimonth of 1979).

Endogenous variables

$RQFS_t$ = retail quantity of FCOJ in the USA. Source: computed from Florida Department of Citrus and A. C. Nielsen Company, 1972-1980.

$RPFS_t$ = retail price of FCOJ in the USA. Source: computed from Florida Department of Citrus and A. C. Nielsen Company, 1972-1980 (nominal values), and United States Department of Commerce, Bureau of Economic Analysis, 1975-1980 (consumer price index).

$WQFFl_t$ = wholesale quantity of FCOJ in Florida. Source: computed from Florida Canners Association, 1971-1980.

$WPFFl_t$ = Wholesale price of FCOJ in Florida. Source: computed from Florida Deaprtment of Citrus, Economic Research Department, 1972-1980 (nominal values), and United States Department of Commerce, Bureau of Economic Analysis, 1975-1980 (producer price index).

$WSkFS_t$ = wholesale stock of FCOJ in the USA, expressed in bimonths of Florida supplies. Source: derived (see Equation 5 in Chapter III).

$WQkFS_t$ = wholesale quantity in stock of FCOJ in the USA. Source: derived (see Equation 6 in Chapter III).

$MQFSB_t$ = import quantity of FCOJ by the USA from Brazil Source: computed from United States Department of Commerce, Bureau of the Census, 1969-1979b.

SpB_t = price spread between Florida's FCOJ wholesale price ($WPFFl_t$) and the USA FCOJ import price from Brazil ($MPFSB_t$). Source: derived (see Equation 8 in Chapter III).

$MPFSB_t$ = import price of FCOJ by the USA from Brazil. Source: computed from United States Department of Commerce, Bureau of the Census, 1969-1979b (nominal

values), and United States Department of Commerce, Bureau of Economic Analysis, 1975-1980 (producer price index).

$RQOS_t$ = retail quantity of other orange juices in the USA. Source: same as $RQFS_t$.

$RPOS_t$ = retail price of other orange juices in the USA. Source: same as $RPFS_t$.

$RpOS_t$ = retail proportion of other orange juices marketed in cardboard containers in the USA. Source: derived (see Equation 12 of Chapter III).

$WQOFl_t$ = wholesale quantity of other juices in Florida. Source: same as $WQFFl_t$.

$WPOFl_t$ = wholesale price of other orange juices in Florida. Source: same as $WPFFl_t$.

$WSkOS_t$ = wholesale stock of other orange juices in the USA, expressed in bimonths of Florida supplies. Source: derived (see Equation 15 in Chapter III).

$WQkOS_t$ = wholesale quantity in stock of other orange juices in the USA. Source: derived (see Equation 16 in Chapter III).

$XQFCB_t$ = export quantity of FCOJ to Canada from Brazil. Source: computed from Brazil, Carteira de Comércio Exterior Banco do Brasil S.A. (CACEX), 1972-1979.

$XPFCB_t$ = export price of FCOJ to Canada from Brazil. Source: computed from Brazil, Carteira de Comércio Exterior do Banco do Brasil S.A. (CACEX), 1972-1979 (nominal values), and International Monetary Fund, 1970-1980 (consumer price index).

$XQFCS_t$ = export quantity of FCOJ to Canada from the USA. Source: computed from United States Department of Commerce, Bureau of the Census, 1969-1979a.

$XPFCS_t$ = export price of FCOJ to Canada from the USA. Source: computed from United States Department of Commerce, Bureau of the Census, 1969-1979a (nominal values), and International Monetary Fund, 1970-1980 (consumer price index).

$XQFEB_t$ = export quantity of FCOJ to the EEC7 countries from Brazil. Source: same as $XQFCB_t$.

$XPFEB_t$ = export price of FCOJ to the EEC7 countries from Brazil. Source: same as $XPFCB_t$.

$XQFES_t$ = export quantity of FCOJ to the EEC7 countries from Brazil. Source: same as $XPFCB_t$.

$XQFES_t$ = export quantity of FCOJ to the EEC7 countries from the USA. Source: same as $XQFCS_t$.

$XPFES_t$ = export price of FCOJ to the EEC7 countries from the USA. Source: same as $XPFCS_t$.

$XQFNB_t$ = export quantity of FCOJ to the European non-EEC3 countries from Brazil. Source: same as $XQFCB_t$.

$XPFNB_t$ = export price of FCOJ to the European non-EEC3 countries from Brazil. Source: same as $XPFCB_t$.

$XQFNS_t$ = export quantity of FCOJ to the European non-EEC3 countries from the USA. Source: same as $XQFCS_t$.

$XPFNS_t$ = export price of FCOJ to the European non-EEC3 countries from the USA. Source: same as $XPFCB_t$.

Predetermined variables

$MQFSOc_t$ = import quantity of FCOJ by the USA from other countries. Source: computed from United States Department of Commerce, Bureau of the Census, 1969-1979b.

$MPFSOc_t$ = import price of FCOJ by the USA from other countries. Source: same as $MPFSB_t$.

$MPFCOc_t$ = import price of FCOJ by Canada from other countries. Source: computed from Statistics Canada, 1969-1979 (nominal values) and International Monetary Fund, 1970-1980 (consumer price index).

$XQFOcS_t$ = export quantity of FCOJ to other countries from the USA. Source: same as $XQFCS_t$.

$XQOCS_t$ = export quantity of other orange juices to Canada from the USA. Source: same as $XQFCS_t$.

$XPOCS_t$ = export price of other orange juices to Canada from the USA. Source: same as $XPFCS_t$.

$RPShS_t$ = retail price of frozen orange-flavored synthetics and drinks in the USA. Source: same as $RPFS_t$.

$RQObS_t$ = retail quantity of other orange juices in cardboard containers in the USA. Source: same as $RQFS_t$.

$WPFFl_{t-1}$ = $WPFFl_t$ lag by one period.

$WPOFl_{t-1}$ = $WPOFl_t$ lag by one period.

$WSkFS_{t-1}$ = $WSkFS_t$ lag by one period.

$WSkOS_{t-1}$ = $WSkOS_t$ lag by one period.

$WQkFS_{t-1}$ = $WQkFS_t$ lag by one period.

$WQkOS_{t-1}$ = $WQkOS_t$ lag by one period.

WQsFFl = wholesale quantity supplied of FCOJ in Florida. Source: same as $WQFFl_t$.

$WQsOFl_t$ = wholesale quantity supplied of other orange juices in Florida. Source: same as $WQFFl_t$.

$RxBS_t$ = exchange rate of the Brazilian cruzeiro against the USA dollar. Source: computed from Fundação Getúlio Vargas, 1972-1980 (nominal exchange rate values and wholesale price index in Brazil), and United States Department of Commerce, Bureau of Economic Analysis, 1975-1980 (wholesale price index in the USA).

$RxBC_t$ = exchange rate of the Brazilian cruzeiro against the Canadian dollar. Source: derived, given the values of $RxBS_t$ and $RxSC_t$.

$RxBE_t$, $RxBN_t$, $RxSE_t$, $RxSN_t$ = exchange rate value indices (February-March of 1973=100) of the Brazilian cruzeiro (B) and the USA dollar (S) against currencies of the EEC7 (E) and the European non-EEC3 (N) countries, respectively (for more detail see Appendix D). Source: derived from United States Board of Governors of the Federal Reserve System, 1972-1980 (nominal exchange rate values), United States Department of Commerce, Bureau of Economic Analysis, 1975-1980 (wholesale price index in the USA), International Monetary Fund, 1970-1980 (consumer price indices and population of European countries used to construct weighted

average consumer price indices for EEC7 and European non-EEC3 groups of countries), and computed values of $RxBS_t$.

$RxSC_t$ = exchange rate of the USA dollar against the Canadian dollar. Source: computed from United States Board of Governors of the Federal Reserve System, 1972-1980 (nominal exchange rate values), United States Department of Commerce, Bureau of Economic Analysis, 1975-1980 (wholesale price index in Canada).

AC_t, AC_{t-1} = current and lagged advertising expenditures of the Florida Department of Citrus in Canada. Source: computed from Florida Department of Citrus, 1980 (nominal values), and International Monetary Fund, 1970-1980 (consumer price index in Canada).

AE_t, AN_t = annual advertising expenditures of the Three-Party Program in EEC7 and the European non-EEC3 countries, respectively. Source: computed from Florida Department of Citrus, 1980 (nominal values), and International Monetary Fund, 1970-1980 (consumer price indices and population of European countries used to construct weighted average consumer price indices for EEC7 and European non-EEC3 countries).

AS_t, AS_{t-1} = current and lagged advertising expenditures (generic and brand) of the Florida Department of Citrus in the USA. Source: computed from Florida Department of Citrus, 1980 (nominal values), and United States Department of Commerce, Bureau of Economic Analysis, 1975-1980 (consumer price index).

IC_t = quarterly disposable income per capita in Canada, seasonally adjusted at annual rates. Source: computed from Statistics Canada, 1979 (nominal values), United States Board of Governors of the Federal Reserve System, 1972-1980 (exchange rates), and International Monetary Fund, 1970-1980 (consumer price index and population in Canada).

IS_t = quarterly disposable income per capita in the USA, seasonally adjusted at annual rates. Source: computed from United States Department of Commerce, Bureau of Economic Analysis, 1975-1980 (nominal values and consumer price index) and United States Department of Commerce, Bureau of the Census, 1975-1980 (population).

$PdSp_t$, $PdSp_{t-6}$ = current and lagged annual estimates of orange production in the state of São Paulo (Brazil), expressed in billion boxes of 90 pounds (approximately 40.77 kilograms). Source: computed from United States Department of Agriculture, Foreign Agricultural Service, 1980a and 1980c.

PdS_t = estimates of orange production in the USA, expressed in billion boxes of 90 pounds (approximately 40.77 kilograms). Source: computed from Florida Crop and Livestorck Reporting Service, 1972-1980.

PlC_t, PlE_t, PlN_t, $PlOc_t$, PlS_t = population in Canada, the EEC7, the European non-EEC3, other countries and the USA, expressed in million persons. Source: International Monetary Fund, 1970-1980 (Canada and European

countries) and United States Department of Commerce, Bureau of the Census, 1975-1980.

D_t = dummy variable to account for the effects of the USA (Florida) freeze in 1977. D_t is equal to one for observations from February-March bimonth of 1977 on, and zero otherwise.

T_t = linear time trend to account for time-related changes in Florida's wholesale price equations or as a proxy variable for income per capita in the export demand equations for the European countries.

Zi_t = five (i=1,...,5) dummy variables to account for seasonal effects on demand. $Z1_t$ is equal to one for December-January bimonths, and zero otherwise. Similarly, $Z2_t$ through $Z5_t$ is equal to one for February-March, April-May, June-July and August-September bimonths, respectively, and zero otherwise.

APPENDIX F

MEANS, STANDARD DEVIATIONS AND COEFFICIENTS OF VARIATION FOR VARIABLES USED IN THE MODEL

Means, standard deviations and coefficients of variation for variables used in the model

Variables[1]	Mean[2]	Standard deviation	Coefficient of variation (percent)[3]
Endogenous variables			
$RQFS_t$	362.0988	37.2812	10.30
$RPFS_t$	1.5336	.1945	12.68
$WQFFl_t$	539.9482	86.1218	15.95
$WPFFl_t$	.9964	.1663	16.69
$WSkFS_t$	2.7021	1.0110	37.42
$WQkFS_t$	1424.6138	490.5815	34.44
$MQFSB_t$	35.1260	47.7737	136.01
SpB_t	.5428	.1019	18.77
$MPFSB_t$	.4536	.1364	30.07
$RQOS_t$	135,4163	32.3195	23.87
$RPOS_t$	2.0397	.1625	7.97
$RpOS_t$	.4740	.0997	21.03
$WQOFl_t$	147.5382	20.1639	13.67
$WPOFl_t$	1.3530	.1458	10.78
$WSkOS_t$	1.1602	.4607	39.71
$WQkOS_t$	168.9039	61.6674	36.51
$XQFCB_t$	163.1442	109.1834	66.92
$XPFCB_t$	.4778	.1261	26.39
$XQFCS_t$	191.9097	43.7903	22.82
$XPFCS_t$	1.1073	.1521	13.74

(continued)

Means,...(continued)

Variables[1]	Mean[2]	Standard deviation	Coefficient of variation (percent)[3]
$XQFEB_t$	97.0726	48.4249	49.89
$XPFEB_t$	.4751	.1077	22.67
$XQFES_t$	10.6397	7.2904	68.52
$XPFES_t$	.7674	.2290	29.84
$XQFNB_t$	252.9446	161.5484	63.87
$XPFNB_t$	.4672	.0885	18.94
$XQFNS_t$	83.9191	40.8927	48.73
$XPFNS_t$	.8913	.1305	14.64
Predetermined variables			
$MQFSOc_t$	7.1593	5.8655	81.93
$MPFSOc_t$	.5306	.1214	22.88
$MPFCOc_t$	.5943	.1288	21.67
$XQFOcS_t$	4.8153	2.7459	57.02
$XQOCS_t$	46.1726	8.9247	19.33
$XPOCS_t$	1.2712	.1281	10.08
$RPShS_t$	1.5408	.0570	3.79
$RQObS_t$	67.2895	28.8092	42.81
$WPFFl_{t-1}$	.9979	.1680	16.84
$WPOFl_{t-1}$	1.3606	.1525	11.21
$WSkFS_{t-1}$	2.6881	1.0126	37.67
$WSkOS_{t-1}$	1.1670	.4598	39.40
$WQkFS_{t-1}$	1409.7772	494.3198	35.06

(continued)

Means,...(continued)

Variables[1]	Mean[2]	Standard deviation	Coefficient of variation (percent)[3]
$WQkOS_{t-1}$	168.5535	61.6873	36.60
$WQsFFl_t$	555.7976	418.2683	75.26
$WQsOFl_t$	153.5056	60.1723	45.07
$RxBS_t$	7.8396	.2198	2.80
$RxBC_t$	7.9101	.4940	6.25
$RxSC_t$	100.9441	6.4257	6.37
$RXBE_t$	96.2446	6.6291	6.89
$RxSE_t$	98.1033	6.4797	6.61
$RxBN_t$	95.9477	4.9062	5.11
$RxSN_t$	97.8104	4.8607	4.97
AS_t	9.2798	2.8285	30.48
AS_{t-1}	9.4226	3.0982	32.88
AC_t	3.4744	1.9475	56.05
AC_{t-1}	3.5049	1.9786	56.45
AE_t	2.8621	1.0075	35.20
AN_t	40.4665	14.8154	36.61
IS_t	5.2174	.1862	3.57
IC_t	4.6990	.2971	6.32
PdS_t	.2271	.0187	8.22
PdS_{t-1}	.2267	.0193	8.51
$PdSp_t$	.0934	.0293	31.37
$PdSp_{t-6}$	.0790	.0214	27.09

(continued)

Means,...(continued)

Variables[1]	Mean[2]	Standard deviation	Coefficient of variation (percent)[3]
PlC_t	22.7586	.5813	2.55
PlE_t	197.5148	3.2573	1.65
PlN_t	16.9168	.1336	.79
$PlOc_t$[4]	197.5148	3.2573	1.65
PlS_t	214.0112	3.3803	1.58

[1]Endogenous variables are listed according to their equational ordering formulation. Predetermined variables are listed according to the number of capital letters (five, four and two) and type of transaction or type of variables (import, export, retail, wholesale, exchange rate, advertising, disposable income and orange production). [2]Most of the non-monetary variables are expressed in single strength or reconstituted juice equivalent gallons per thousand persons. $WSkFS_t$, $WSkOS_t$ and respective lags are expressed in number of bimonths of Florida's supplies; $RpOS_t$ is a proportion of $RQObS_t$ to $RQOS_t$; orange production variables are expressed in billion boxes of 90 pounds (approximately 40.77 kilograms); and population variables are expressed in million persons. Monetary variables are expressed in the USA dollar in terms of 1975 prices. Price variables are expressed in dollars per single strength or reconstituted juice equivalent gallon. Exchange rates are expressed in units of the exporting country currency (Brazilian cruzeiros or cents) per unit of foreign currency, or as an index. Advertising variables are also expressed in dollars per thousand persons. Disposable income variables are expressed in thousand dollars per capita. [3]Coefficient of variation=100 (standard deviation)/mean. [4]Population of other countries was approximated by the EEC7 population.

APPENDIX G

STRUCTURAL-FORM ESTIMATES OF ELASTICITIES AND FLEXIBILITIES AT THE VARIABLE MEANS

Structural-form estimates of elasticities and flexibilities evaluated at the variable means[1]

Dependent variable (Equation #1)	Elasticity	Flexibility
	---------Percent	-----------
$RQFS_t$ (Equation 1)		
Own-price ($RPFS_t$)	-.4180	
Cross-price ($RPOS_t$)	-.6323	
Cross-price ($RPShS_t$)	.5357	
Income (IS_t)	.8948	
Current advertising (AS_t)	.0359	
Lagged advertising (AS_{t-1})	.0234	
$RPFS_t$ (Equation 2)		
Current FCOJ wholesale price transmission ($WPFFl_t$)	.5328	
Lagged FCOJ wholesale price transmission ($WPFFl_{t-1}$)	.2642	
$WQFFl_t$ (Equation 3)		
Own-price ($WPFFl_t$)	-.6618	
Cross-price ($WPOFl_t$)	.6141	
FCOJ retail transmission ($RQFS_t$)	.3901	
Other orange juices retail transmission ($RQOS_t$)	.3621	
$WPFFl_t$ (Equation 4)		
Current FCOJ stock ($WSkFS_t$)		-.0374
Lagged FCOJ stock ($WSkFS_{t-1}$)		-.0742
Current orange production estimates (PdS_t)		-.7959
Lagged orange production estimates (PdS_{t-1})		-.4276
$MQFSB_t$ (Equation 7)		
Price spread (SpB_t)	1.6607	
Other orange juices wholesale transmission ($WQOFl_t$)	5.0697	

(continued)

Structural-form,...(continued)

Dependent variable (Equation #1)	Elasticity	Flexibility
	----------Percent----------	
$MPFSB_t$ (Equation 9)		
Current FCOJ wholesale price transmission ($WPFFl_t$)	.5123	
Lagged FCOJ wholesale price transmission ($WPFFl_{t-1}$)	1.0201	
Exchange rate transmission ($RxBS_t$)	-.1642	
Lagged orange production estimates in São Paulo ($PdSp_{t-6}$)		-.1341
$RQOS_t$ (Equation 10)		
Own-price ($RPOS_t$)	-2.0587	
Cross-price ($RPFS_t$)	1.1466	
Cross-price ($RPShS_t$)	1.5593	
Income (IS_t)	3.4629	
Current advertising (AS_t)	.0203	
Lagged advertising (AS_{t-1})	.0264	
$RPOS_t$ (Equation 11)		
Current other orange juices wholesale price transmission ($WPOFl_t$)	.0960	
Lagged other orange juices wholesale price transmission ($WPOFl_{t-1}$)	.5561	
Retail proportion of other orange juices in cardboard containers ($RpOS_t$)		-.0521
$WQOFl_t$ (Equation 13)		
Own-price ($WPFOl_t$)	-.2284	
Other orange juices retail transmission ($RQOS_t$)	.5352	
$WPOFl_t$ (Equation 14)		
Current other orange juices stocks ($WSxOS_t$)		-.0179

(continued)

Structural-form,...(continued)

Dependent variable (Equation #)	Elasticity	Flexibility
	----------Percent----------	
Current orange production estimates (PdS_t)		.0534
Lagged orange production estimates (PdS_{t-1})		-.7400
$XQFCB_t$ (Equation 17)		
Own-price export ($XPFCB_t$)	-1.1884	
Cross-price export ($XPFCS_t$)	2.8003	
Cross-price export ($XPOCS_t$)	3.9404	
Income (IC_t)	3.8719	
Current advertising (AC_t)	.1368	
Lagged advertising (AC_{t-1})	.0659	
$XPFCB_t$ (Equation 18)		
USA export price transmission ($XPFCS_t$)	1.6429	
Exchange rate transmission ($RxBS_t$)	-.5693	
Lagged orange production estimates in São Paulo ($PdSp_{t-6}$)		-.0475
$XQFCS_t$ (Equation 19)		
Own-price export ($XPFCS_t$)	-.4616	
Cross-price export ($XPFCB_t$)	-.0409	
Cross-price export ($XPOCS_t$)	.4303	
Income (IC_t)	2.0365	
Current Florida's advertising (AC_t)	-.1131	
Lagged Florida's advertising (AC_{t-1})	.1626	
$XPFCS_t$ (Equation 20)		
Florida's wholesale price transmission ($WPFFl_t$)	.4465	
USA import price from Brazil transmission ($MPFSB_t$)	.1857	
Exchange rate transmission ($RxSC_t$)	-.5287	

(continued)

Structural-form,...(continued)

Dependent variable (Equation #)	Elasticity	Flexibility
	----------Percent----------	
$XQFEB_t$ (Equation 21)		
Own-price export ($XPFEB_t$)	-.7237	
Cross-price export ($XPFES_t$)	-.0734	
Current Florida's advertising (AE_t)	.5292	
$XPFEB_t$ (Equation 22)		
USA export price transmission ($XPFES_t$)	.5610	
Exchange rate transmission ($RxBS_t$)	-2.0659	
Lagged orange production estimates in São Paulo ($PdSp_{t-6}$)		-.0915
$XQFES_t$ (Equation 23)		
Own-price export ($XPFES_t$)	-1.7351	
Cross-price export ($XPFEB_t$)	-.0883	
Current Florida's advertising (AE_t)	.5029	
$XPFES_t$ (Equation 24)		
Florida's wholesale price transmission ($WPFFl_t$)	.3298	
USA import price from Brazil transmission ($MPFSB_t$)	.4362	
Exchange rate transmission ($RxSE_t$)	-1.3934	
$XQFNB_t$ (Equation 25)		
Own-price export ($XPFNB_t$)	-.3374	
Cross-price export ($XPFNS_t$)	-.0939	
Current Florida's advertising (AN_t)	-.9574	

(continued)

Structural-form,...(continued)

Dependent variable (Equation #)	Elasticity	Flexibility
	----------Percent----------	
$XPFNB_t$ (Equation 26)		
USA export price transmission ($XPFNS_t$)	.7969	
Exchange rate transmission ($RxBS_t$)	-1.3911	
Lagged orange production estimates in São Paulo ($PdSp_{t-6}$)		.0678
$XQFNS_t$ (Equation 27)		
Own-price export ($XPFNS_t$)	-2.4662	
Cross-price export ($XPFNB_t$)	.3747	
Current Florida's advertising (AN_t)	1.2377	
$XPFNS_t$ (Equation 28)		
Florida's wholesale price transmission ($WPFFl_t$)	.4349	
USA import price from Brazil transmission ($MPFSB_t$)	.1132	
Exchange rate transmission ($RxSN_t$)	.8779	

[1]See Appendix F for variable means.

APPENDIX H

ACTUAL AND REDUCED-FORM ESTIMATED VALUES OF ENDOGENOUS VARIABLES

(Graphs)

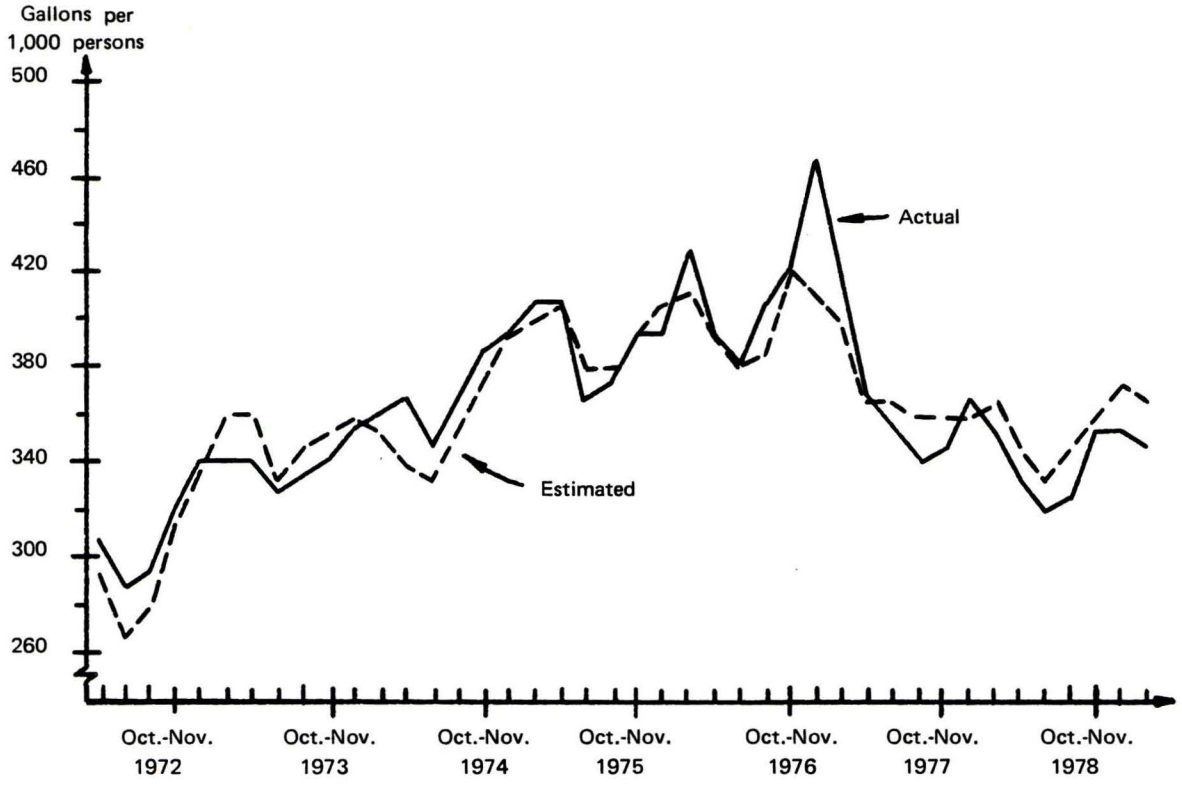

Figure H.1. Actual and reduced-form estimated values of retail quantities of FCOJ in the USA ($RQFS_t$), April-May/1972 to February-March/1979.

Note: FCOJ quantities are expressed in gallons of single strength juice equivalent.

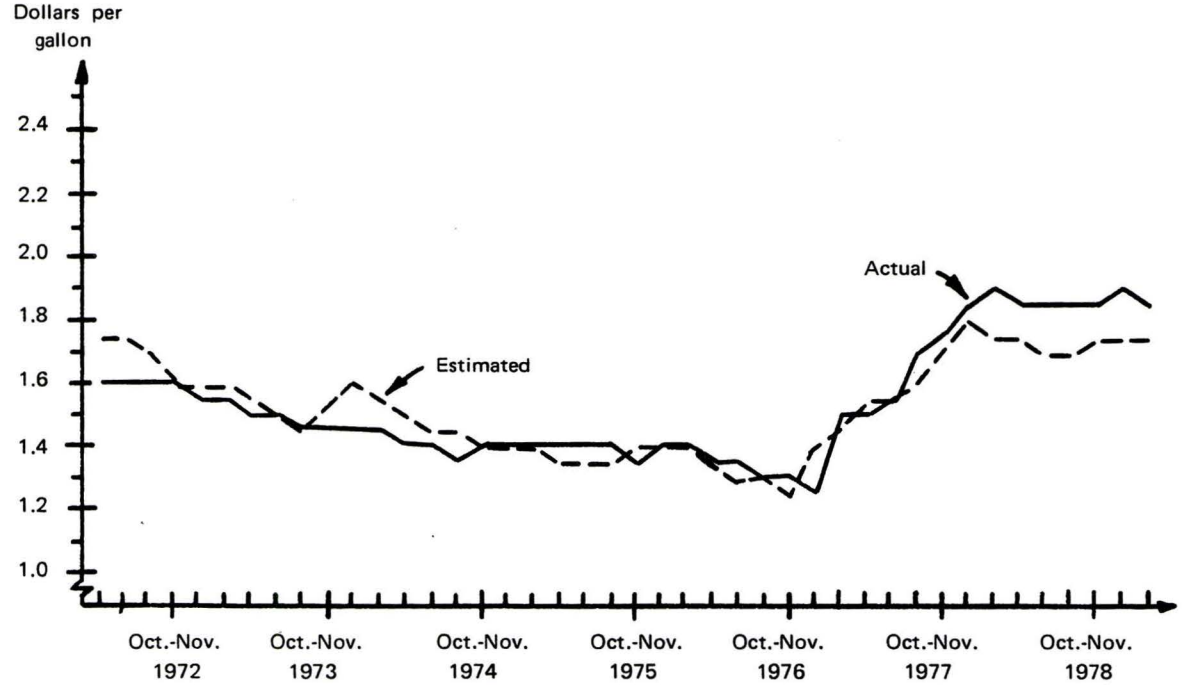

Figure H.2. Actual and reduced-form estimated values of retail prices (1975=100) of FCOJ in the USA ($RPFS_t$), April-May/1972 to February-March/1979.;

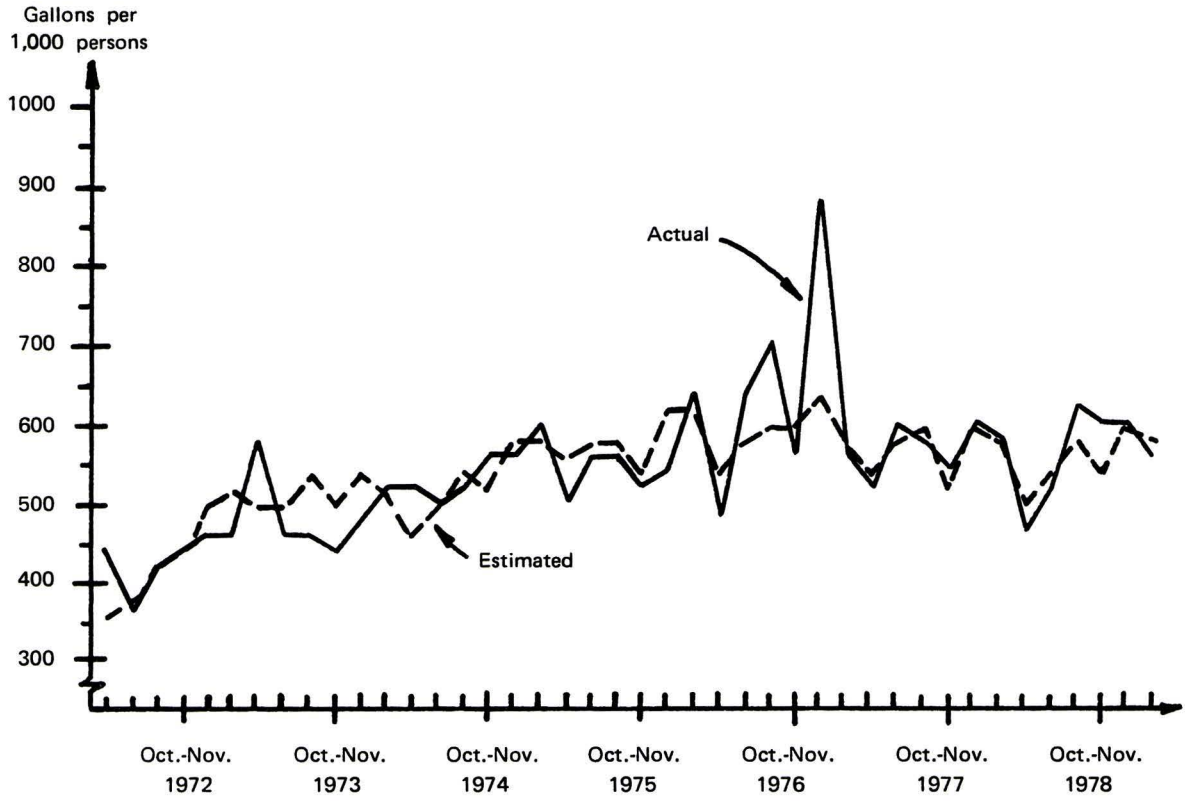

Figure H.3. Actual and reduced-form estimated values of wholesale quantities of FCOJ in the Florida ($WQFFI_t$), April-May/1972 to February-March/1979.

Note: FCOJ quantities are expressed in gallons of single strength juice equivalent.

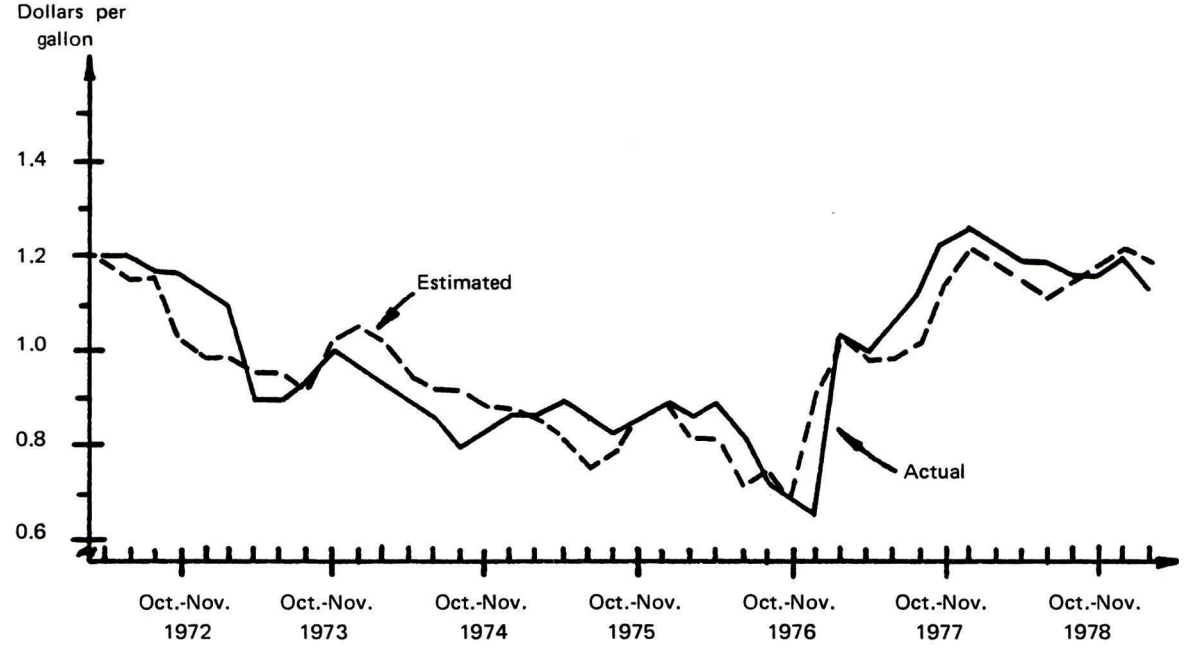

Figure H.4. Actual and reduced-form estimated values of wholesale prices (1975=100) of FCOJ in Florida ($WPFFI_t$), April-May/1972 to February-March/1979.

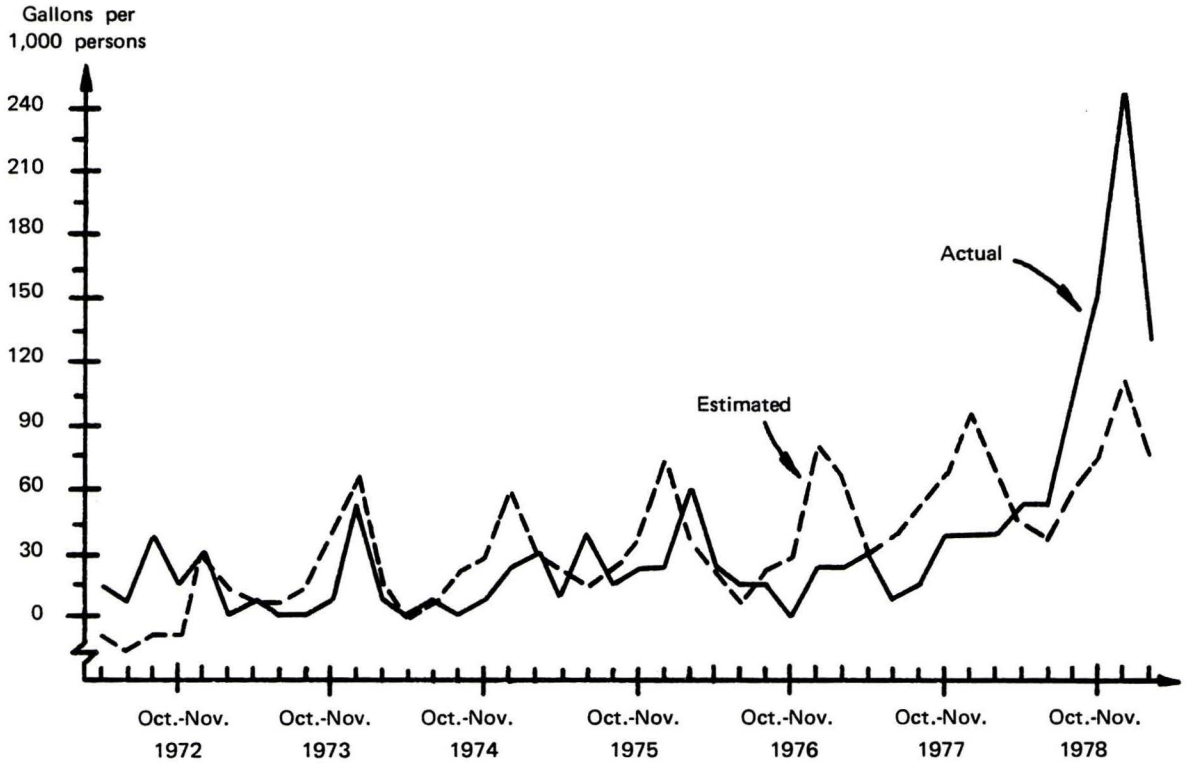

Figure H.5. Actual and reduced-form estimated values of import quantities of FCOJ by the USA from Brazil ($MQFSB_t$), April-May/1972 to February-March/1979.
Note: FCOJ quantities are expressed in gallons of single strength juice equivalent.

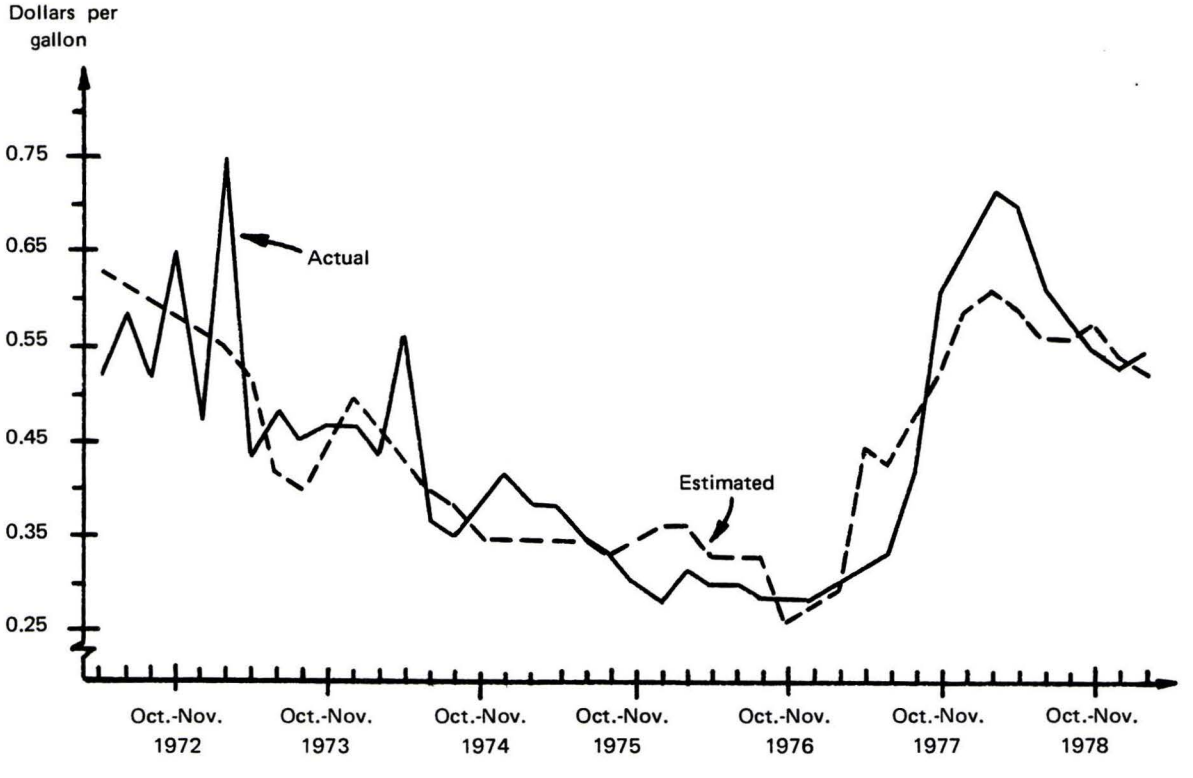

Figure H.6. Actual and reduced-form estimated values of import price (1975=100) of FCOJ by the USA from Brazil ($MPFSB_t$), April-May/1972 to February-March/1979.

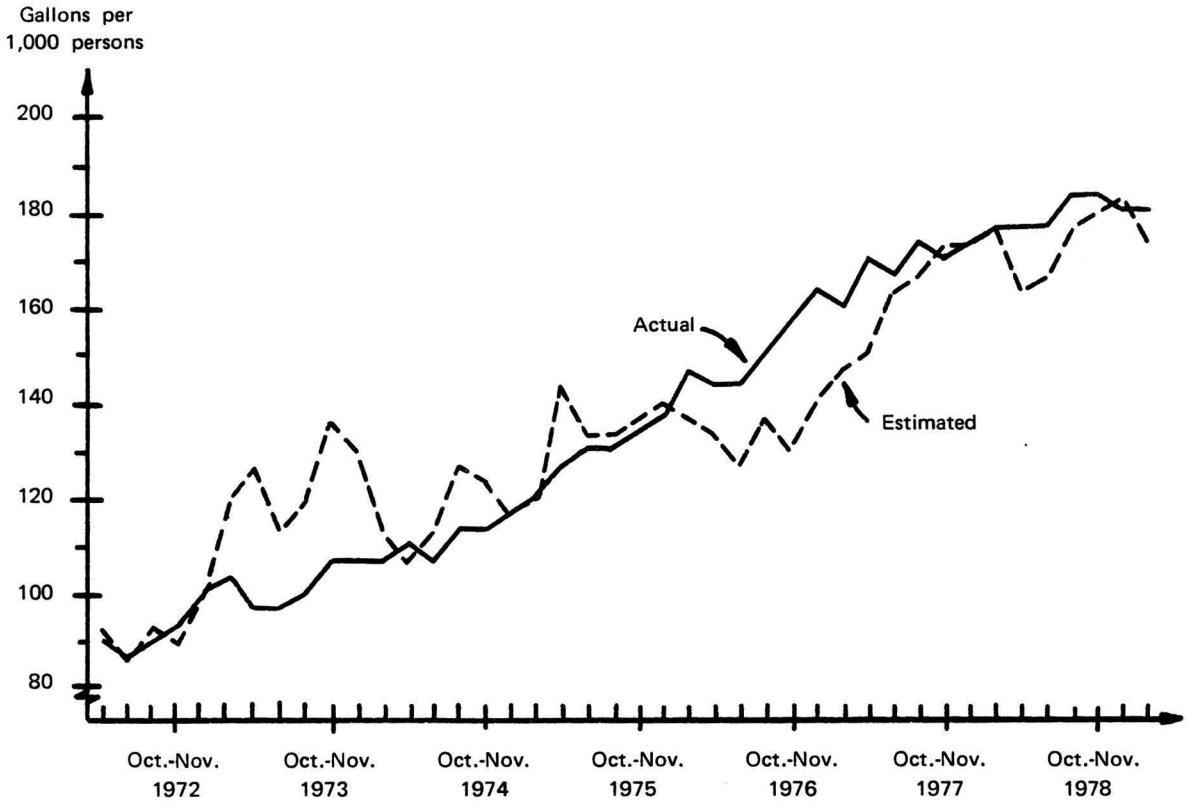

Figure H.7. Actual and reduced-form estimated values of retail quantities of other orange juices in the USA ($RQOS_t$), April-May/1972 to February-March/1979.
Note: Other orange juices are expressed in gallons of single strength juice equivalent.

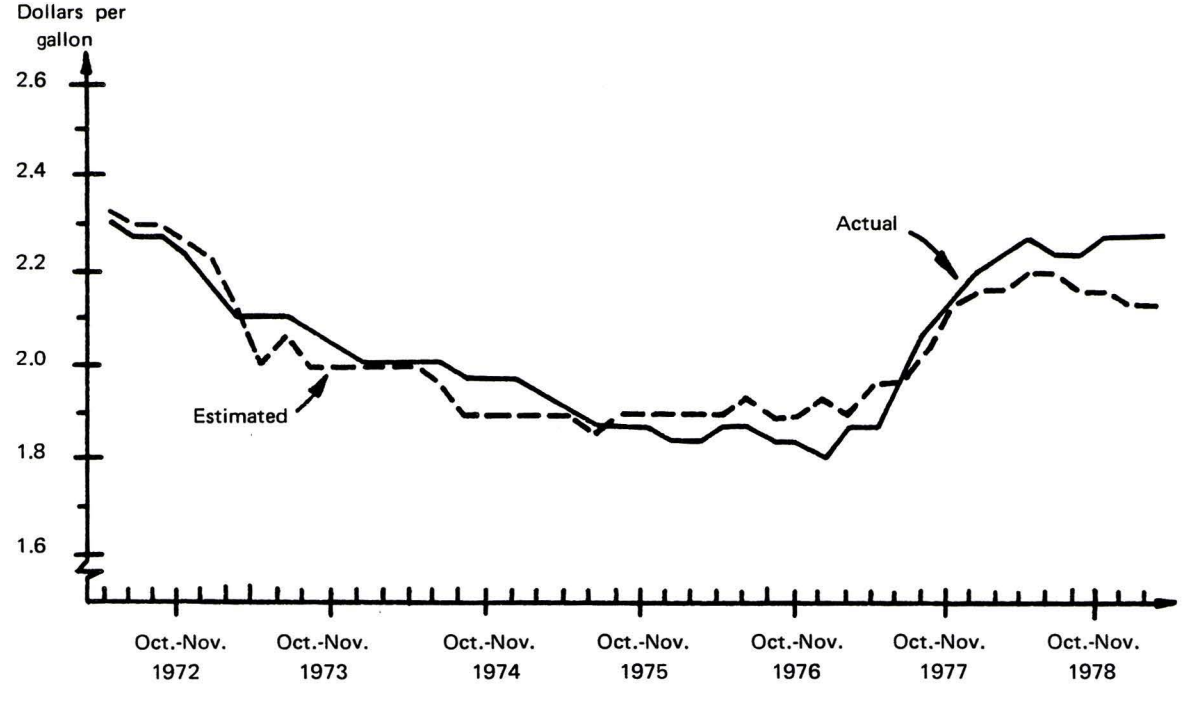

Figure H.8. Actual and reduced-form estimated values of retail prices (1975=100) of other orange juices in the USA ($RPOS_t$), April-May/1972 to February-March/1979.

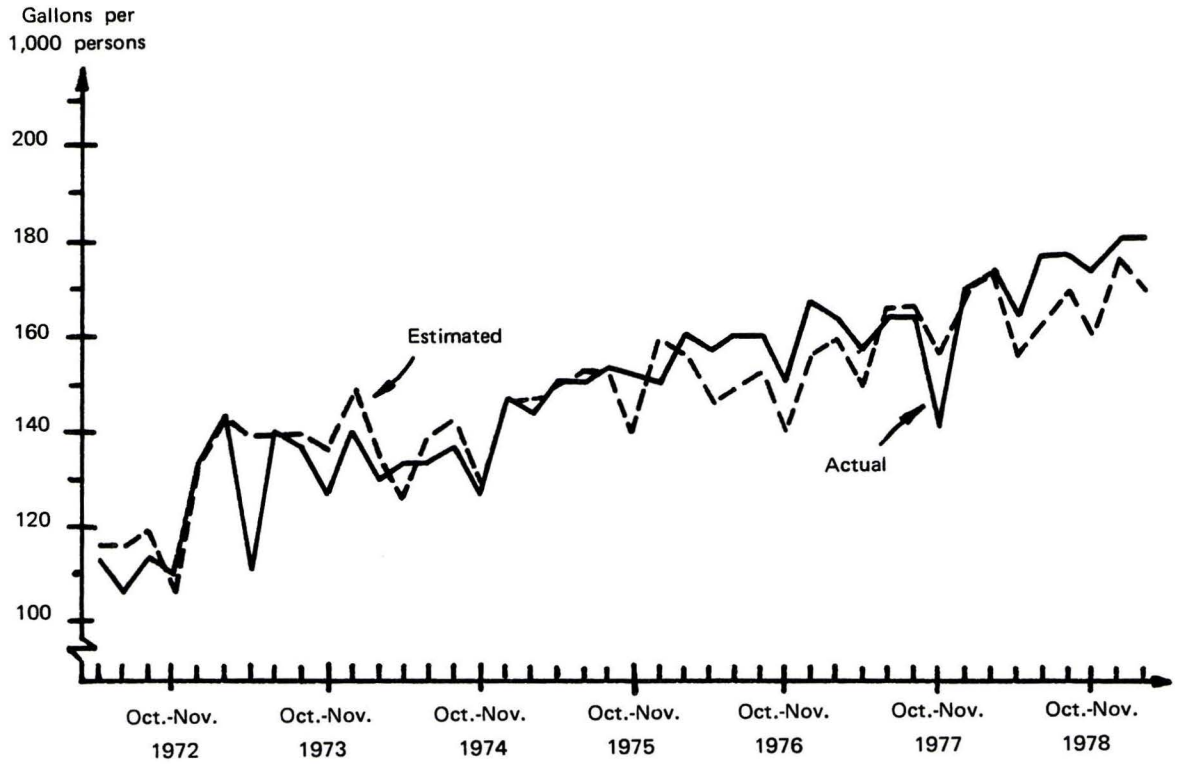

Figure H.9. Actual and reduced-form estimated values of wholesale quantities of other orange juices in Florida ($WQOFl_t$), April-May/1972 to February-March/1979.
Note: Other orange juices quantities are expressed in gallons of single strength juice equivalent.

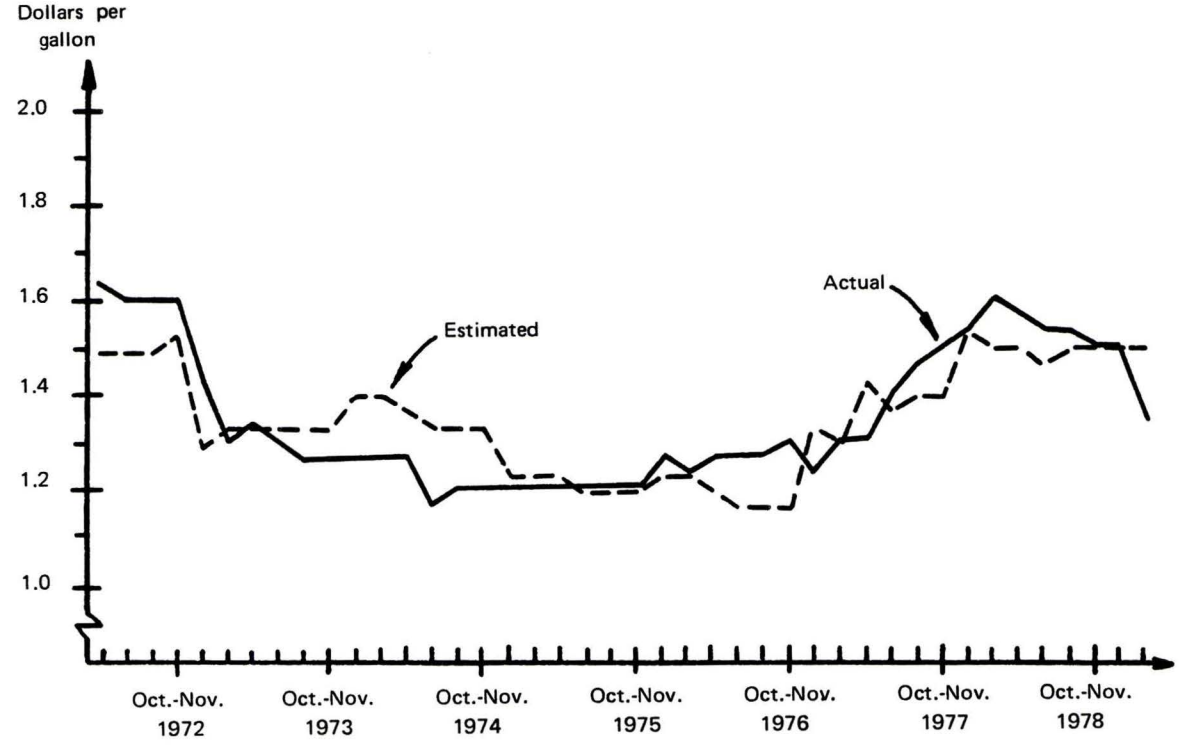

Figure H.10. Actual and reduced-form estimated values of wholesale prices (1975=100) of other orange juices in Florida ($WPOFl_t$), April-May/1972 to February-March/1979.

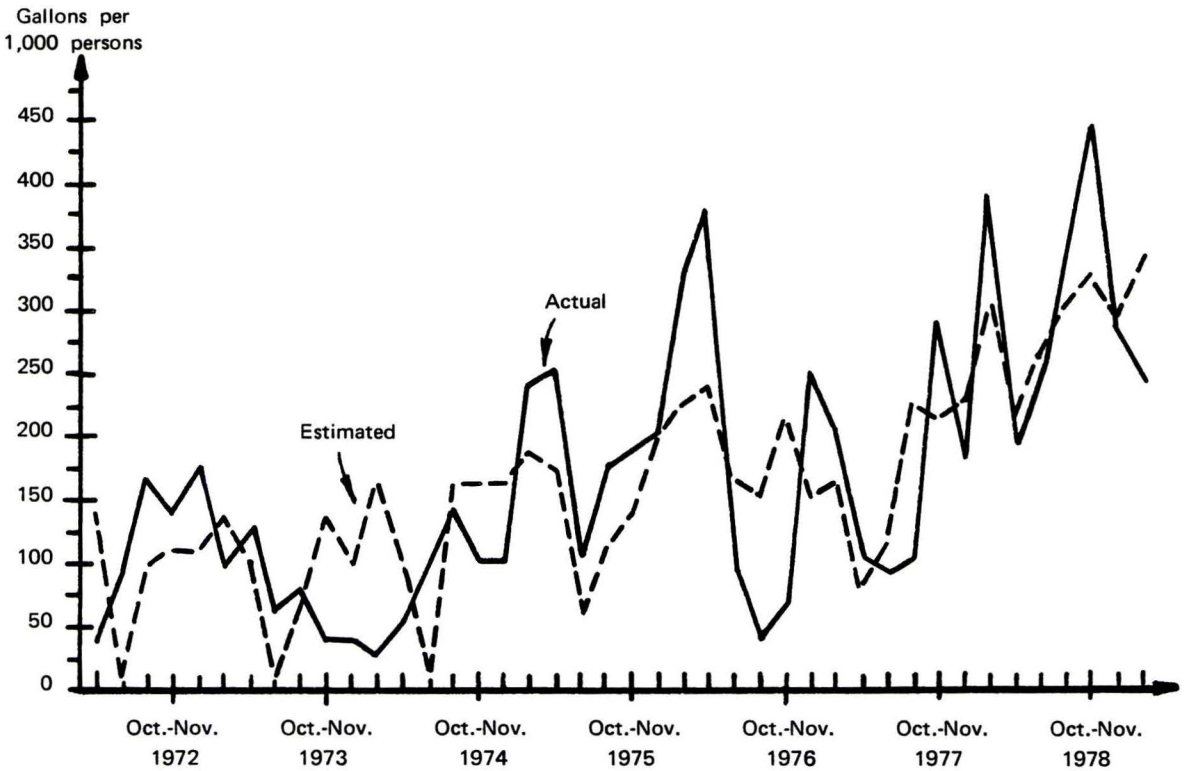

Figure H.11. Actual and reduced-form estimated values of export quantities of FCOJ to Canada from Brazil ($XQFCB_t$), April-May/1972 to February-March/1979.
Note: FCOJ quantities are expressed in gallons of single strength juice equivalent.

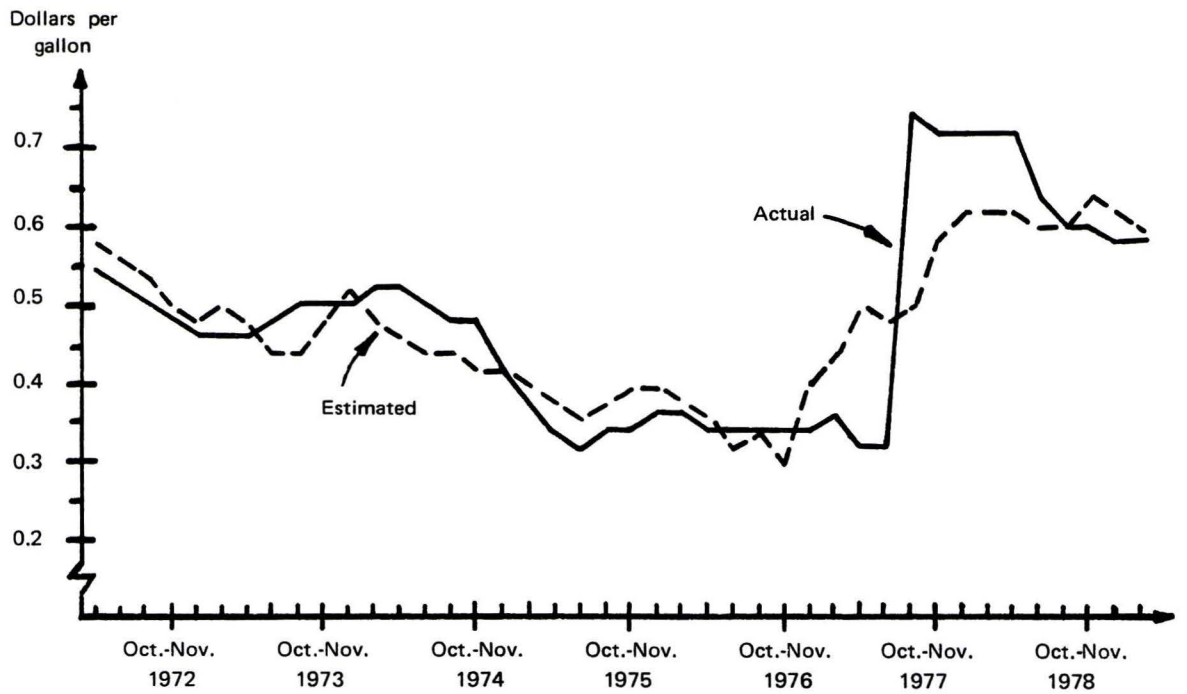

Figure H.12. Actual and reduced-form estimated values of export price (1975=100) of FCOJ to Canada from Brazil ($XPFCB_t$), April-May/1972 to February-March/1979.

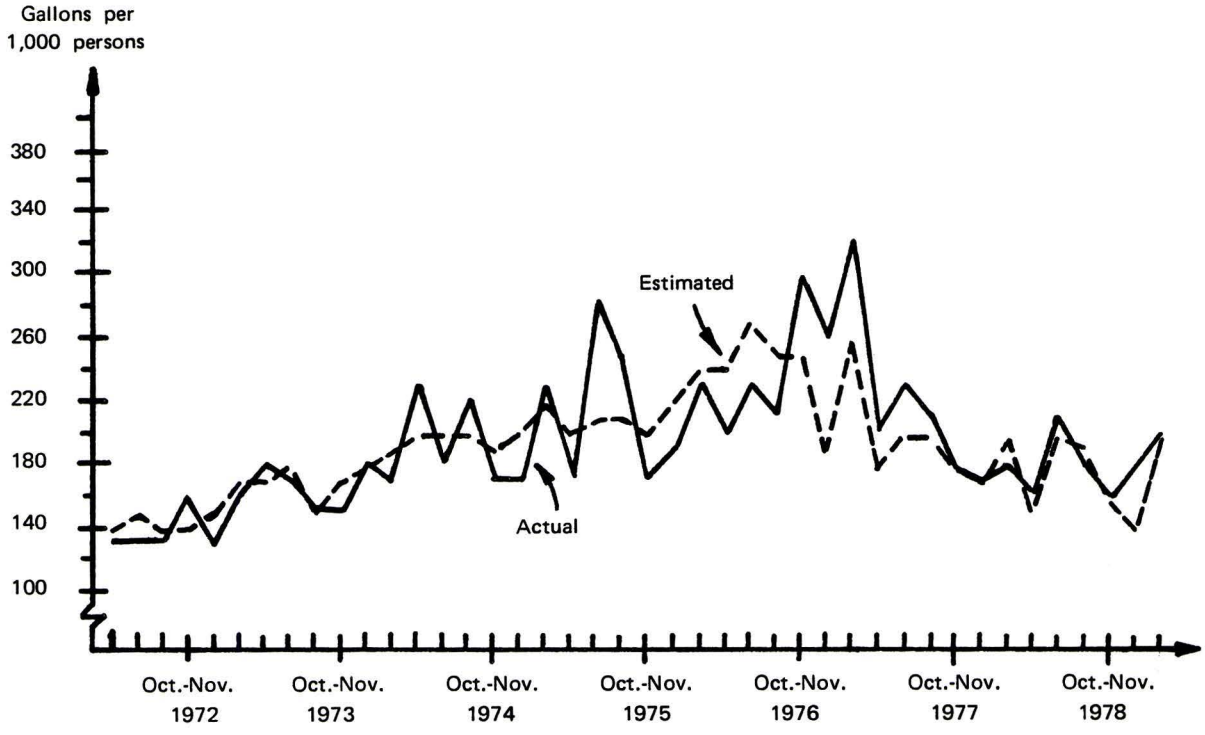

Figure H.13. Actual and reduced-form estimated values of export quantities of FCOJ to Canada from the USA ($XQFCS_t$), April-May/1972 to February-March/1979.
Note: FCOJ quantities are expressed in gallons of single strength juice equivalent.

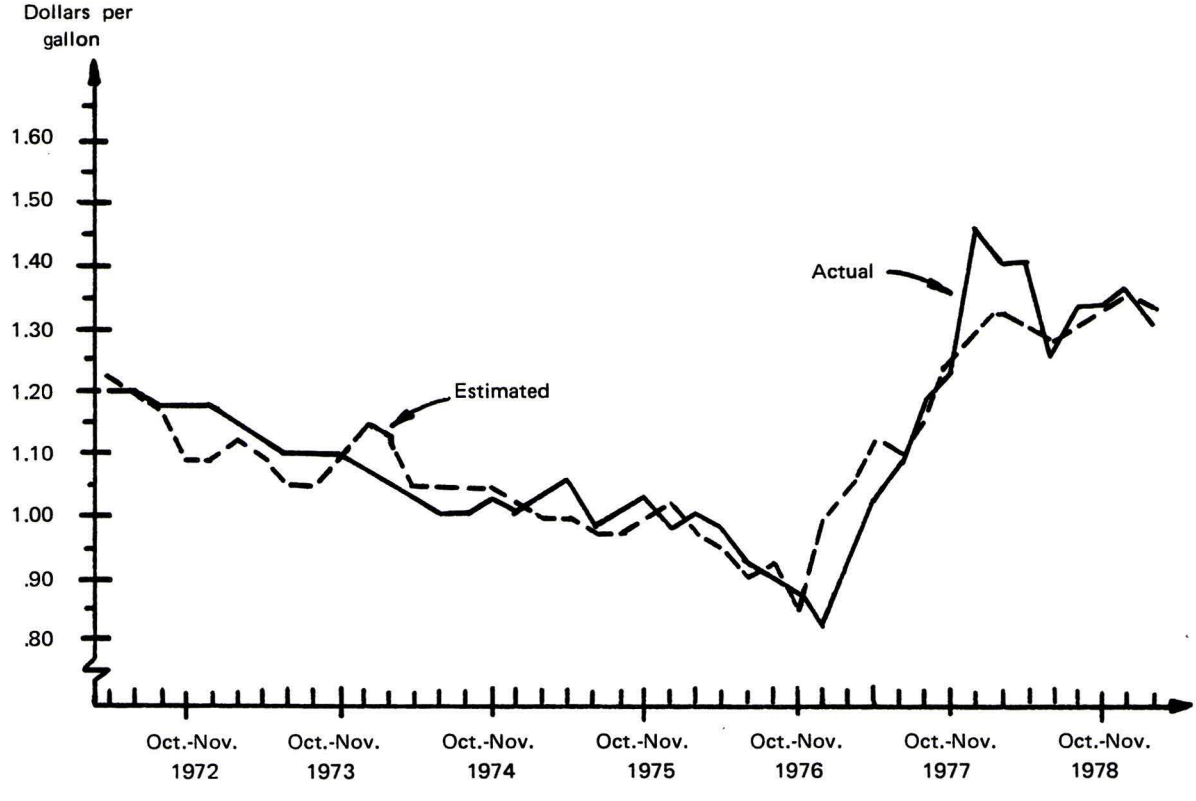

Figure H.14. Actual and reduced-form estimated values of export price (1975=100) of FCOJ to Canada from the USA ($XPFCS_t$), April-May/1972 to February-March/1979.

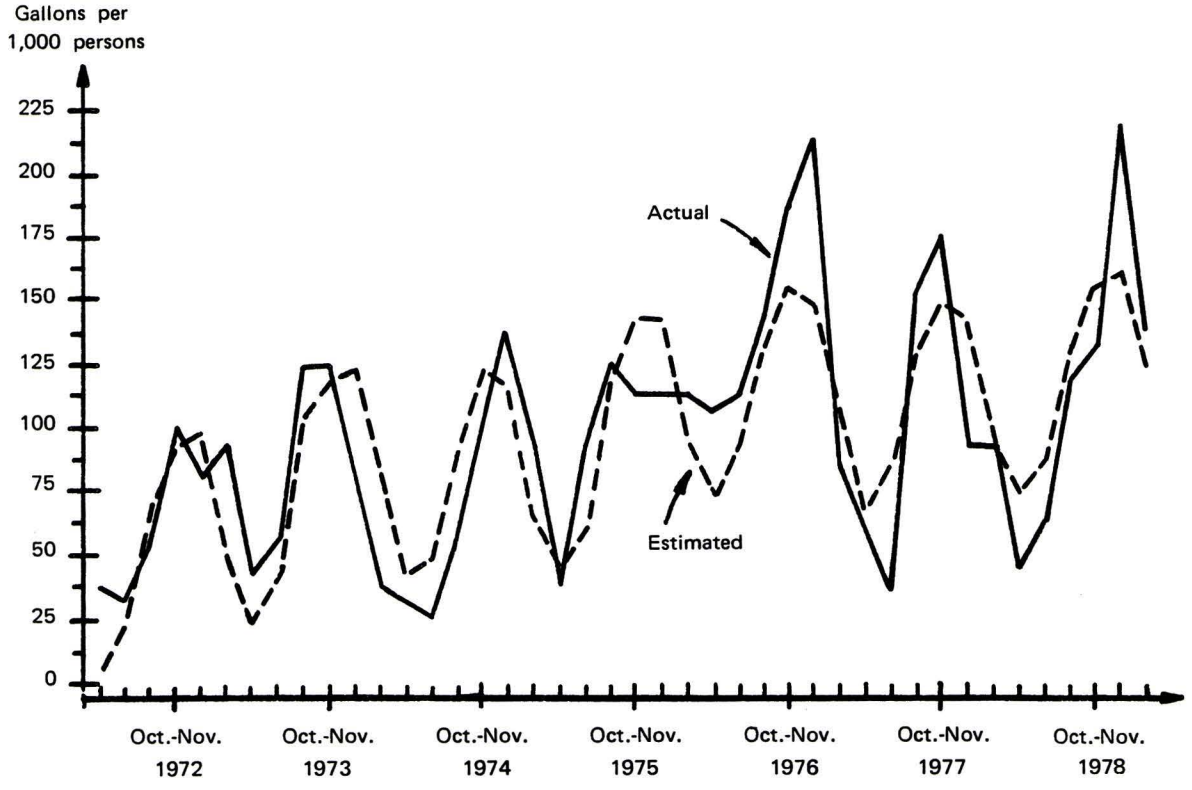

Figure H.15. Actual and reduced-form estimated values of export quantities of FCOJ to the EEC7 countries from Brazil ($XQFEB_t$), April-May/1972 to February-March/1979.
Note: FCOJ quantities are expressed in gallons of single strength juice equivalent.

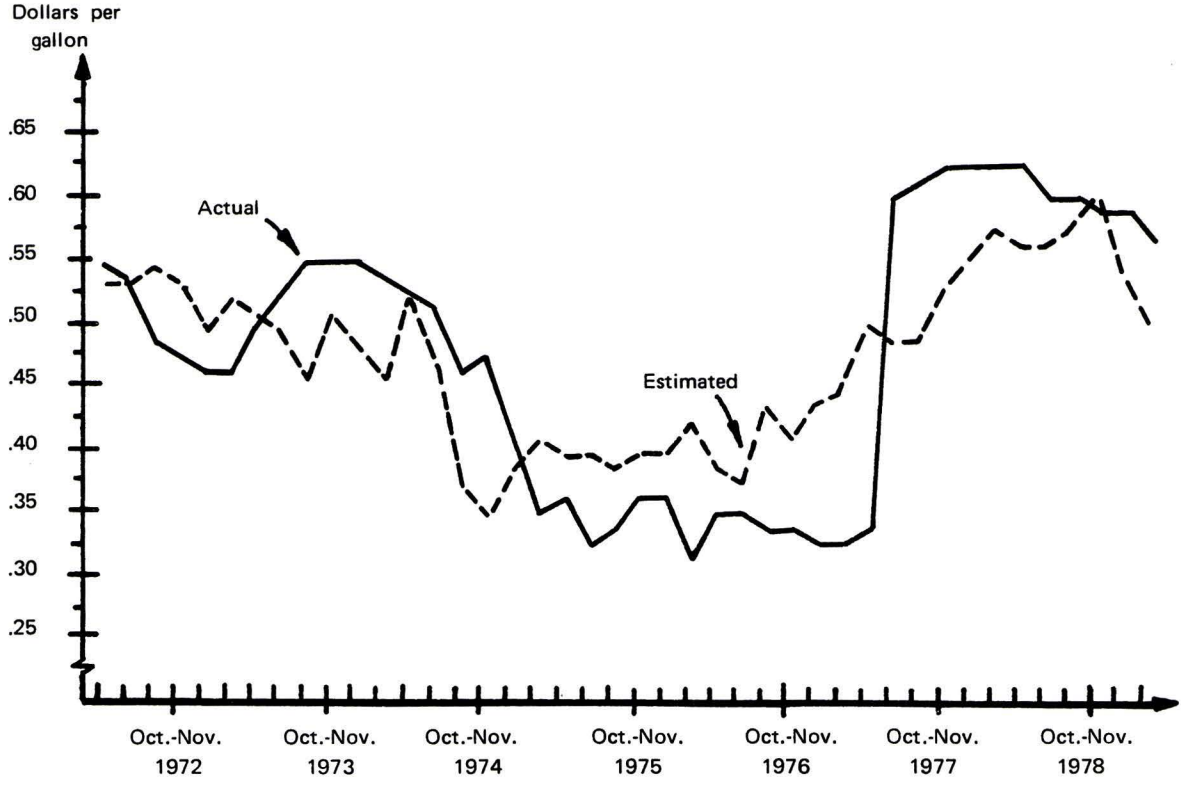

Figure H.16. Actual and reduced-form estimated values of export price (1975=100) of FCOJ to the EEC7 countries from Brazil ($XPFEB_t$), April-May/1972 to February-March/1979.

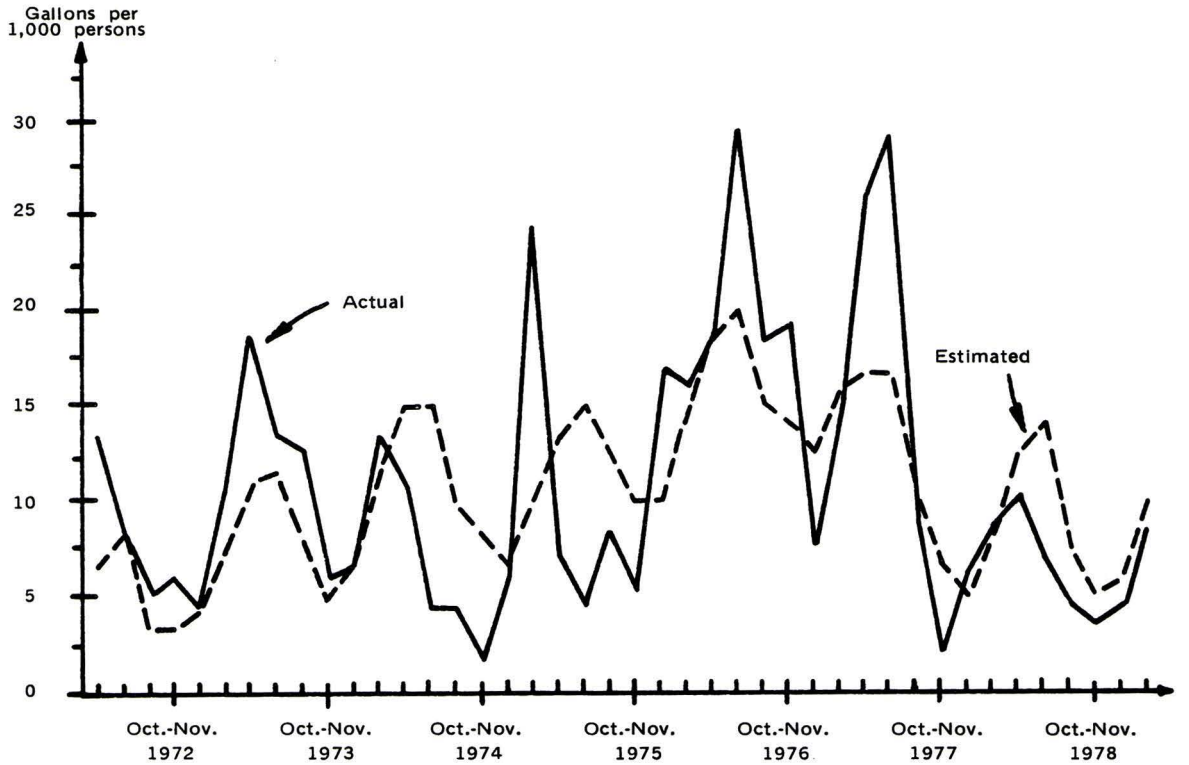

Figure H.17. Actual and reduced-form estimated values of export quantities of FCOJ to the EEC7 countries from the USA ($XQFES_t$), April-May/1972 to February-March/1979.
Note: FCOJ quantities are expressed in gallons of single strength juice equivalent.

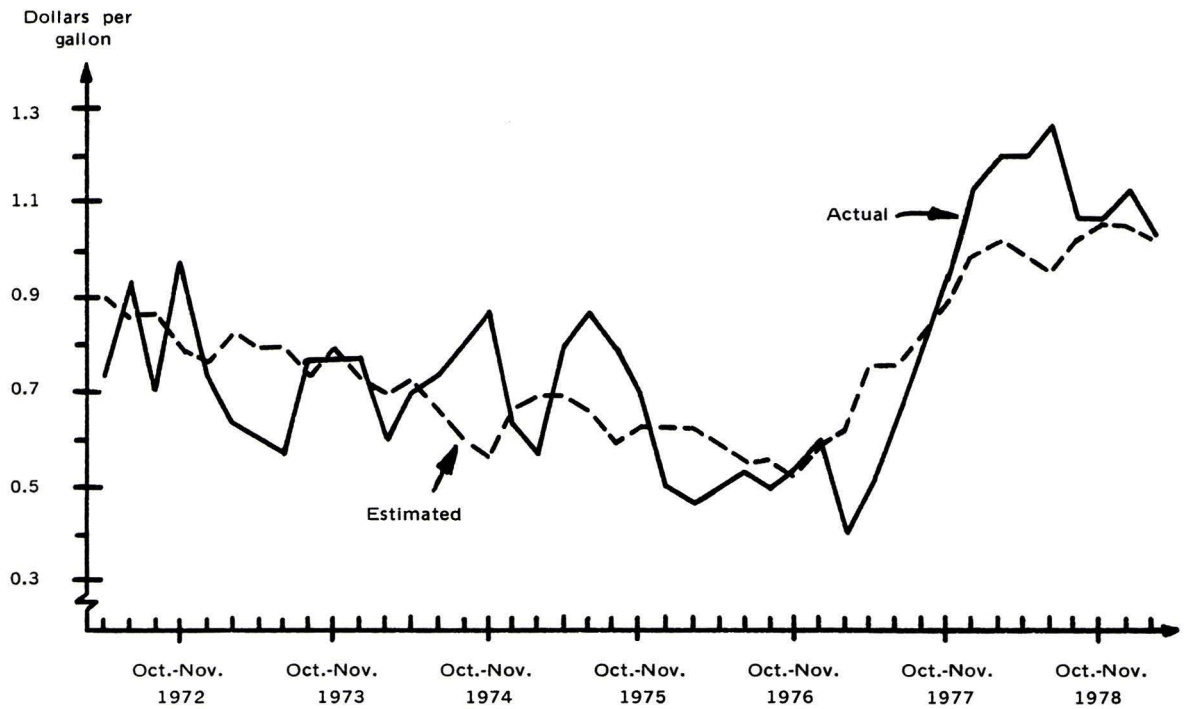

Figure H.18. Actual and reduced-form estimated values of export price (1975=100) of FCOJ to the EEC7 countries from the USA ($XPFES_t$), April-May/1972 to February-March/1979.

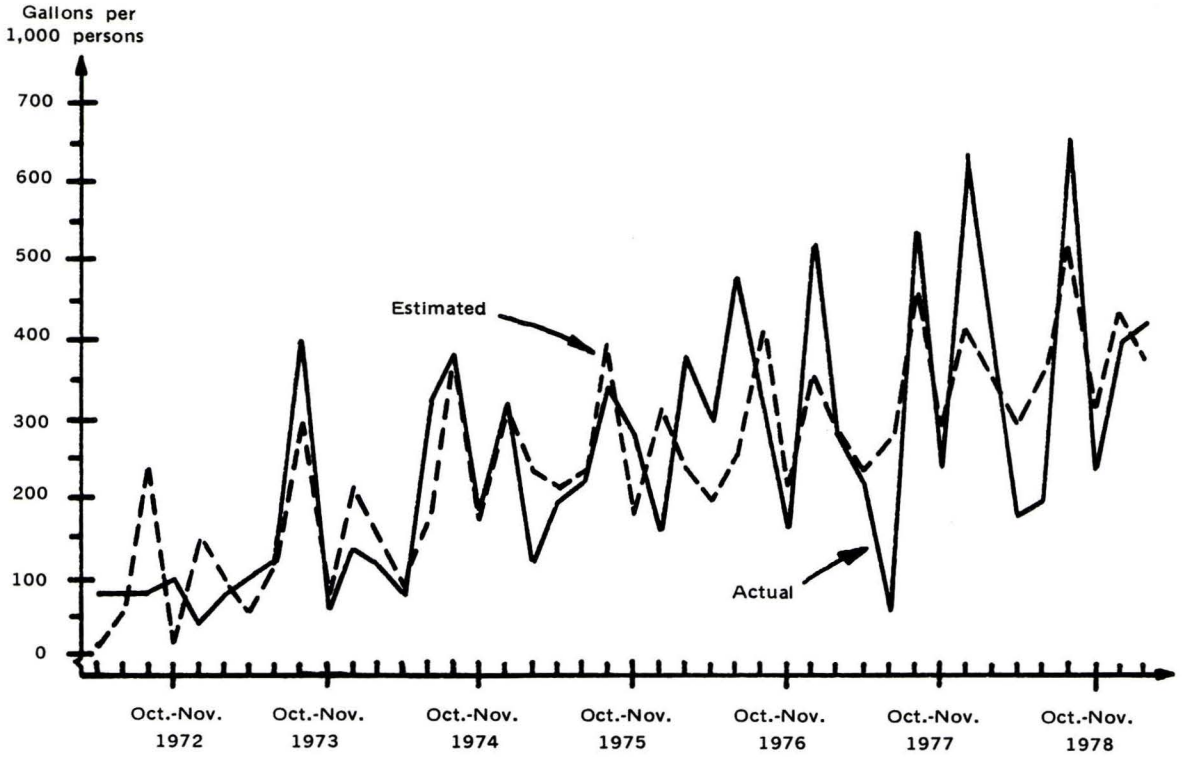

Figure H.19. Actual and reduced-form estimated values of export quantities of FCOJ to the European non-EEC3 countries from Brazil ($XQFNB_t$), April-May/1972 to February-March/1979.
Note: FCOJ quantities are expressed in gallons of single strength juice equivalent.

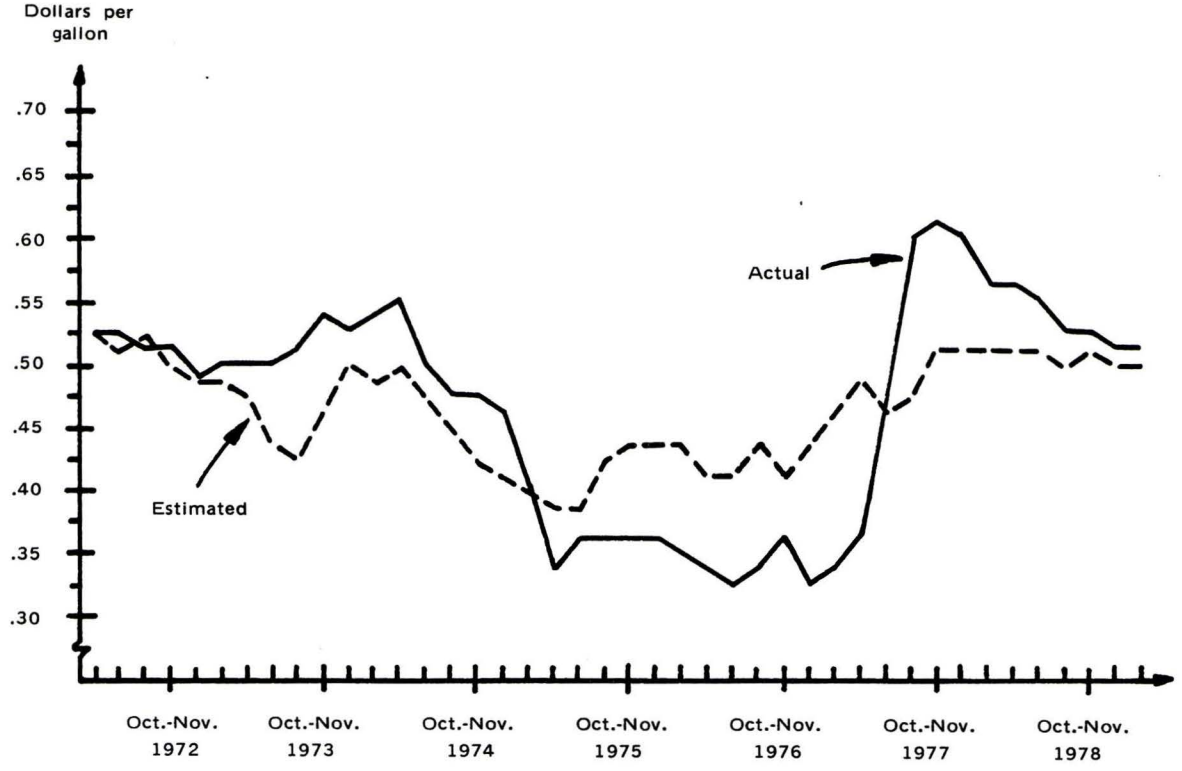

Figure H.20. Actual and reduced-form estimated values of export price (1975=100) of FCOJ to the European non-EEC3 countries from Brazil ($XPFNB_t$), April-May/1972 to February-March/1979.

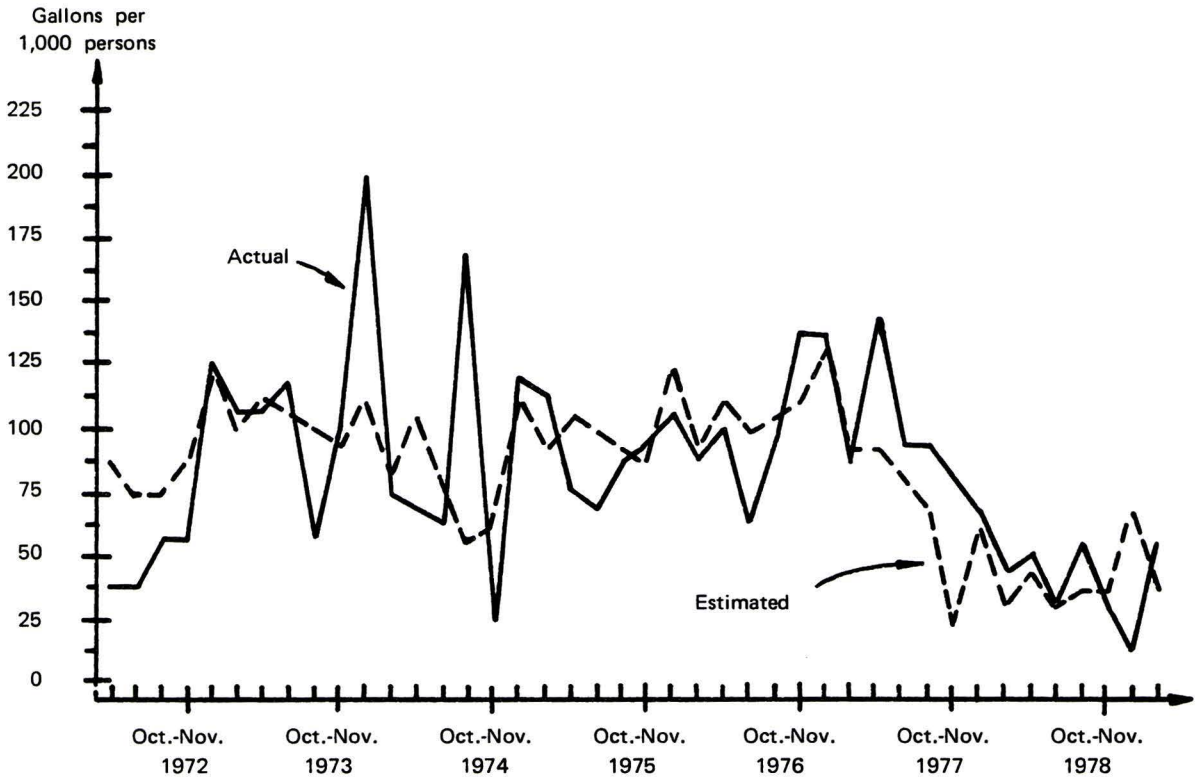

Figure H.21. Actual and reduced-form estimated value of export quantities of FCOJ to the European non-EEC3 countries from the USA ($XQFNS_t$), April-May/1972 to February-March/1979.
Note: FCOJ quantities are expressed in gallons of single strength juice equivalent.

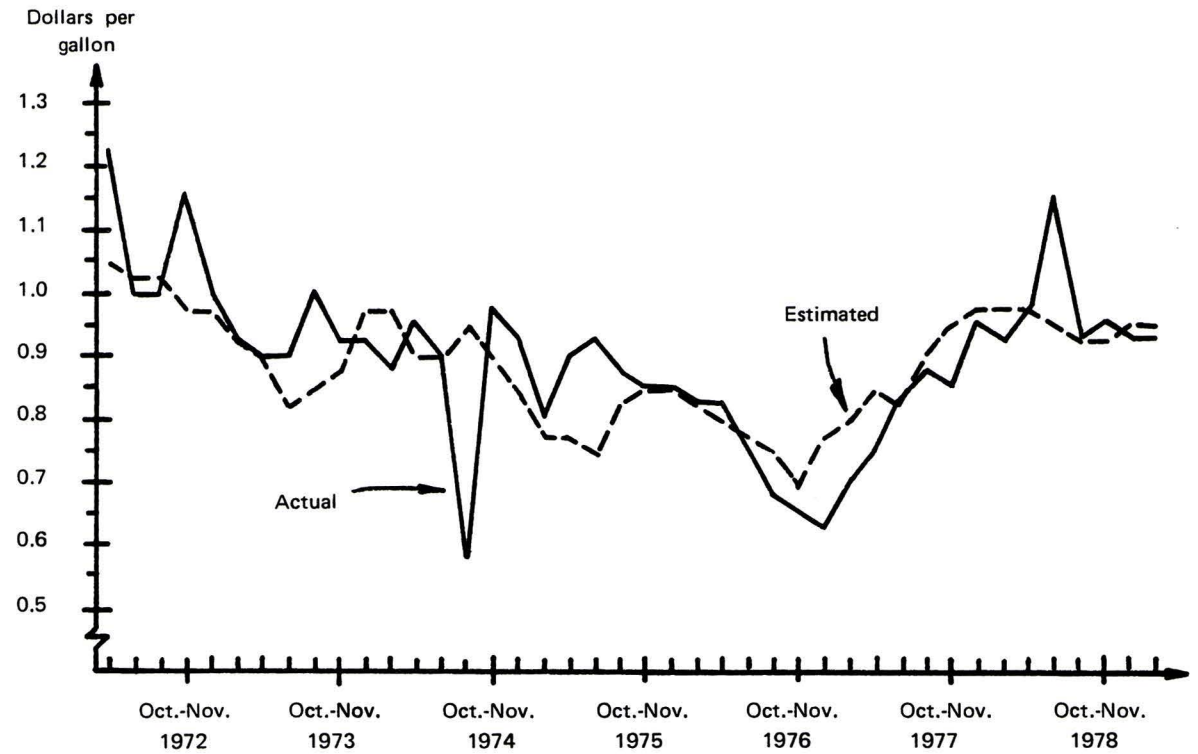

Figure H.22. Actual and reduced-form estimated values of export price (1975=100) of FCOJ to the European non-EEC3 countries from the USA ($XPFNS_t$), April-May/1972 to February-March/1979.

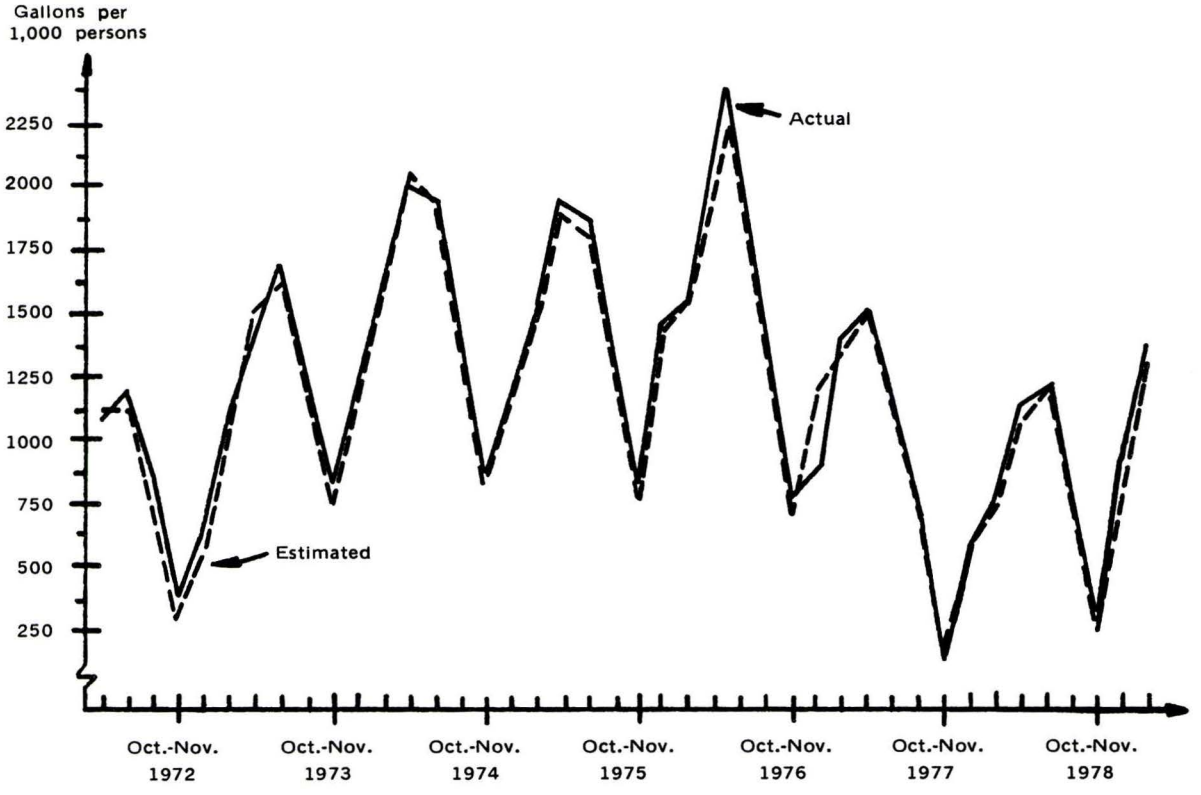

Figure H.23. Actual and reduced-form estimated values of wholesale quantities in stocks of FCOJ in the USA ($WQkFS_t$), April-May/1972 to February-March/1979.
Note: FCOJ quantities in gallons of single strength juice equivalent.

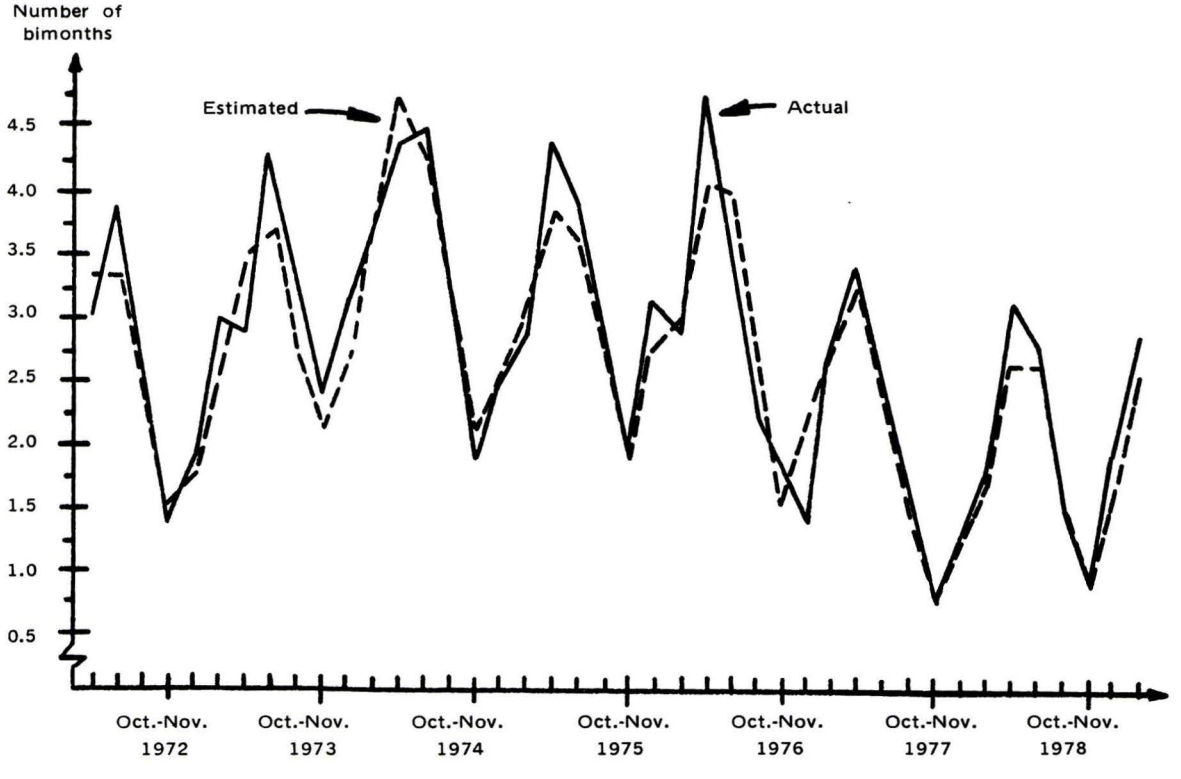

Figure H.24. Actual and reduced-form estimated values of wholesale stocks of FCOJ in the USA ($WSkFS_t$), April-May/1972 to February-March/1979.
Note: FCOJ stocks are expressed in number of bimonths of Florida's supplies.

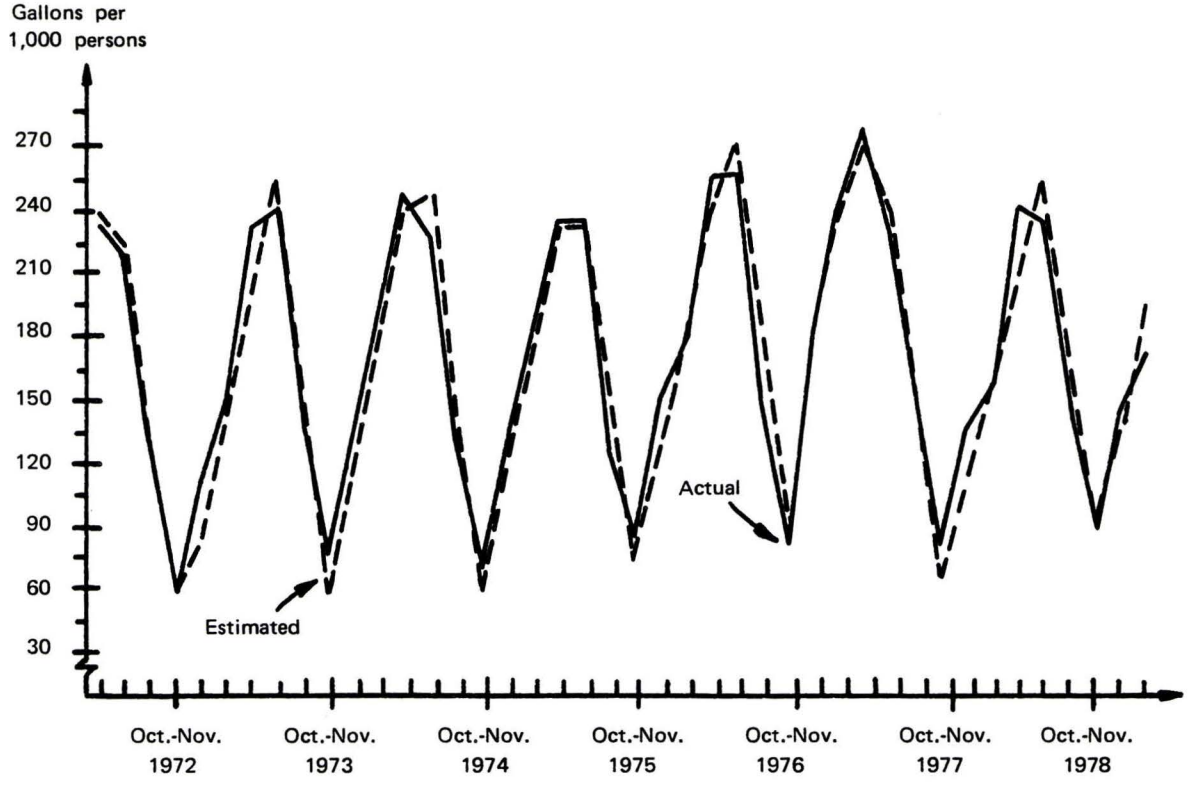

Figure H.25. Actual and reduced-form estimated values of wholesale quantities in stocks of other orange juices in the USA ($WQkOS_t$), April-May/1972 to February-March/1979.

Note: Other orange juice quantities are expressed in gallons of single strength juice equivalent.

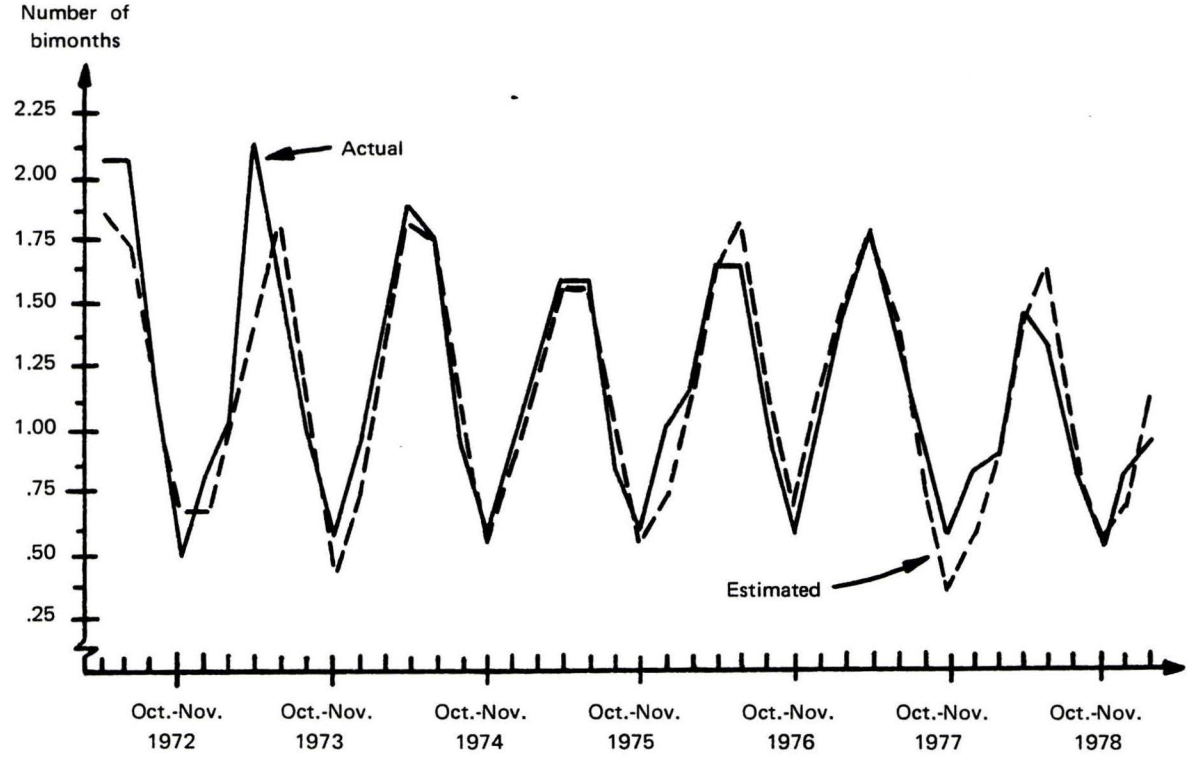

Figure H.26. Actual and reduced-from estimated values of wholesale stocks of other orange juices in the USA ($WSkOS_t$), April-May/1972 to February-March/1979.

Note: Other orange juices stocks are expressed in number of bimonths of Florida's supplies.

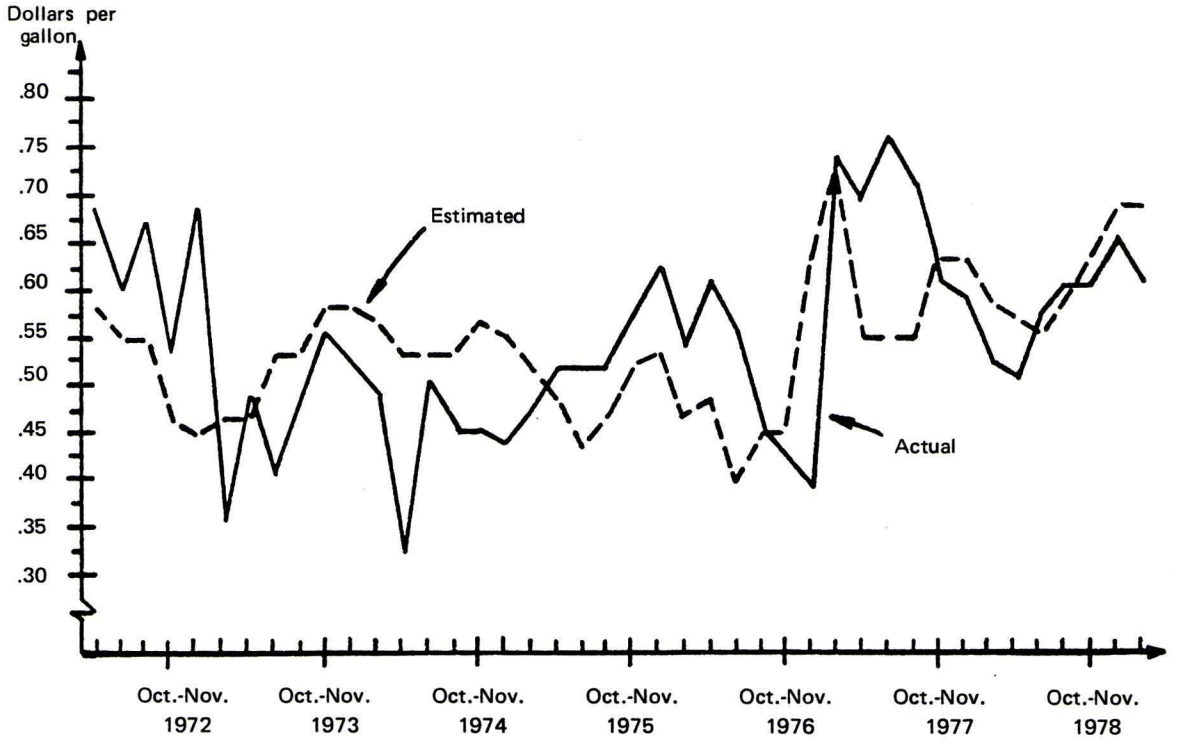

Figure H.27. Actual and reduced-form estimated values of the price (1975=100) spread between wholesale price of FCOJ in Florida ($WPFFI_t$) and import price of FCOJ by the USA from Brazil ($MPFSB_t$), April-May/1972 to February-March/1979.

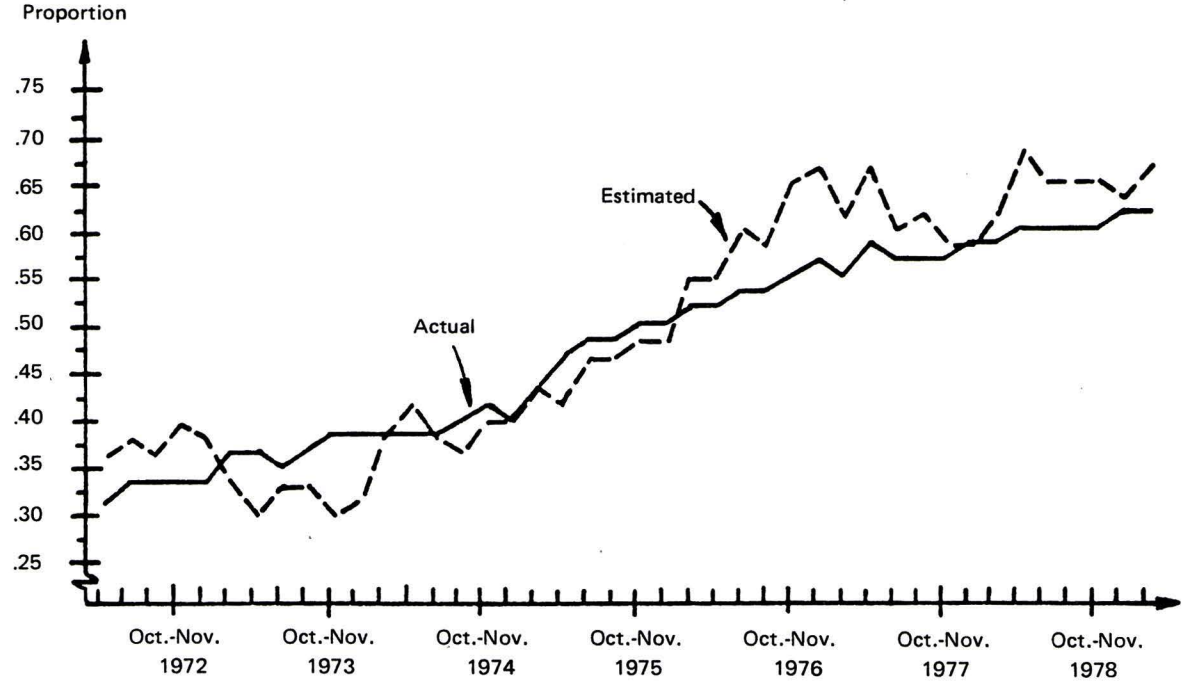

Figure H.28. Actual and reduced-form estimated values of retail proportion of other orange juices in cardboard containers in the USA ($RpOS_t$), April-May/1972 to February-March/1979.

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Luiz José Maria Irias was born in Ponte Nova, Minas Gerais, Brazil, on January 9, 1944. He has a B.S. degree in agricultural engineering (1967) and an M.S. degree in agricultural economics (1970) from the Universidade Federal de Viçosa, Minas Gerais, Brazil. He worked as an agricultural economics researcher for the Centro de Estudos Agrícolas do Instituto Brasileiro de Economia Agrícola da Fundação Getúlio Vargas, Rio de Janeiro (1969 to 1971) and for the Empresa Brasileira de Assistência Técnica e Extensão Rural (1971 to 1973). Since 1974 he has been working for the Empresa Brasileira de Pesquisa Agropecuária, a federal government enterprise that carries out agricultural research in Brazil. In the fall of 1976, he started his graduate study at the University of Florida, Gainesville, USA, for the degree of Doctor of Philosophy with major in Food and Resource Economics. He is a member of the International Association of Agricultural Economists, American and Southern Agricultural Economics Associations, Sociedade Brasileira de Economistas Rurais and Associação dos Engenheiros Agrônomos do Distrito Federal. He is married to Raulina Grossi Irias and has two daughters, Ana Claudia and Ana Cristina.

I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Philosophy.

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