ORANGE BEARING ACREAGE AND BRAZILIAN ORANGE JUICE TRADE: THE IMPACT ON THE CALIFORNIA-ARIZONA AND FLORIDA CITRUS REGIONS

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ABSTRACT

One of the most critical decisions that a citrus producer must make is the scheduling of new plantings and replacement of old trees. In other words he must decide on bearing acreage changes.

Two supply response models for bearing acreage difference were developed for Florida and the western (California-Arizona) citrus industries. The models for bearing acreage are based on French and Matthews work on acreage adjustments in perennial crops. The purpose of these regional citrus models is to examine both domestic and international factors affecting orange acreage in the major citrus growing regions in the U.S.A.

Most of the data employed in this study were compiled at the University of Florida and University of Tennessee libraries and from personal communication with Dr. Robert Behr, Director of the Economic Research Department at the Department of Citrus. Ms. Emily Mc Clain, candidate for the degree of Doctor of Philosophy at the University of Florida, provided additional information.

The study concluded that Florida bearing acreage differences (FLBAD) is a function of Brazilian orange production lagged one year (BORPDT1), Florida orange on-tree prices lagged two years (FLTPRT2), Freezes (FREZ), Average Brazilian frozen concentrated orange juice (FCOJ) export prices to the U.S. lagged years one and two (BXPUSV). The study found the California-Arizona bearing acreage difference (CZBAD) model to be a function of California Arizona nonbearing acreage lagged four and five years (CAZNBT4 and CAZNBT5), California on-tree prices

lagged two years (CATPRT2), California-Arizona yield lagged five years (CZYIDT5). Both econometric models were assumed to provide the best explanation for bearing acreage changes in Florida and the western citrus industry. This assumption is based on the relatively good job the models did explaining the basis for bearing acreage difference (R^2=.8614) and (R^2=.8784) for Florida and California-Arizona models respectively.

Florida on-tree prices, freezes and Brazil FCOJ export prices were found to play major explanatory roles in FLBAD econometric model. The study indicates that Florida on-tree prices were found to be positively related to bearing acreage changes, while freezes and Brazilian FCOJ export prices are inversely related. In addition, the study concludes that therida bearing acreage model was very sensitive to international factors such as the Brazil/U.S. exchange rate and domestic factors affecting the international citrus industry like U.S. orange production.

California-Arizona nonbearing acreage lagged four and five years, California-Arizona yield and California on-tree prices for oranges were found to be major factors affecting bearing acreage in the West. The study found the variable California-Arizona yield to be inversely related and to have an elastic response to the California-Arizona bearing acreage difference model. On the other hand, California on-tree prices as expected, were found to be positively related to the model and to have an inelastic response to the model. Finally the study determined that no major link exists between the California-Arizona bearing acreage model and Brazilian FCOJ trade factors used in this study.

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CHAPTER I

INTRODUCTION

The world's consumption, production, and trade of citrus products have increased immensely in the past ten years. As a result, the processed orange products industry has been one of the most progressive and competitive industries in agriculture, and nowhere are the effects of this competition seen more clearly than in the frozen concentrated orange juice (FCOJ) industry. FCOJ, represents the primary form of orange trade because of its facility to be stored, ability to be manufactured within a range of measurable standards, and capability to reduce concerns about sanitary problems found in fresh fruit.

As shown in Table 1, Brazil is the largest producer of oranges and the world's leading producer and exporter of FCOJ. Following Brazil, the United States, Israel, Spain, Italy, and Mexico are the next largest producers of oranges.

Orange production in the United States is split between two major growing regions: Florida, which primarily produces oranges for use in frozen concentrated orange juice (FCOJ), and California-Arizona, which primarily produces oranges for the fresh market. Both regions compete in and are heavily influenced by international markets. However, given that they emphasize different markets, the potential exists for each region to be affected differently by international trade developments.

This study examines the major factors affecting orange bearing acreage in the southern and western citrus regions of the United States

Table 1. World Production of Oranges by year and country, 1969-84.

Year	Brazil	Israel	Italy	Mexico	Spain	U.S.A	World
			-----Thousands of Metric Tons-----				
1969	1622	845	1677	899	1731	7527	21638
1970	2005	909	1669	937	2135	7658	22503
1971	2132	1076	1599	1405	2005	7875	24715
1972	2760	1148	1766	1114	2179	7889	25529
1973	2872	1221	1604	1270	2642	9245	28932
1974	3782	1233	1891	1089	2460	8931	29333
1975	4065	1016	2098	1110	2479	9913	30660
1976	4065	995	1931	905	2643	10170	30918
1977	3574	968	2258	1283	2489	10144	30567
1978	4231	949	1950	750	1914	9268	28479
1979	6471	992	1959	1398	2526	8310	24050
1980	9282	943	2104	1810	2597	10734	38502
1981	9872	812	2057	1720	2605	9514	36725
1982a	9942	1105	1752	1650	1629	7025	28666
1983	9210	889	1498	1380	1652	8827	29294
1984	9588	950	2299	1220	2077	6573	28687

[a] Data prior to 1982 includes Tangarines.
Source: Commodity Research Bureau, Commodity Yearbook 1986, Jersey city, New Jersey.

and the effect international trade of FCOJ has on these citrus markets. Given that Brazil is the major international FCOJ trader, this study concentrates on Brazil's impact on the two United States citrus regions. The basic analysis of Brazil's influence will be used to understand better the development of trade relations between Brazil and the United States. This analysis will then be used to determine how citrus producers in the South and the West utilize their resources given changes in trade.

The study also assesses the extent to which the major citrus regions in the United States may react differently to changes in international FCOJ trade. This assessment can then be used to provide a basis for developing trade policies that take into account the different reactions of the citrus regions.

PROBLEM STATEMENT

In 1980 the United States of America lost the lead in production of oranges and orange juice. Brazil at that point emerged to take that place and become the world's primary supplier. As a result, FCOJ trade flow patterns were altered, and more importantly for growers in the United States, this led to regional changes in citrus production.

Trade relations between Brazil and the United States have been strained in recent years as Brazil's trade-oriented industries have grown in importance in world markets. One result of Brazil's success in world markets has been an increased intolerance by the U.S. government for Brazilian government export subsidies, which had been accepted as part of a developing nation's infant industry. In the eyes of U.S. producers, who were kept out of Brazilian markets, Brazil's increased industrial development and its increased presence in U.S. markets no longer justified the protection it received as a "developing nation" (International Trade Commission, 1986). One result of the increased U.S. pressure was Brazil's reduction of direct government intervention in export markets, and the increased use of exchange rate devaluations. Table 2 shows Brazilian exchange rates expressed in cruzados per dollar.

Brazil's use of exchange rate devaluations and factor cost subsidies has helped to continue the growth of its export industries. Additional concerns have been raised as more is learned about the use of government intervention to take advantage of increased economies of size. In this case the competitive position of one nation's industry now is viewed as a threat to the health of similar industries in other nations (United Nations CEPAL 1985). Given these concerns it has become increasingly important to gauge the effect of changes in world trade conditions.

While some domestic agricultural producers have looked to the government to intervene in order to protect their industry, little has been done to restrict FCOJ trade between the U.S. and Brazil. The United States International Trade Commission (ITC) for FCOJ from Brazil examined grower complaints and used data from 1978 to 1986 to conclude that there was a reasonable indication that the FCOJ industry in the United States is materially injured by imports from Brazil (ITC 1986).

Table 2. Brazilian Exchange Rate Expressed in Cruzado/Dollar, 1967-86

Year	Cruzado/Dollar
1967	.0025
1968	.0031
1969	.0040
1970	.0045
1971	.0053
1972	.0059
1973	.0061
1974	.0074
1975	.0090
1976	.0123
1977	.0161
1978	.0209
1979	.0425
1980	.0642
1981	.1280
1982	.2530
1983	.9840
1984	3.1840
1985	10.4900
1986	14.8950

Source: Computed from the International Monetary Fund, International Financial Statistics, various issues.

The USDA estimates that Brazil produced 954 million gallons of FCOJ in 1984-85 and 1181 million gallons of FCOJ in 1985-86 (Gunter, 1986). Since Brazil's domestic market is quite small, most of the production is exported.

Coinciding with Brazil's growth in the FCOJ market were substantial increases in worldwide orange juice consumption. Myers (1978) reported a consumption increase of 80 percent in Canada and the United States from 1968 to 1976. Furthermore, consumption has continued to climb in the United States since then [Beverage World, 1987]. Similar trends in consumption are taking place in Europe. European imports of orange juice increased by more than 60 percent in the period from 1969 to 1978. During this period, Brazil's exports to Europe increased by more than 750 percent, while exports from the U.S. increased only by 50 percent (Irias, 1981) (Table 3). According to Irias (1981) the growth in the FCOJ market and the attendant increases in trade have not been shared evenly between the United States and Brazil.

Florida's biennial commercial citrus census showed 624,492 acres of citrus as of January 1986. This was a decrease of 18 percent from the 761,365 acres reported in the 1984 census. Most of this reduction resulted from the series of severe freezes that occurred during the 1980's. Some growers and caretakers continued to remove acreage that was not rejuvenated following the killing freezes (FCLRS 1986).

Producers in Florida have different concerns from growers in the western citrus region. Florida, for instance, has mainly two factors affecting changes in bearing acreage. First, the weather plays a major

Table 3. Brazil and U.S.A. Exports to Europe by year, 1969-85.

Year	Brazil Exports to Europe	U.S. Exports to Europe
	-----1,000 [1]S.S.E. Gallons-----	
1969	19096	10721
1970	32478	18761
1971	54368	22832
1972	72998	22377
1973	124683	31189
1974	96220	25353
1975	157250	28305
1976	201618	39431
1977	171004	35817
1978	162592	16627
1979	203816	19465
1980	349940	21747
1981	445380	27944
1982	234150	20371
1983	330870	21836
1984	353920	16532
1985	200004	7886

1: SSE(Single Strength Equivalent): The number of gallons of single strength juice which could be made from the FCOJ. One gallon of 45 Brix FCOJ would equal 4.38 gallons of single strength (11 Brix) juice.
Source: Foodnews, July 5, 1985 (EUROSTAT).
Irias, J.M. An Econometric model of International Trade of Frozen Concentrated Orange Juice 1981.

role in the Florida citrus industry; freezes have accounted for more losses in bearing acreage than any other factor. The second factor is land availability. In the past 10 years developers have found in Florida an excellent place to build cities for elderly people, therefore increasing the price of land. In this study land expansion was assumed to be a barrier affecting growers' decisions concerning expected bearing acreage in the California citrus industry. At the present time, profits in the orange industry have not yet reached levels at which growers could afford to increase bearing acreage. On the other hand, the Arizona citrus industry has the potential for land expansion, but difficulties such as land quality and water availability impede this potential from becoming a reality.

In summary, bearing acreage changes in the citrus industry suggest an examination of the different factors that could be involved in growers' decisions about new plantings and the removal of old trees.

LITERATURE REVIEW

Several studies have addressed the issue of trade in FCOJ and its effects on the Florida citrus industry. Ward (1976) developed one of the first major FCOJ trade models addressing trade issues. The Ward model consisted of a system of simultaneous equations for imports to Florida, Florida export prices to Europe, European demand for Florida FCOJ, and the price spread between Florida and Brazil FCOJ, excluding tariffs. Ward's model found European demand to be highly sensitive to Florida concentrate price changes.

Myers (1979) presented an overview of the FCOJ import and export policies and programs by evaluating how different governmental policies, industry programs, and economic factors affected the volume and direction of product flows throughout the system. This allowed Myers to show the relationships between price spreads, tariff levels, and duty drawback (refundable imports tax) provisions and their effects on the quantity of Florida imports.

European consumption of FCOJ also plays an important role in the international market for FCOJ. Priscott (1969) and Ward (1976) focused on Florida's FCOJ exports to Western European countries. Both studies showed highly price-elastic markets with changes in exchange rates significantly affecting export demands. Ward's (1976) 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 lower priced FCOJ from Brazil.

Tilley and Lee (1981) used a system of simultaneous equations to analyze Canadian orange juice consumer demand and import demand from Brazil and the United States. Canada's imports from Brazil were found to be highly price-elastic, while imports from the United States were price-inelastic.

Brazilian participation in world trade of orange juice has been studied by Morais and Madeiros (1978), Moretti (1978), and Irias (1981). Morais and Madeiros described the Brazilian citrus industry in a general fashion. Moretti's work used 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. Moretti's results indicated that concentrate exports were highly responsive to changes in prices and exchange rates. More specific he concluded that the own price elasticity of demand for Brazilian FCOJ exports was significantly elastic, indicating that a price reduction of Brazilian FCOJ will increase their markets and revenues. In addition Moretti concluded that quantity demanded was highly responsive to population.

Irias (1981) developed a trade model for FCOJ. The model consisted of a system of demand and price equations for orange juice and essentially explained trade flows and prices. The conceptual framework consisted of a system of simultaneous demand and price equations for FCOJ. As expected, orange juice prices and quantities were found to play a major role in changes in trade flows. However, Irias found that advertising, the exchange rate index, and stock variables did not affect trade as significantly.

Roberts (1986) used the papaya industry in Hawaii to study the effect of changes in imports and tariffs on a regionally based commodity. The author developed an econometric model that explained changes in bearing acreage, yields, the allocation of papayas in various sectors, and imports. Roberts used this model to project the effects of changes in imports, tariffs, and quotas. The model indicated that, in general, the absence of government intervention would lead to lost revenues in the Hawaiian papaya industry.

The literature surrounding supply response models for citrus acreage is not well developed. However, there are several works dealing with the supply response of other perennial crops that may be used as the basis for modelling changes in citrus bearing acreage.

French and Matthews (1971) examined the decision process of growers involved in the production of perennial crops. The authors estimated a planting equation and an acreage removal to project changes in regional acreage of asparagus. Their basic conclusions were that yield expectations and profits have an influence in bearing acreage changes. This model allowed for hypotheses about the influence of grower expectations to be tested in the framework of a supply response model.

James Dunn and Richard Beilock (1979) made a more complete study of the early work from French and Matthews. Dunn and Beilock estimated that the quantity planted of a perennial crop or the quantity invested was a function of short- and long-run profitability and the alternative uses of land. Dunn and Beilock mentioned the work done by Bateman (1961) and Wickens and Greenfield (1973).

Bateman, who worked with cocoa, concluded that current planting decisions were based upon current prices and that the primary determinant of plantings was the expected long-run profitabilities of cocoa and its alternative, coffee.

Wickens and Greenfield (1973) expanded on Bateman's work and presented three major conclusions. First, potential output was simply the average yield times the stock of trees (adjusted for age groups). Second, planting was a function of current and past prices. Third, actual output was potential output adjusted for recent and current prices and current physical factors.

Baritelle and Price (1974) also included frost data in their study of the U.S. apple industry. Although frost data were used to explain tree mortality, this data did not attempt to explain new plantings. The effects of frosts were reflected in relative prices, since a frost meant lower output and, therefore, higher prices.

OBJECTIVES

The primary objective of the study was to provide an economic analysis of the factors that affect orange bearing acreage changes and their interaction with international trade elements, with a major emphasis on Brazil-U.S. FCOJ trade. This analysis addressed the basic economic factors affecting bearing acreage in the United States and examined the influence that the Brazilian citrus industry has on U.S. bearing acreage. Developments in international trade were analyzed in terms of their effects on the Florida and Southwestern orange industries. This analysis involved the following steps:

(1) Identify and evaluate the major factors affecting growers' decisions for orange bearing acreage changes.

(2) Examine the interactions between the Brazilian orange industry and the United States orange industry and evaluate the differences in regional acreage response to changes in economic and international factors.

PROCEDURE

The development of the regional equations follows the work done by French and Matthews (1971) and Dunn and Beilock (1979) on acreage adjustments in perennial crops.

The international trade link objective was achieved by using current FCOJ trade models as suggested by R.M. Behr (Director of the Economic Research Office in the Florida Citrus Department, 1988). The use of these existing models reduced data collection problems and avoided the need to recalculate reduced-form elasticities and flexibilities for econometric FCOJ trade models. These elasticities and flexibilities were then used to examine and determine how future trade patterns could affect orange bearing acreage in the United States citrus industry.

The use and adaptation of a currently developed FCOJ trade model allowed for a more concentrated examination of the regional citrus acreage models. This procedure, built on previous work, helped to identify more quickly the types of international trade factors that needed to be included in the acreage response models. Although the trade model and the supply response models were separate, they were linked through common variables to simulate the effect of changes in international markets on regional orange production. This allowed for a comparison of orange production responses in Florida and the Western United States due to changes in international market factors.

CHAPTER II

THE CITRUS INDUSTRY AND INTERNATIONAL TRADE

The citrus industry in the United States started in the 19th century when Spanish expeditions brought the first citrus seeds into mainland Florida. Today citrus is grown in Florida, California, Texas, Arizona, Louisiana, and Hawaii. Florida and California stand out as the most important orange producers in the United States (Table 4).

Oranges are consumed either as fresh fruit or in some form of processed product. The utilization depends on the type of citrus variety, geographical production region, and consumer preferences. Prior to the early 1950's, most oranges were consumed in fresh form. Processing technologies developed and implemented in the 1950's in Florida led to a major change in the form of orange consumption. Today most oranges are processed and marketed in the FCOJ form.

Florida accounts for about two-thirds of U.S. orange production (Florida Crop and Livestock reporting service, 1985). Approximately 95 percent of Florida's oranges are used in processed form with FCOJ representing roughly 80 percent of the total Florida orange production (Table 5). California and Arizona produce most of the remaining one-third of U.S. orange production. Approximately 80 percent of California-Arizona orange production goes into the fresh market (Table 6).

Roughly 23 percent of the total U.S. orange crop is consumed as fresh fruit. The difference in utilization of oranges between fresh and

Table 4. U.S.A. Orange Production by State and Year, 1969-86.

Year	Florida	California	Texas	Arizona	US Total
	------Millions of 90-LB Boxes------				
1969	129.7	36.9	4.5	4.5	175.6
1970	137.7	32.5	4.2	3.9	178.3
1971	142.3	31.3	6.2	3.0	182.8
1972	137.0	36.2	5.8	4.1	183.1
1973	169.7	35.1	7.4	4.2	216.4
1974	165.8	33.7	6.2	2.8	208.5
1975	173.3	45.8	4.3	4.1	227.5
1976	181.2	44.0	5.8	2.2	233.2
1977	186.8	37.8	6.5	3.3	234.4
1978	167.8	35.5	5.8	3.0	212.1
1979	164.0	31.1	6.0	2.4	203.5
1980	206.7	49.5	3.8	2.9	262.9
1981	172.4	54.4	4.1	2.2	233.1
1982	125.8	34.9	5.6	2.5	168.8
1983	139.6	63.4	5.4	3.2	211.6
1984	116.7	40.4	2.4	1.5	161.0
1985	103.9	43.7	0.5	2.0	149.2
1986	119.0	45.7	0.3	1.9	166.9

Source: Citrus Summary, Florida Crop and Livestock Report Service (FCLRS), 1970 thru 1987.

Table 5. Florida Orange Production and Processed Utilization, 1979-86.

Year	Total Production	Total Processed	FCOJ	FCOJ as % Total Production
	-------Million of 90-lb Boxes--------			percent
1979	164.0	152.3	129.1	79
1980	206.7	195.7	173.2	84
1981	172.4	164.1	144.3	84
1982	125.8	118.2	104.4	83
1983	139.6	129.3	114.3	82
1984	116.7	109.1	94.0	81
1985	103.9	97.2	86.1	83
1986	119.0	110.1	96.1	81

Source: FCLRS, Florida Agricultural Statistics: Citrus Summary,1985-86.

Table 6. California-Arizona Orange Production and Fresh Utilization, 1977-86.

Year	Total Production	Fresh Utilization	
	-----Million	Cartons-----	percent
1977	98.5	69.8	71
1978	92.4	62.9	68
1979	80.4	52.8	66
1980	125.8	83.4	66
1981	135.7	78.6	58
1982	89.9	71.0	79
1983	159.8	91.6	58
1984	100.6	78.1	78
1985	109.7	84.7	77
1986	114.2	91.3	80

Source: United States Department of Agriculture, Crop Reporting Board, 1988.

processed products among producing regions is one of the reasons for significant differences in the marketing structures of the producing regions. Fluctuations in the fresh market are a concern for growers in the Western States, since California and Arizona are the largest suppliers of fresh oranges in the United States. On the other hand, Florida markets roughly 6 percent of its crop as fresh fruit. The Florida fresh market has been very stable since 1972 except for the last two years, which have shown increases (Table 7).

United States bearing acreage for oranges increased by 59 percent from 1963 to 1973. Since then, the acreage decreased at a stable rate until 1980. At that time, bearing acreage began to decrease at an increasing rate due to the severe freezes that occurred in Florida, accounting for an enormous decline in bearing acreage in the U.S. orange industry. U.S. orange acreage in 1986 totalled 564,600 acres, a decrease of almost 21 percent from the 688,700 acres reported in 1984 and about a 42 percent decline from 1980, when 806,000 acres were reported in the United States (Table 8). At the present time, Florida has almost the same orange bearing acreage that it had in 1963 (Figure 1). Freezes have reduced the orange crop four times in the last six seasons and in 1983-84 and 1984-85 severely damaged the trees as well. The northern part of the citrus belt was the most damaged. Alachua, Flagler, and St. Johns counties suffered the greatest losses. Although Florida growers are beginning to increase their plantings in the southern region of Florida, production is not expected to return to its pre-freeze level for many years (Polopolus and Gunter, 1985). It should

Table 7. Florida Fresh Market for Oranges, 1973-86.

Year	Total Crop	Fresh Orange	Percent Fresh
	------Million	Boxes------	percent
1973	169.7	10.2	6.01
1974	165.8	8.9	5.36
1975	173.3	11.3	6.52
1976	181.2	10.5	5.79
1977	186.8	7.7	4.12
1978	167.0	8.9	5.30
1979	164.0	10.5	6.40
1980	206.7	9.8	4.74
1981	172.4	7.1	4.11
1982	125.8	6.5	5.10
1983	139.6	9.1	6.50
1984	116.7	6.3	5.39
1985	103.9	6.3	6.00
1986	119.0	8.6	7.20

Source: Florida Department of Citrus, Citrus Reference Book, 1987.

Table 8. Bearing Acreage in the United States by Year and State, 1960-86.

Year	Florida	California	Arizona	Texas	U.S.
		------acres------			
1960	370000	138700	7400	31900	552500
1961	374100	136500	7700	35000	557800
1961	408700	131600	8700	32400	585900
1963	370000	127900	9800	35000	543700
1964	388000	127700	11700	26000	554600
1965	435000	122400	13800	26000	598400
1966	472000	125700	16800	27000	641500
1967	522000	130400	23500	29000	704900
1968	557639	139900	19300	31000	747800
1969	595600	150500	19300	35000	800400
1970	636128	160200	15500	35000	846800
1971	660500	167900	18100	40500	887000
1972	624209	180400	19500	42500	866600
1973	619600	188800	24500	35000	867900
1974	614608	196900	24400	32500	867500
1975	610400	196900	24100	30900	862300
1976	596400	197700	23000	30900	848000
1977	594300	192500	21000	28200	836000
1978	579000	188600	16800	28400	812800
1979	571500	187100	14800	27800	801200
1980	576600	185700	15700	28000	806000
1981	573400	182700	13200	25300	794600
1982	560200	179700	13500	23700	777100
1983	536800	177400	12600	24000	750800
1984	530300	177500	12600	24300	688700
1985	420100	175200	10900	11400	617600
1986	367600	174700	10900	11400	564600

Source: Florida Crop and Livestock Reporting Service, Citrus Summary, various issues.

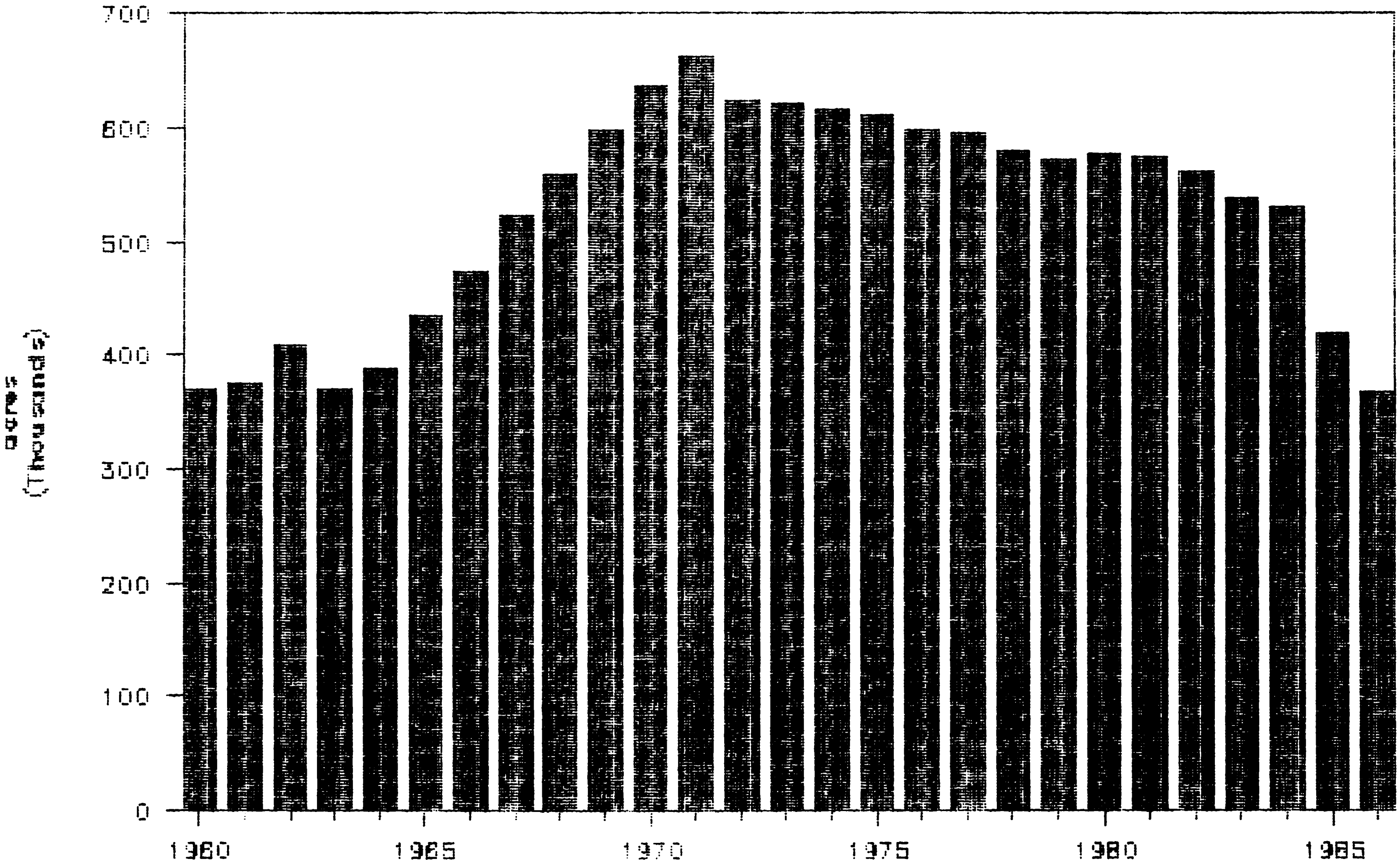

Figure 1. Florida orange bearing acreage, 1960-86.

Source: Florida Crop and Livestock Reporting Service, Citrus Summary, various issues.

be mentioned that these declines in acreage have been offset to some extent by an increase in yields.

The changes in the acreage of nonbearing fruit trees provide some indication of the short-run growth that can be expected within each region, since orange trees take from four to five years before bearing fruit. Figure 2 shows how nonbearing acreage in Florida has increased substantially in the past six years. Hence, growers in Florida expect a growth in orange bearing acreage for the next two to five years. On the other hand, since 1980 California-Arizona nonbearing acreage has had a very stable growth rate of 3 percent (Figure 3). The lower proportion of nonbearing acreage indicates that large increases in production are not likely unless they come because of new technology.

In general, Florida and the western citrus regions face different sets of problems. However, the two regions may compete with each other; therefore, they must be aware of each different orange market. In addition, both regions are subject to separate natural and economic forces.

In Florida, basic marketing problems are often the result of the fact that the orange growers have less control over production because of weather conditions than most other producers of annual crops (Pierce, 1978). The West, unlike Florida, does not have as many problems due to weather. However, they have problems opening and keeping new markets. California and Arizona have one of the best climates to grow citrus in the world; no recent major frosts and plenty of sunshine characterize this region. The fres market, unlike the FCOJ

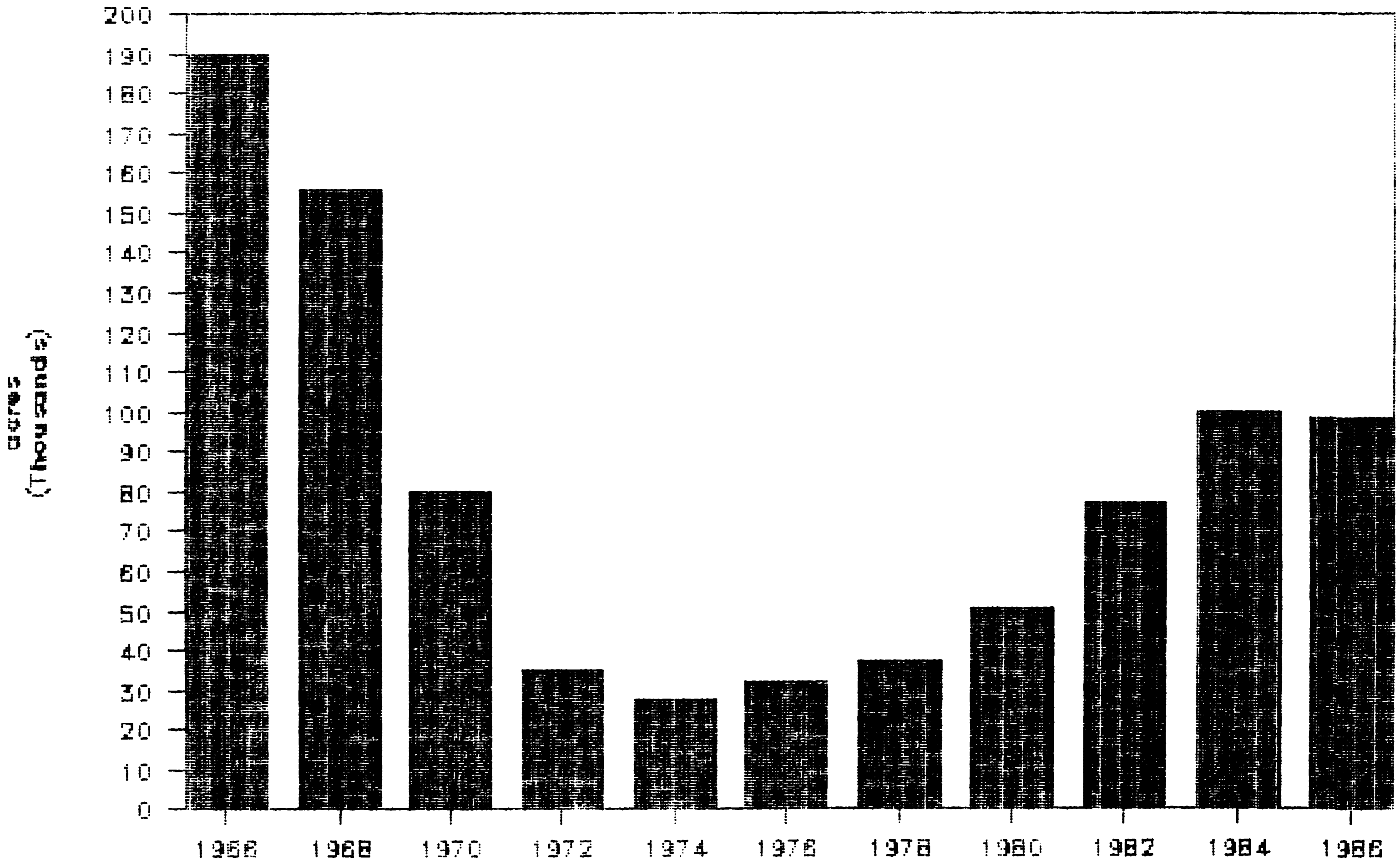

Figure 2. Florida orange nonbearing acreage, 1966-86.

Source: Florida Crop and Livestock Reporting Service, Citrus Summary, various issues.

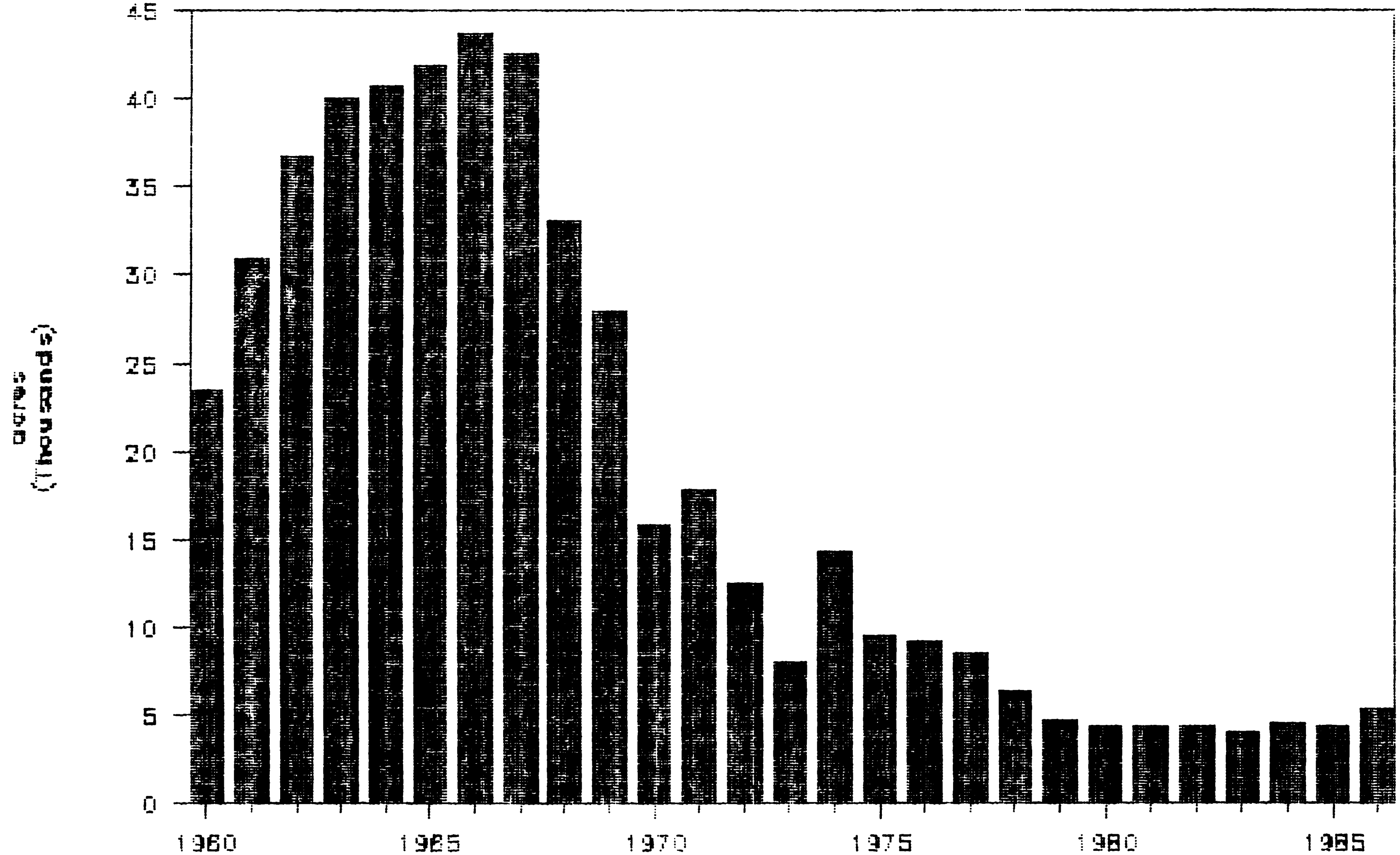

Figure 3. California-Arizona orange nonbearing acreage, 1960-86.

Source: Navel and Velencia Orange Administrative Committees, <u>Annual Reports</u>, various issues.

market, faces market constraints because of the convenience and availability of processed fruit.

BRAZIL AND THE INTERNATIONAL TRADE OF FCOJ

Commercial production of oranges in Brazil started at the turn of the century. The industry dedicated almost all its resources to the local and export markets for fresh citrus until the early 1960's, when Brazil entered the processed citrus market. Brazil's entry into the world market for orange juice followed the 1962 freeze in Florida, which increased prices in the world market and created a strong demand for foreign juice in the U.S. market. These unfavorable situations in Florida allowed Brazil to develop markets and to increase its tree numbers. By 1978-79 Brazil had planted several thousands of acres. Figure 4 shows the number of orange trees planted since 1965.

Sao Paulo, which produces more than 80 percent of the Brazilian orange production, is considered the "Florida" of Brazil. However, unlike the peninsula, Sao Paulo has extensive areas for the citrus industry to expand. The federal and state governments have several plans to help growers as well as producers of oranges and orange juice. Brazil overtook the U.S. as the leading producer of oranges and FCOJ early in the 1980's (Table 9). Brazilian orange production accounted for one-third of the world's 1985 crop according to the Food and Agriculture Organization.

The Instituto de Economica Agricola (IEA) in Sao Paulo estimated the 1986-87 season commercial inventory of trees to be 137.3 million

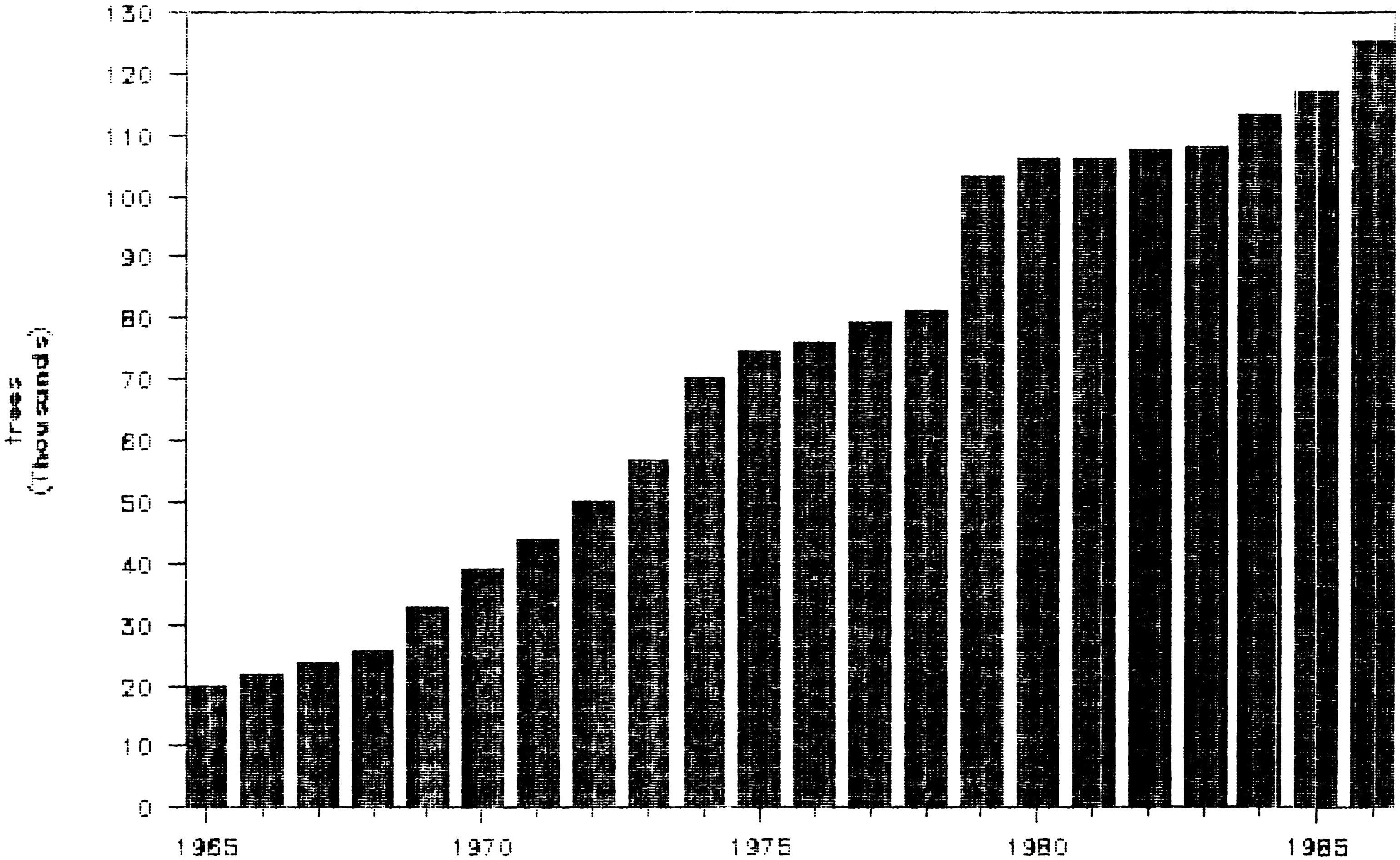

Figure 4. Brazilian orange tree numbers, 1965-86.

Source: Florida Agricultural Statistics, Citrus Summary, various issues.

Table 9. Orange and FCOJ Production, U.S.A and Brazil, by Year, 1979-85.

year	U.S.A.		Brazil	
	Oranges	FCOJ	Oranges	FCOJ
	Million Boxes	Mill 42 Brix Gal	Million Boxes	Mill 42 Brix Gal
1979	164.0	187.8	151.5	140.0
1980	206.7	251.0	166.8	146.2
1981	172.4	181.5	175.4	165.2
1982	125.8	133.3	184.4	202.1
1983	139.6	169.6	186.8	189.6
1984	116.7	121.2	196.7	169.0
1985	103.9	118.5	190.0	250.3

Sources: Florida Agricultural Statistics, Citrus Summary, 1985-1986
Dr. Robert Behr, Director of the Economic Research Office, Florida Citrus Department, Personal communication, 1988.

(Florida Department of Citrus, Behr, 1988). In contrast, Florida's tree inventory indicated a population of 43.461 million trees for 1986 (Florida Crop and Livestock Reporting Service FCLRS 1986, 1987) (Table 10). Although Florida trees yield more than Brazilian trees, this is a substantial difference.

Brazil exports most of its FCOJ production, with only 3 percent being consumed domestically. The United States has been Brazil's major customer and Europe its second largest. Furthermore, Brazil's exports have increased immensely over the years (Table 11). United States imports from Brazil have increased enormously in the past six years due mainly to the severe freezes in Florida (Table 12). With the United States demand for orange juice steadily rising and reduced Florida production, imports are expected to continue to increase in the future and U.S. producers are likely to find themselves facing much more competition from Brazil in both domestic and export markets (Tuttel, 1987). Although United States FCOJ exports have declined in the past ten years (Figure 5), they are still a very important source of revenue for producers.

The duty drawback provision in the U.S. for FCOJ is one of the main reasons producers still export FCOJ. This drawback provision allows importers to use imports as part of their overall marketing programs, since processors are eligible for a refund on any FCOJ imported, blended with domestic FCOJ, and exported again. Producers contend that as long as they are able to acquire low-priced FCOJ they can compete in foreign markets. Thus imports of Brazilian concentrate play a unique role in the development of foreign markets for U.S.

Table 10. Florida and Brazil Orange Tree Numbers, 1965-86.

Year	Florida	Brazil
	------------Thousands of Trees----------	
1965	N.A.	19815
1966	N.A.	21550
1967	56631	23433
1968	N.A.	25435
1969	57802	32830
1970	N.A.	39000
1971	53731	44000
1972	N.A.	50200
1973	52522	56500
1974	N.A.	70018
1975	N.A.	74278
1976	52163	75946
1977	N.A.	79271
1978	50843	81329
1979	N.A.	103270
1980	51978	106090
1981	N.A.	106240
1982	53505	107580
1983	N.A.	108000
1984	49885	113480
1985	N.A.	117000
1986	43461	125000

Source: Florida Agricultural Statistics: Citrus Summary, Various issues.

Table 11. Brazil Exports of FCOJ, by year and Destination, 1969-85.

year	Europe	Canada	U.S.	total exports
	-------1,000	S.S.E. Gallons-------		
1969	19096	5940	3587	29528
1970	32478	5448	1277	42513
1971	54368	13242	29720	98238
1972	72998	13547	22428	110719
1973	124683	11170	13952	153710
1974	96220	9459	29360	137782
1975	157250	26828	26180	229802
1976	201618	20117	21183	266568
1977	171004	26281	59461	271248
1978	162592	43021	187389	423865
1979	203816	36634	92805	371402
1980	349940	27458	97675	692200
1981	445380	23932	203103	827298
1982	234150	19771	373987	706128
1983	330870	31863	337163	934540
1984	353920	47482	533590	1065459
1985	200004	21935	562445	977715

Source: U.S. Department of Commerce, Report Number IM145X, various issues 1973-1987.

Table 12. U.S.A. Imports of FCOJ from Brazil by Year, 1974-86.

Year	-------Thousands of SSE Gallons------
1974	15884
1975	29992
1976	29064
1977	28842
1978	117470
1979	163890
1980	100122
1981	197876
1982	352239
1983	349084
1984	510056
1985	578133
1986	500510

Source: U.S. Department of Commerce, Report #IM145X, various issues.

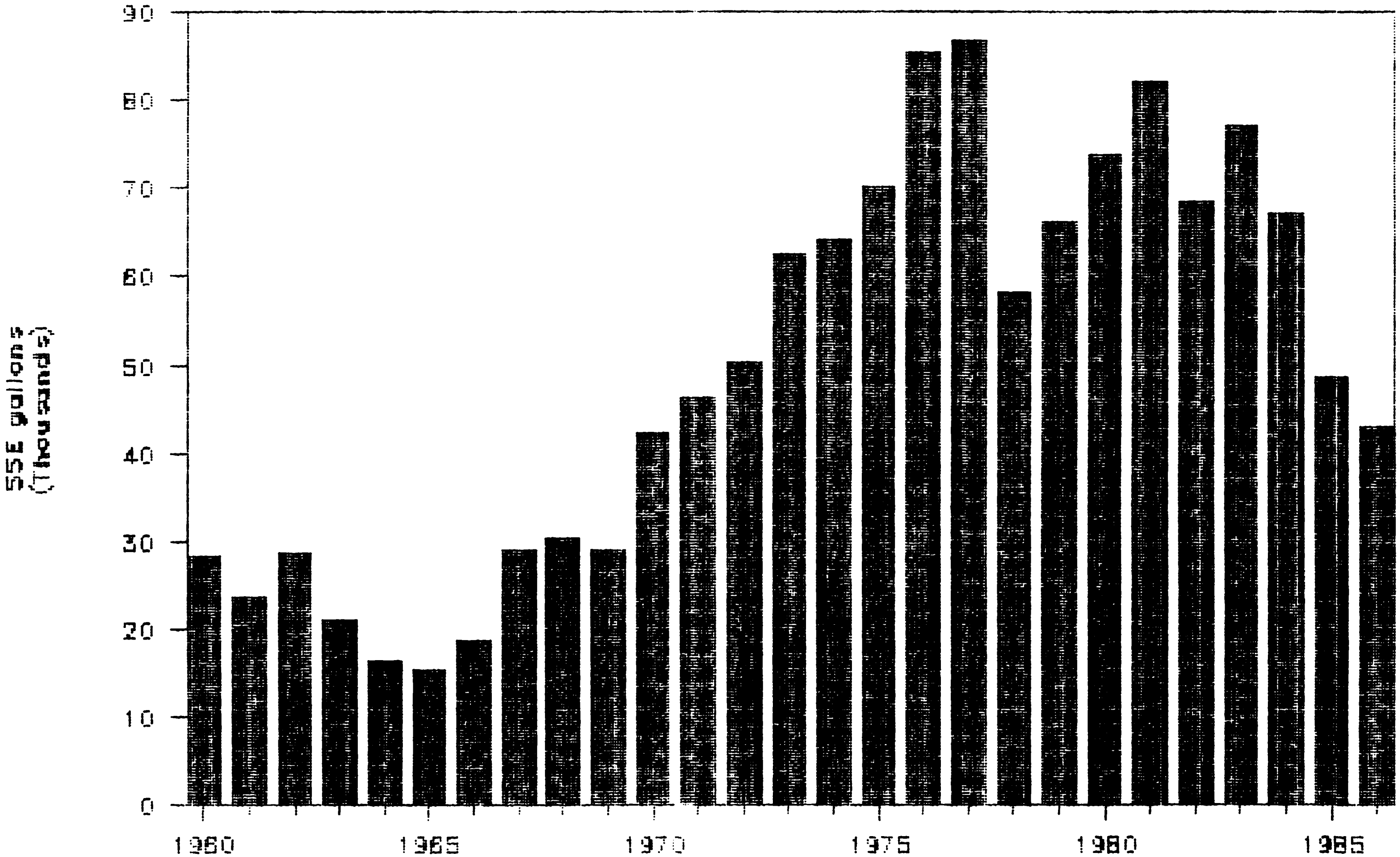

Figure 5. U.S. FCOJ exports, 1960-86.

Source: U.S. Department of Commerce, Bureau of the Census, various issues.

producers. This is one reason processors argued that a two-price system is essential for U.S. exports (Ward, 1976). Brazil prices its FCOJ differently. For instance, Brazil's price to the U.S. is lower than Brazil's price of FCOJ to Europe. Therefore, processors in the United States use this lower price FCOJ blended with the more expensive domestic FCOJ in order to be able to compete in the international market.

United States exports of fresh oranges, although having different markets and very different situations, has followed a pattern similar to exports of FCOJ. In 1980 the U.S. exported 1,061 million pounds. By 1983 U.S. exports declined 28 percent to 763 million pounds. In 1986 exports were as low as 658 million pounds, which represents a 40 percent decrease in exports (Table 13). These numbers are a matter of concern in an industry that is trying to find a way to recover to pre-1980 export shipment levels.

FROZEN CONCENTRATED ORANGE JUICE (FCOJ)

FCOJ is without doubt the most important product in the citrus industry. A great percentage of orange juice is traded in the form of FCOJ. There appears to be no difference in quality between domestic FCOJ and Brazilian FCOJ for manufacturing purposes (International Trade Commission 1986).

Apparent U.S. consumption of FCOJ as measured by total available FCOJ has remained relatively constant for some years. Total available U.S. FCOJ changed from 1.3 billion gallons in 1982-83 to 1.2 billion

Table 13. U.S.A. Exports of Fresh Oranges by Years, 1973-86.

year	Fresh Exports
	---thousand of pounds---
1973	642703
1974	721792
1975	1060427
1976	1016857
1977	904390
1978	784604
1979	700432
1980	1061486
1981	959847
1982	757784
1983	762638
1984	688950
1985	694313
1986	657713

Source: United States Department of Agriculture, Foreign Agricutural Trade of the United States (Fatus), Fiscal years 1973 thru 1986.

gallons in 1983-84 to 1.3 billion gallons in 1984-85 (compiled from official statistics of the U.S. Department of Commerce and from statistics of the Florida Citrus Processors Association).

U.S. production of FCOJ from Florida oranges decreased from 685 million gallons in 1982-83 to 479 million gallons in 1984-85. Figures in 1986 indicate that this decline should continue (Florida Citrus Processors) unless orange production increases which would allow the supply of FCOJ to increase.

Domestic shipments have also declined steadily for four years. In 1982, exports of FCOJ were at the level of 71.5 million gallons SSE. By 1985 they had declined by 45 percent with a reported FCOJ shipment of 39.4 million gallons SSE. FCOJ imports from Brazil increased in volume from 97.7 million gallons in 1980 to roughly 500 million in 1986, an increase of 411 percent. However, imports declined from 1985 to 1986 by about 12 percent. U.S. imports from Brazil are expected to continue to decline due to an increase in U.S. orange production as new acreage begins to bear fruit.

The ratio of Brazilian FCOJ imports to FCOJ production from the Florida crop is significant; thus Brazilian imports are not merely a supplementary source of supply, but are an integral part of the United States market (International Trade Commission, 1986). Brazilian imports account for about 45 percent of FCOJ available in the U.S. and 97 percent of U.S. imports from all sources (Department of Commerce and Florida Citrus Processors Association). In recent years a number of facilities for storing FCOJ have been built. These new facilities are located outside the state of Florida. These new facilities blend

Brazilian FCOJ with domestic FCOJ. This capability means that Brazilian FCOJ does not need Florida processors in order to enter the U.S. domestic market. In fact, several orange juice firms have built "tank farms" outside of Florida to avoid state taxes.

A decline in FCOJ prices followed record high prices caused by recent freezes (Table 14). It was expected that high prices would drop after orange production began to increase again.

EXCHANGE RATE

An exchange rate is the rate at which one currency trades for another on the foreign exchange market. If exchange rates are rigidly fixed by authorities, shifts in the supply and demand for foreign exchange will result in variation in the country's international reserves rather than variation in the exchange rate. The terms "appreciation" and "depreciation" are applied to movements of the value of a currency in response to buying and selling pressures in the foreign exchange market. The terms "revaluation" and "devaluation" are applied to changes in the value of a currency through deliberate adjustments of a parity or exchange rate peg by the government. There are two major reasons why governments maintain freely fluctuating exchange rates. The first is that it helps to keep the balance of payments in balance, and the second is that it eliminates the need for international reserves. For the United States, the rate is the value of the dollar in terms of the currency of the trading country.

Table 14. Wholesale Price of FCOJ in the U.S., by Year, 1970-85.

Year	dollars per dozen 6 Oz. cans
1970	1.763
1971	1.951
1972	2.141
1973	2.141
1974	2.157
1975	2.281
1976	2.272
1977	2.951
1978	3.547
1979	3.920
1980	3.760
1981	4.790
1982	4.730
1983	4.490
1984	5.780
1985	6.080

Source: Commodity Research Bureau, Commodity Year Book, NJ: Jersey City years 1980 and 1986.

This study assumed exchange rate to be a major component affecting international trade of oranges and FCOJ. The value of United States dollar is determined by the free market. On the other hand, the Brazilian cruzado has had several official devaluations in the past six years (Figure 6). Therefore, this variable should be analyzed when studying the international trade elements affecting the citrus industry in the U.S.

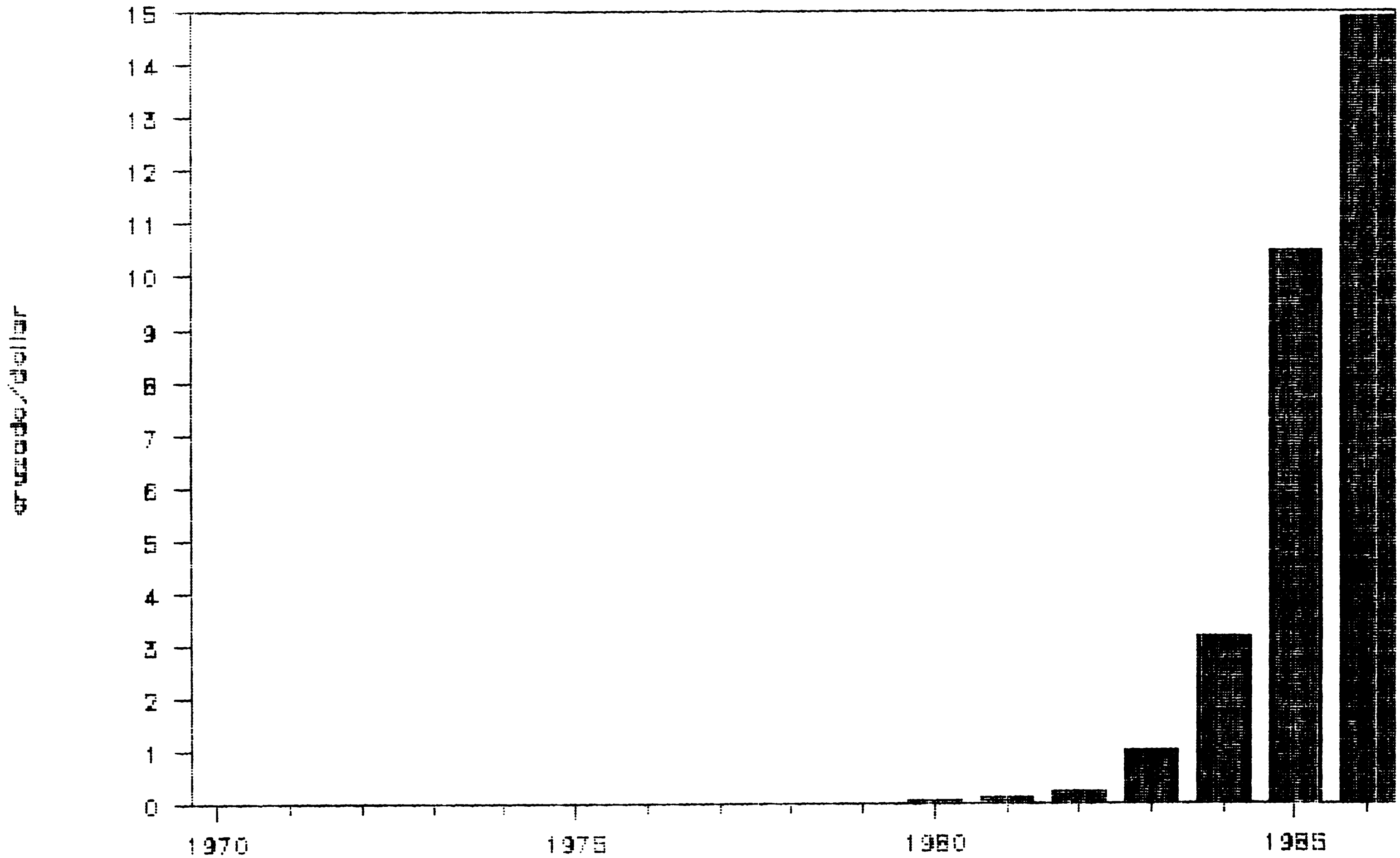

Figure 6. Brazilian exchange rate expressed in cruzado/dollar 1960-86.

Source: International Monetary Fund, <u>International Financial Statistics</u>, various issues.

CHAPTER III

THEORETICAL CONCEPTS AND MODEL DEVELOPMENT

Perennial products are harvested from a single planting over a period of time (years or decades). Therefore, producers of this type of commodity must deal with long-term decisions about planting, removal, and harvesting. Perennial crop production is distinguished from the production of annual crops by: (1) the long period between initial input and first output, (2) an extended period of output flowing from the initial production or investment decision, and (3) eventually, a gradual deterioration of the productive capacity of the plants (French and Matthews 1971).

This study consisted of two parts: (1) two regional supply response models and (2) the interaction between these models and Brazilian FCOJ trade using the reduced-form elasticities and flexibilities obtained from the econometric model of international trade in FCOJ developed by Irias (1980). When combined, the two parts formed the basis for an analysis of the effect of international trade in FCOJ on the bearing acreage changes in the southern and western citrus regions of the United States. The remainder of this chapter presents the development of the supply response models and their links to international trade.

The regional models used were based on advances by Dunn and Beilock, who incorporated and refined the findings of a number of authors. These included French and Matthews, who studied the supply of asparagus in 1971; Bateman (1965,1969), who presented studies on Ghanaian cocoa; Wickens and Greenfield (1973), who studied the world coffee supply; and Baritelle and Price (1974), who included frost data in their study of the U.S. apple industry.

French and Matthews (1971) developed an equation in which the change in bearing acreage of a perennial crop was determined by unit profit, yield expectations lagged k time periods (k = number of years required for the plant to begin to produce a profit), freezes, and nonbearing acreage lagged k. The models developed in this study were based on Dunn and Beilock's and French and Matthews' work.

THE GENERAL MODEL

The full model contains two regional acreage response equations: one for the Florida citrus industry and another for the California -Arizona orange industry. These regional equations were combined with the reduced-form elasticities and flexibilities found in Irias' international model of FCOJ. The orientation of this model was aggregative. That is, the model attempted to explain the behavior of producers as a group, as French and Matthews demonstrated using perennial crops. Each regional equation involved six economic and cultural factors, respectively. This analysis is proceeded first by a discussion of the variables in each of the regional equations.

The total change in Florida orange bearing acreage from one year to the next may be defined as:

FLBAD = f(BORPDT1(+), FLTPRT2(+), FREZ(-), BRPUSV(+), USXTT1(+), USXTT5(+)).

Positive and negative signs represent the expected relationship between the dependent and the independent variables. The Florida model was assumed to be a linear function of six major components: (1) Brazilian orange production lagged one year, BORPDT1(t1 stands for lag one); (2) Florida on-tree prices lagged two years, FLTPRT2; (3) Freezes, FREZ; (4) Average Brazilian export price to the U.S. lagged one and two years, BXPUSV (v stands for the average between BXPUST1 and BXPUST2); and (5, 6) U.S. total FCOJ exports lagged one and three years, USXTT1 and USXTT5 respectively. Table 15 defines the variables used.

ECONOMIC VARIABLES

Florida Bearing Acreage Difference Model (FLBAD) The dependent variable determines the changes from one year to another in the Florida orange bearing acreage. Using Florida bearing acreage difference as the dependent variable provided an explanation for the annual movement of orange bearing acreage in Florida.

Brazilian Orange Production Lagged One Year (-) As noted in chapter I, French and Matthews (1971) suggested that yield or production of a perennial crop plays a major role in bearing acreage difference. The study assumed that with greater production fewer increments are expected in bearing acreage. Growers' planting decisions are influenced by demand and by the productivity of the perennial

Table 15. Description of Variables in the Florida Bearing Acreage Difference Model

Variables	Description
FLBAD	Florida Bearing Acreage Difference Dependent Variable (Acres)
BORPDT1	Brazil Orange Production Lagged one year (1,000 metric tons.)
FLTPRT2	Florida On-Tree Prices Lagged two years ($ per carton.)
FREZ	Freezes Occurred in Upstate Florida
BXPUSTV	Average Brazil FCOJ Export Price to the U.S. ($ per SSE gallons.)
USXTT1	United States Exports of FCOJ Lagged one year (1,000 SSE gallons.)
USXTT5	United States Exports of FCOJ Lagged five years (1,000 SSE gallons.)

product. Thus, Florida yield, Brazilian orange yield, and Brazilian orange production lagged five years and one year were tested for the study. The first three variables were not found to influence orange bearing acreage changes in Florida. Therefore, they were dropped from the model. On the other hand, Brazilian orange production lagged one year shows a very close relationship to bearing acreage changes in Florida. Therefore, this variable was retained in the final model. The presence of a one year variable lag was assumed because of short-period strategies developed by growers to offset unexpected changes in the market. These strategies are mainly the delayed removal of old trees and the early use of new trees entering the bearing stage.

The link between Brazilian orange production lagged one year and the Florida bearing acreage difference was assumed to be price related. High production in Brazil means lower prices for oranges and orange juice. Therefore, Florida production is influenced by these low prices. Because of the decrease in prices growers in Florida may vary decisions such as the early removal of old trees which are no longer profitable. Therefore, the change from one year to the next would be negative since the initial condition was an increase in Brazilian orange production. Thus, this variable is expected to be related negatively to FLBAD, meaning that as Brazilian production increases, FLBAD should be negative.

Florida On-Tree Prices Lagged Two Years (+) Most studies of perennial crops indicated that lagged and current prices represent unit profit or long-run profitability to growers. In his study of apples, Bateman (1965) concluded that unit profit or expected profitability must be included in any equation that attempts to explain bearing acreage difference. In the current study, Florida on-tree prices were used to explain profits for growers. The lagged two years variable was chosen because Florida and world prices change approximately every two years. Thus, growers in Florida may plan short-period adjustments in bearing acreage because of changes in orange and orange juice prices. The coefficient on Florida on-tree prices lagged two years (FLTPR) was assumed to have a positive sign. The positive sign was hypothesized because producers will increase their acreage if prices are increased.

Freezes (-) Most authors working with fruits and other perennial products included freezes in the majority of their analyses. Freezes, as noted in chapter II, may not be the only reason for bearing acreage decreases, but for the past ten years freezes have been a major cause for the loss of orange trees in the Florida citrus industry. Freezes were assumed to influence strongly changes in bearing acreage. The study used a dummy variable for freezes (1 for freezing years and a 0 for years in which freezes did not occur). A negative relationship was expected between freezes and changes in Florida orange acreage.

Brazil FCOJ Export Average Price to the U.S. Lagged One and Two Years (+) As the price of a substitute, economic theory suggests that average Brazilian FCOJ export prices to the U.S. are an important factor in the Florida bearing acreage difference (FLBAD) model. This variable was hypothesized to be a good indicator, following the reasoning presented for on-tree prices in Florida. That is, growers may make short-period adjustments to confront unexpected changes in Brazilian FCOJ export prices, thereby either decreasing losses or increasing gains. This is especially true since Florida and the world FCOJ market prices are heavily influenced by Brazilian orange juice prices. Florida processors depend on the Brazilian FCOJ industry because of the low Brazilian prices and the quantity imported to the U.S. and the rest of the world. Processors declare that the only way they can compete on the international market is by importing Brazilian FCOJ and blending it with domestic FCOJ to take advantage of lower Brazilian prices. Florida producers rely on processors to utilize their oranges to produce FCOJ for domestic and foreign markets and thereby receive a reasonable price for the crop. This interdependence between producers and processers influences the two variables FLBAD and Brazilian FCOJ export prices of the model. If Brazilian prices are high, then Florida prices are likely to increase also. Therefore the relationship expected between bearing acreage changes in Florida and Brazil FCOJ export prices is positive. In other words, if the Brazilian export price for FCOJ (BXPUS) increases, the bearing acreage difference in Florida is expected to be positive.

U.S. FCOJ Total Exports Lagged One and Five Years (+,+) As stated in the above paragraph, exports are important in the Florida citrus market. In addition, the duty drawback provision allows producers to recoup the import duties tax when they export imported FCOJ. In addition, exports influence the price of domestic oranges and orange juice consumed in the U.S. Given the importance of the overseas market for FCOJ, in this study FLBAD depended on U.S. exports of FCOJ lagged one and five years (USXT). The one year lagged variable was assumed to be a good indicator of the quick response by growers to unexpected changes in the orange and orange juice market, as stated for other variables. Since orange trees start producing after four years, the variable lagged five years was expected to be a good indicator of longer term changes in bearing acreage due to FCOJ exports. The relationship between bearing acreage changes and U.S. FCOJ exports lagged one and five years should be positive.

California-Arizona Bearing Acreage Difference Model (CZBAD) This variable determined the changes from one year to another for California-Arizona orange bearing acreage. The dependent variable was also developed following the Dunn and Beilock and French and Matthews studies. As noted before for the Florida dependent factor, the use of the California-Arizona bearing acreage difference variable helps chart the course bearing acreage in California-Arizonahas has followed year by year. This model was assumed to have a different framework from the Florida model, since Florida and the West focus on separate markets. Thus, the Brazilian citrus industry was not expected to have the same impact in California as in Florida. In any event, a determination of whether or not a link or relationship exists between the western citrus market and the Brazilian citrus industry was addressed in this study. The total change in orange bearing acreage in California-Arizona from one year to the next may be defined as:

CZBAD = f(CAZNBT4(+), CAZNBT5(+), CZYIDT5(-), CATPRT2(+),
USXTFT1(+), BRXUST3(+)).

Positive and negative signs represent the expected relationships among the dependent variable and the independent factors. The California-Arizona bearing acreage difference model (CZBAD) was hypothesized to be a function of: (1) California-Arizona nonbearing acreage lagged four years (CAZNBT4); (2) California-Arizona nonbearing acreage lagged five years (CAZNBT5); (3) California-Arizona yield lagged five years (CZYIDT5); (4) California on-tree prices lagged two years (CATPRT2); (5) United States exports of fresh oranges lagged one year (USXTFT1); and (6) Brazilian exports to the United States lagged three years (BRXUST3). Table 16 defines the variables used.

California-Arizona Nonbearing Acreage Lagged Four and Five Years (+,+) As in most studies, nonbearing acreage was considered a crucial factor affecting bearing acreage changes. The nonbearing acreage lagged four or five years variable was used to indicate the number of new plants to be incorporated into the bearing sector. French and Matthews, Bateman, and Dunn and Beilock determined that nonbearing acreage lagged "N" (N = number of years required for the plant to begin to produce a profit) plays a major role for any perennial crop. Thus, a relationship between the dependent variable and the nonbearing acreage variable was assumed in this study. California-Arizona nonbearing acreage lagged four years and lagged five years (CAZNBT4, CAZNBT5) were expected to be positively related to CZBAD. If California-Arizona nonbearing acreage lagged four and five years increases, a positive effect on changes in California-Arizona orange bearing acreage can be expected. Nonbearing acreage was not used in the analysis for Florida's regional model, because nonbearing data are only collected for alternate years.

California-Arizona Yield for Oranges Lagged Five Years (-) Most previous studies on perennial crops suggested that producers project

Table 16. Description of Variables in the California-Arizona Bearing Acreage Difference Model

Variables	Description
CZBAD	California-Arizona Bearing Acreage Difference Dependent Variable (Acres)
CAZNBT4	California-Arizona Non-Bearing Acreage Lagged four years (Acres)
CAZNBT5	California-Arizona Non-Bearing Acreage Lagged five years (Acres)
CZYIDT5	California-Arizona Yield Lagged five years (Average number of cartons/acre harvested)
CATPRT2	California On-Tree Price Lagged two years ($ per carton)
USXTFT1	United States Exports of Fresh Oranges Lagged one year (1,000 pounds)
BRXUST3	Brazil Exports of FCOJ to the U.S. Lagged three years (1,000 S.S.E. gallons)

their future bearing acreage on the basis of yield. French and Matthews, working with asparagus found that yield lagged "N" was a major element affecting bearing acreage changes. The positive influence of improved agrarian technologies on yields in the California-Arizona orange industry has played a major role for the past 20 years, leading producers to be more concerned about increasing yield than increasing bearing acreage. In other words, yield increases have been a way of substituting for expensive acreage expansion. In the study, California-Arizona yield lagged five years was expected to be a negative function of CZBAD. Consequently, if California-Arizona yield lagged five years increases, a reduction in the California-Arizona orange bearing acreage could be expected.

<u>California On-Tree Prices for Oranges Lagged Two Years (+)</u> Price was included in the model as a measure of unit profit or expected profitability. As noted in chapter I, Bateman (1965), working with cocoa, concluded that unit profit or expected profitability should be included as a variable in any model that attempts to explain bearing acreage difference. Theory tells us that producers in California and Arizona take current and lagged on-tree prices into consideration for present and future planting. Following the reasoning for Florida on-tree prices, California on-tree prices lagged two years were assumed to be the best measure of profit for growers. In addition, California-Arizona on-tree price lagged two years was expected to be related positively to changes in orange bearing acreage in the California-Arizona regions, meaning that if prices of fresh oranges

increase this will result in an increase in bearing acreage two years later.

<u>U.S. Total Exports for Fresh Oranges Lagged One Year (+)</u> The California-Arizona citrus industry as well as the Florida citrus industry depend very much on their international markets. Thus, for this study, U.S. exports of fresh fruit lagged one and five years were hypothesized to be good indicators of exports influencing bearing acreage difference. After analyzing the variable U.S. exports lagged five years, the study determine to dropped it from the equation, while U.S. exports lagged one year remained in the final model. A one-year lag variable was assumed to be a consequence of short-period adjustments by growers in the delayed removal of old trees and the early use of new trees entering the bearing stage. In addition, overseas markets were assumed to play a major role in the California -Arizona citrus industry because lower prices offer the possibility for expansion in juice markets currently held by Florida and Brazil. CZBAD should have a positive reaction to an increase in U.S. exports of fresh oranges.

<u>Brazil FCOJ Exports to the U.S. Lagged Three Years (+)</u> Finally, the California-Arizona equation incorporated Brazilian FCOJ exports to the U.S. to determine whether bearing acreage changes in California-Arizona are influenced by Brazilian FCOJ exports. An increase in California-Arizona bearing acreage was expected for any increments in Brazilian FCOJ exports into the United States. Larger Brazilian FCOJ exports to the U.S. were expected to be associated with better opportunities for the California-Arizona industry to increase

their fresh market because Brazilian oranges are not being used for fresh market purposes. Therefore, an increase in western bearing acreage would result from price improvements and expanded Brazilian FCOJ exports.

THE IMPACT OF U.S. ORANGE PRODUCTION AND BRAZILIAN EXCHANGE RATE ON ORANGE BEARING ACREAGE

As noted above, the regional citrus acreage models incorporated a number of independent variables that dealt with the effects of Brazilian FCOJ trade. In the Florida change in bearing acreage equation, Brazilian orange production and the two year average price of Brazilian FCOJ exports were used to capture the influence of international trade factors. In the California-Arizona citrus model, the quantity of Brazilian FCOJ exports to the United States was used to incorporate international trade influences. Although the Brazilian variables were considered exogenous in the regional model, these factors were apparently influenced by other variables, such as changes in the Brazil-U.S. exchange rate and the domestic factor of U.S. orange production. To capture the indirect effects caused by changes in domestic and international trade conditions, this study used the reduced-form elasticities and flexibilities from the model developed by Irias.

Irias' model, developed in 1981, is a simultaneous equation system for international trade in FCOJ. This model was developed for two major producing and exporting countries (U.S.A. and Brazil) and four major importing regions. The model consists of demand and price equations for FCOJ and other orange juices. The conceptual formulation of the economic model resulted in a system of simultaneous equations with 28 endogenous variables and 41 predetermined variables. Two-stage least squares method was used to estimate the over-indentified structural-form equations of the system.

Two variables, Brazil FCOJ exports to the U.S. and Brazil FCOJ export prices to the U.S., were present in both the supply response equations and the Irias model. Therefore, these variables were used as the link between Irias' model and the supply response equations. As noted earlier, the values for the derived reduced-form elasticity and flexibility coefficients found in Irias' model were used in this study (Irias' Table 37). A review of Irias's work indicated that Brazil's exchange rate and U.S. orange production could be used as the predetermined factors affecting Brazilian FCOJ exports and Brazilian FCOJ export price to the U.S. The reasons for choosing these two variables were: (1) they are major components of the Brazil-U.S. trade of FCOJ; and (2) the assumption developed by the Florida Department of Citrus in its world orange juice outlook for the 1989-90 through 1998-99 seasons, that indicates that citrus growers can expect an increase in U.S. orange production of 43 percent in the next ten years. This is an important increase that could give the U.S. an improved share of citrus markets.

The elasticities and flexibilities used in this study are presented in Table 17. The data should help to clarify the procedure used in this study to calculate the impact of Brazlian exchange rate and U.S. orange production in the U.S. orange bearing acreage changes. For every 1 percent change in the predetermined variables, the endogenous variables change by the amount shown in Table 17.

To analyze the effect of these variables on the Florida and California-Arizona bearing acreage changes, fluctuations in Brazil-U.S. exchange rate and in U.S. orange production were studied. In the case of U.S. orange production, the study used the Florida Department of Citrus forecast of 43 percent increment as a reference point, but in the analysis included a 10 percent increase as well as a 20 percent increase. For the Brazil exchange rate variable, current high devaluations occurring in Brazil were used as a reference point. presently, Brazilian currency is depreciating at a rate greater than 200 percent per year. However, this number was not used in this study because at the time the Irias model was developed Brazil was not experiencing such large devaluations. Instead, the study used values of 5, 10, 20, 40, and 50 percent for changes in the Brazilian exchange rate. These depreciation values would be considered large for a nation such as the United States.

Table 17 Irias' derived reduced-form elasticity and flexibility estimates for Brazil exchange rate and U.S. orange production evaluated at the means of the respective variables.

Endogenous	Predetermined	
	Elasticities	Flexibilities
	Brazil exchange rate expressed cruzeiros/dollar	U.S. orange production
MQFSB	.2268	-.4552
MPFSB	-.1642	-.2225

MQFSB: Brazil FCOJ exports to the U.S. (1,000 SSE gallons).
MPFSB: Brazil FCOJ export price to the U.S. ($/SSE gallon).
Source: Irias' "An Econometric Model of International Trade of FCOJ", (1981)

These fluctuations were applied to Irias' derived reduced-form elasticity values. Table 17 shows that a 1 percent change in the Brazilian exchange rate could cause a 22 percent change in Brazilian FCOJ exports. Expanding upon this application, this analysis showed Brazilian FCOJ exports changes due to changes in the Brazilian exchange rates by 5 10 20 40 and 50 percent. Thus, new estimates were obtained for the endogenous variables (Brazil FCOJ exports to the U.S and Brazil FCOJ export prices) according to the different changes in percentages. Following this analysis, the current values for Brazilian FCOJ exports and Brazilian FCOJ export prices in the supply response model were exposed to the new estimates, thus obtaining a value that represents the response of the endogenous factors to the changes in the predetermined variables. Finally, these calculations were used to determine how bearing acreage changes respond to these international trade elements.

Data Sources

U.S. orange production data for Florida and California-Arizona and Brazilian orange production data were obtained from various issues of the Commodity Year Book (Commodity Research Bureau). U.S. and Brazilian orange production were given in thousand metric tons.

Bearing acreages for all U.S. states producing citrus were obtained from the Citrus Summary, (Florida Crop and Livestock Reporting Service). Nonbearing acreage for California and Arizona was obtained from various issues of the Navel Orange Administrative Committee (NOAC) and the Valencia Orange Administrative Committee (VOAC). Florida nonbearing acreage was not used because Florida only inventories nonbearing acreage every two years. California-Arizona orange yields were obtained from the Valencia Orange Administrative Committee and were given by average number of cartons per acre harvested.

California on-tree prices were obtained from VOAC and NOAC. The values were given in dollars/carton. Florida on-tree prices were obtained from the Florida Agricultural Statistics Citrus Summary and were calculated for all oranges. The value was given in dollars/box.

Quantities for U.S. exports of fresh oranges were obtained from Foreign Agricultural Trade of the United States (FATUS), and their values were shown in thousand pounds. U.S. exports of FCOJ were computed from the United States Department of Commerce, Bureau of the Census, 1969-1986. U.S. exports of FCOJ have been published in three different size containers since 1972. Before 1972 all FCOJ exports were added and published in only one category. Data before 1969 were obtained from FATUS fiscal years 1960 thru 1969.

Florida freezes information was obtained from Florida Crop and Livestock Reporting Service (September 1986) and personal communication with Dr. Robert Behr, Director of the Economic Research Office, Florida Department Citrus.

Values of Brazilian exports were computed from FATUS by dividing the value of exports in U.S. dollars by the corresponding quantity. Irias' results were computed from the Brazil Servico de Estatistica Economica e Financeira, Ministerio da Fazenda, 1970-1979 and also from Banco do Brazil S.A. Carteira de Comerico Exterior-CACEX. These values were given in dollars/SSE. Brazilian export quantities were obtained from the Foreign Agricultural Trade of The United States years 1960-1969. Data for the years 1970-1979 were obtained from Irias (1980) who based his computations on information from Servicio do Estatistica Economica e Financeira, Ministerio de Fazenda, 1970-1979. Data for 1980-1988 were obtained from U.S. Department of Commerce, Bureau of the Census. Brazilian quantity exported was transformed in single strength equivalents using the following relation:

One thousand gallons of SSE = 0.718 metric tons of 65 brix concentrate.

CHAPTER IV

STATISTICAL RESULTS AND IMPLICATIONS

The two equations were initially estimated using the formulation developed in chapter III. The parameter estimates from these models provided the empirical measurements needed to analyze the regional citrus industry and its relationship to the international market.

This study used t-values to test the hypothesis with respect to estimated coefficients. If the absolute value of the t-statistic is equal to or greater than 2.160 for α =.05 at 13 d.f. and 1.771 for alpha = .10 at 13 degrees of freedom, the estimated coefficient is said to be statistically different than zero. This implies that a significant relationship exists between the tested explanatory variables and the dependent variables.

The statistical results obtained from the Florida acreage response model are presented in Table 18. The regression coefficients, standard errors, t-values, R^2, adjusted R^2, F value, and Durbin Watson value are also reported.

The critical value for the F distribution for the study is 4.62 at the 1 percent level of significance. As seen in Table 18, the F value is 13.46, which is statistically significant at the α = 0.01 level. Therefore the general model indicated a significant relationship among changes in Florida bearing acreage and the independent variables. The coefficient of determination (R^2) was .8614, indicating that approximately 86 percent of the variation of the FLBAD was explained by

Table 18. Estimated Parameters and Standard Errors for Florida Bearing Acreage Regional Model

Variables	Regression	Standard error	t-ratio
BORPDT1	11.477	4.9684	2.310
FLTPRT2	20433.018	8842.3927	2.311
FREZ	-26520.100	11772.8763	-2.253
BXPUSV	-141198.000	26171.5855	-5.395
USXTT1	-0.737	0.3973	-1.857
USXTT5	0.604	0.4368	1.385

R^2 = 0.8614 ADJ R-SQ = 0.7974 D.F.= 13 F=13.46 D.W. = 1.79

the econometric model.

In the theoretical model Brazilian orange production (BORPD) was expected to be negatively related to Florida bearing acreage difference (FLBAD). The estimated coefficient was not consistent with this hypothesis, which may be due in part to efforts by Florida growers to increase bearing acreage as Brazil increases production. Florida growers may have increased production to compete with Brazil and to avoid a Brazilian takeover of more international and U.S. markets. The coefficient for Brazilian orange production indicated that changes in Florida bearing acreage are quite sensitive to changes in Brazilian orange production lagged one year. For every thousand metric tons increase in Brazilian orange production, Florida bearing acreage (FLBA) will increase by eleven acres.

The sign of the estimated coefficient for Florida on-tree prices lagged two years was consistent with the *a priori* hypothesis. Thus, Florida on-tree prices for oranges lagged two years and Florida bearing acreage difference were positively related. This relationship indicated that if Florida on-tree prices lagged two years increases, growers are more likely to halt the removal of old trees to take advantage of the increasing prices. Therefore, an increase in bearing acreage was anticipated. The results suggested that FLBAD is very sensitive to changes in on-tree prices. For each 10-cent per carton increase in the on-tree price of oranges, Florida bearing acreage increased by approximately 2,043 acres.

The sign of the estimated coefficient for freezes was consistent with the expected estimates. Freezes and FLBAD were inversely related.

The coefficient indicated that freezes diminish the quantity of bearing acreage. Thus, the results indicated that a serious freeze could cause a decrease of 26,520 acres in Florida bearing acreage difference.

In the theoretical model, the Brazilian FCOJ export price average lagged one and two years for FCOJ to the U.S. (BXPUSV) was expected to be positively related to FLBAD. The study results indicated that FLBAD and Brazilian export price were actually inversely related. This relationship was significant at the .01 level. The coefficient indicated that if Brazilian FCOJ prices were down 1.5 years ago, bearing acreage in the current year is expected to increase. The unexpected relationship may be explained by production cycles in agricultural commodities. For example, at a given time Brazilian prices may be high because production is low. Growers in Florida are influenced by these prices, and they may expect different situations from year to year. Thus, growers in Florida might expect to sell their oranges at a better price in a particular year. Thus, producers may use two short-term strategies to take advantage of the high prices: the delayed removal of old trees and the early use of young trees.

Finally, the sign of the estimated coefficient of total U.S. exports for FCOJ lagged one year (USXTT1) was not consistent with the hypothesis. The results showed U.S. exports of FCOJ lagged one year (USXTT1) to be negatively related to FLBAD. This unexpected sign did not appear to create major problems, since the variable was not significant. Possibly, this sign was obtained because if U.S. exports were high in the previous year, growers reduced removals and started picking fruit from young trees to increase production and satisfy processors' demands. The following year growers will have to remove more old trees than expected. In addition, the new trees they expected to include for the first time as bearing profit trees were already included in the previous year. Therefore, bearing acreage difference for that year will be negative.

On the other hand, total U.S. exports for FCOJ lagged five years (USXTT5) was consistent with the a priori hypothesis. This is not surprising because if processors have the opportunity to export more, demand for oranges will increase. Growers will take export potential into consideration. If future exporting looks promising, they will plant more and bearing acreage will eventually increase. However, this variable was not found to be significant.

The statistical results obtained from the California-Arizona bearing acreage difference regional model are presented in Table 19. The regression coefficient, standard errors, t values, R^2, Adjusted R^2, F value, and Durbin Watson value are reported.

The coefficient of determination (R^2) and its corrected value were .8637 and .8211, respectively. This indicating that approximately 82 percent of the variation in changes in California-Arizona bearing acreage was explained by the econometric model. The overall F statistic for the econometric model regression was 20.281, which was statistically significant at the = 0.01 level.

In the theoretical model California-Arizona nonbearing acreage lagged four years (CAZNBT4) was expected to be positively related to the California-Arizona bearing acreage difference. Yet, as Table 19 shows, they were inversely related, indicating that if nonbearing

Table 19 Estimated Parameters and Standard Errors for California -Arizona Bearing Acreage Regional Model

Variables	Regression	Standard error	t-ratio
CAZNBT4	-0.4800	0.1557	-3.082
CAZNBT5	0.9128	0.1478	6.172
CZYIDT5	-798.8650	411.4502	-1.942
CATPRT2	541.9241	529.9443	1.023
USXTFT1	-0.0048	0.0037	-1.281
BRXUST3	0.0188	0.0097	1.932

R^2 = 0.8784 ADJ R-SQ = 0.8297 D.F.= 15 F = 18.05 D.W. = 2.720

acreage lagged four years increases, bearing acreage for the current year is expected to decrease. In any event, this last relationship was significant and showed that, for each one acre increase in California -Arizona nonbearing acreage, California-Arizona acreage will decrease by .4 acres. This unexpected sign may be explained by the following scenario. If growers had an increase in nonbearing acreage four years ago, they would expect to see an increase in bearing acreage after five years. In this instance the year after the current year is indicated, since on average an orange tree must grow for five years before it begins to produce some profit. Therefore, growers would probably try to eliminate most of the old plants that are not profitable in the current year, making the bearing acreage difference negative.

Conversely, California-Arizona nonbearing acreage lagged five years (CAZNBT5) was consistent with the hypothesis. California-Arizona nonbearing acreage lagged five years (CAZNBT5) and CZBAD were positively related to each other, meaning that if nonbearing acreage lagged five years increased a positive number can be expected in bearing acreage difference during the current year. This variable was found to be significant. For each one acre increase in California -Arizona nonbearing acreage, the Florida orange bearing acreage increased by .91 acres.

The sign of the estimated coefficient California-Arizona yield lagged five years (CZYIDT5) was consistent with the *a priori* hypothesis. California-Arizona yield lagged five years (CZYIDT5) and CZBAD were inversely related, even though the variable had a t-value of less than two (1.94). California-Arizona yield lagged five years

(CZYIDT5) seemed to play an essential role, since for each increase of one ton of oranges per acre, the California-Arizona bearing acreage difference decreased by approximately 798 acres. If growers have an increase in yield, they are more likely to avoid acreage expansion, since improved harvesting technology is replacing land acquisition.

The California on-tree price coefficient was positive, which was the expected result, suggesting that growers will increase bearing acreage difference if there is an increase in on-tree prices. However, the results showed that bearing acreage changes are not sensitive to California on-tree prices lagged two years (CATPRT2), since an increase in 10 cents per carton will only increase bearing acreage by 54 acres.

The estimated coefficient for U.S. exports of fresh oranges lagged one year (USXTFT1) was found to be negatively related to changes in California-Arizona bearing acreage. This unexpected sign appears to be no problem, since U.S. exports of fresh orange was found to be not significant. The negative sign might suggest, that if an increase in U.S. exports of fresh oranges took place a year ago, growers in California and Arizona would probably delay the removal of some of the old trees to take advantage of greater demand for exports. Hence, producers will remove more trees in the current year, creating a negative change in bearing acreage.

Among the explanatory variables of the CZBAD model, Brazilian exports of FCOJ to the U.S. lagged three years (BRXUST3) was included as a measurement of the relationship between the western citrus industry and the Florida-Brazilian citrus markets. Its sign was consistent with the expected result. The coefficient and t-value indicate a poor relationship between the independent and dependent variables.

Elasticity Estimates for FLBAD

Elasticity estimates for FLBAD are presented in Table 20. The FLBAD model is unique because has a negative mean for the dependable variable. Because elasticities were evaluated at that mean, all the elasticity results have a sign that actually does not correspond to the direction of the percent changes. To clarify this idea, the explanatory variable of Brazilian orange production lagged one year (BORPDT1) was used as an example. The elasticity for Brazilian orange production was equal to -9.7, and the mean of the dependable variable was -5220. The result for the change in the dependent variable achieved by multiplying these two factors together was a positive number, since multiplying negative signs results in a positive sign. Therefore, the elasticity for Brazilian orange production variable indicates that for every 1 percent increase in Brazilian orange production lagged one year (BORPDT1), Florida bearing acreage changes positively by 9.7 percent.

Florida on-tree prices lagged two years elasticity (-11.91) indicated that changes in Florida bearing acreage increase by more than 11 percent for a 1 percent increase in Florida on-tree prices lagged two years. This indicated that changes in bearing acreage difference exhibit elastic responses to a change in prices.

The elasticity for freezes (FREZ) was estimated to be 1.64, indicating that for every 1 percent increase in the actual occurrence

Table 20. Structural-Form Estimates of Elasticities for Florida Regional Model Evaluated at the Variable Means

Variable	Elasticity
Equation 1	
BORPDT1	-9.7977
FLTPRT2	-11.9100
FREZ	1.6930
BXPUSV	26.9900
USXTT1	6.9600
USXTT5	-5.7400

of freezes, bearing acreage will decrease by 1.64 percent. This value indicates that freezes have an elastic response.

Bearing acreage in Florida was expected to have a positive change by more than 26 percent for every 1 percent increase in average Brazilian export price of FCOJ lagged one and two years. The results of the study indicated that the Brazilian price for FCOJ is an extremely important factor in decisions made by Florida growers. For U.S. total exports of FCOJ lagged one year (USXTT1) and U.S. total exports of FCOJ lagged three years (USXTT3) elasticities were (6.96) and (-5.74), respectively. These results reinforce most of the previous estimates.

Elasticity Estimates for CZBAD

Estimates of elasticities for the California-Arizona bearing acreage difference model are reported in Table 21. Changes of 1 percent in California-Arizona nonbearing acreage lagged four years caused a change in California-Arizona bearing acreage of negative 4 percent. In the case of California-Arizona nonbearing acreage lagged five years (CAZNBT5), a 1 percent change in this variable resulted in a positive 8 percent change in the California-Arizona bearing acreage. Every 1 percent change in the California-Arizona yield lagged five years variable was associated with a negative 3.85 percent change in California-Arizona bearing acreage. The California on-tree prices lagged two years elasticity (.6733) indicated that California on-tree prices represents an inelastic response, meaning that price change does not have a severe effect on changes in orange bearing acreage. This finding was consistent with the parameters found in the

Table 21 Structural-Form Estimates of Elasticities for California -Arizona Regional Model Evaluated at the Variable Means

Variable	Elasticity
Equation 2	
CAZNBT4	-4.5758
CAZNBT5	8.0565
CZYIDT5	-3.8530
CATPRT2	0.6733
USXTFT1	-1.6890
BRXUST3	0.9297

statistical result. The elasticity for U.S. exports of fresh oranges (-1.68) indicated that California-Arizona bearing acreage will have a decrease of approximately 1.68 percent for each 1 percent increase in U.S. exports of fresh oranges lagged one year (USXTFT1).

Brazilian exports of FCOJ to the U.S. elasticities (.9297) indicated that compared with the other variables, CZBAD was relatively insensitive to Brazilian FCOJ exports to the U.S. lagged three years (BRXUST3). This finding was similar to the estimated parameters.

RELATIONSHIP BETWEEN THE FLORIDA AND THE CALIFORNIA-ARIZONA ORANGE INDUSTRIES

The econometric equations used to define the relationship between FLBAD and CZBAD exhibited high R^2 values, indicating similarities in explanations for the respective bearing acreage changes. Similarities in all 12 variables (six in each equation) were difficult to measure. However, similar factors were located for both equations, such as Florida and California on-tree prices, Brazilian FCOJ export prices, Brazilian FCOJ exports to the U.S., U.S. exports of FCOJ, and U.S. exports of fresh oranges. This approach was necessary since, as noted in chapter III, each region had different frameworks and markets. The results for the FLBAD model, as expected, demostrated a relationship between the Florida citrus industry and Brazilian trade factors in FCOJ. In addition, the weather (freezes) plays a major role in the orange industry in Florida. Finally, the only variable found common to both the California-Arizona bearing acreage difference model and the

Florida bearing acreage difference model is Florida and California on-tree prices. In contrast to the Florida regional model, the California-Arizona model did not have the same reaction to the Brazilian trade factors, nor did weather play a major role.

THE IMPACT OF U.S. ORANGE PRODUCTION AND BRAZILIAN EXCHANGE RATE ON ORANGE BEARING ACREAGE CHANGES

The results in bearing acreage changes in California-Arizona due to changes in U.S. orange production are presented in Table 22. The method and procedure used in finding the values presented in Table 22, 23, 24 and 25 were presented and discussed in chapter III (p. 29). These results showed that there were no major changes in CZBAD from an increase in U.S. orange production, possibly because only 30 percent of the oranges grown in the U.S. are produced by California-Arizona growers.

No major changes were found in California-Arizona bearing acreage due to variations in Brazilian exchange rates. The study results showed that there are no major links between Brazil and the western citrus industry. These results are presented in Table 23.

On the other hand, the Florida bearing acreage model showed a different framework. Many changes in bearing acreage occurred because of increments in Brazilian exchange rates with the United States and changes in orange production in the U.S. The study showed that the Florida bearing acreage difference model was sensitive to changes in U.S. orange production (Table 24), mainly because 70 percent of that

Table 22. Effects of U.S. Orange Production on California-Arizona Bearing Acreage Changes, Using Irias Reduced-Form Elasticity.

PERCENT OF CHANGE IN U.S. ORANGE PRODUCTION	BEARING ACREAGE CHANGES (acres)
10%	1131
20%	841
43%	174

Table 23. Effects of Brazil Exchange Rates on California-Arizona Bearing Acreage Changes, Using Irias Model Reduced-Form Elasticity.

PERCENT OF CHANGE IN BRAZIL'S EXCHANGE RATE	BEARING ACREAGE CHANGES (acres)
5%	1493
10%	1710
20%	1565
40%	1994
50%	2142

Table 24. Effects of U.S. Orange Production on Florida Bearing Acreage Using Irias Reduced-Form Elasticity.

PERCENT OF CHANGE IN U.S. ORANGE PRODUCTION	BEARING ACREAGE CHANGES (acres)
10%	20684
20%	29297
43%	49206

production came from Florida. As expected, international trade influenced Florida growers more than California-Arizona producers, since the West has almost no major competition from imports and its efforts are focussed on the fresh export and domestic markets. On the other hand Brazilian orange production is a major factor affecting the Florida citrus industry. Therefore, changes in Brazilian currency values can be expected to have repercussions on Florida orange production and Florida orange bearing acreage. The results are presented in Table 25.

Table 25. Effects of Brazil Exchange Rate on Florida Bearing Acreage Using Irias Reduced-Form Elasticity.

PERCENT OF CHANGE IN BRAZIL'S ECHANGE RATE	BEARING ACREAGE CHANGES (acres)
5%	13766
10%	15601
20%	19272
40%	26473
50%	30003

CHAPTER V

SUMMARY AND CONCLUSIONS

The development of new markets in the FCOJ and fresh orange industries has created new challenges for orange growers, processors and traders as domestic markets become more heavily influenced by changes in international markets. Today's citrus industry is affected mainly by land expansion, a factor that citrus producers are more concerned with now than ever. For the past 20 years, the use of improved agricultural technology in the citrus industry has been widespread, and the improvements the industry has achieved are remarkable, however, today's technology alone can no longer provide growers with sufficient fruit yields to accomodate producers' demands. A different solution is needed to increase production. This solution could be land expansion (new planting), which will eventually increase bearing acreage and, therefore, production in the orange industry in the U.S.

This study analyzes the major components affecting bearing acreage in the U.S. citrus industry. In this study, attempts were made to detect relationships between Florida and California-Arizona changes in bearing acreage due to Brazilian trade factors such as the Brazilian exchange rate or Brazilian FCOJ exports. Studies such as Ward's (1976), Moretti's (1978), and Irias' (1981), among others, show that Brazil plays a major role only in Florida's citrus industry.

The present study should benefit growers in the different citrus regions because major factors affecting bearing acreage changes in the orange industry were analyzed. In addition, the study examined interactions between Brazilian FCOJ trade factors and the orange industries in the U.S.

The objectives of this study were:

1) Identify and evaluate the major factors affecting growers' decisions for orange bearing acreage changes.
2) Examine the interactions between the Brazilian orange industry and the United States orange industry and to evaluate the differences in regional acreage response to changes in economic and international factors.

Supply response models were developed for Florida and the western citrus industry. The analysis focused on bearing acreage differences and included Brazil as an international variable. Brazil, which is the largest producer of oranges and FCOJ in the world, plays a major role in the U.S. FCOJ industry. Discussion of the orange industry in the U.S. and international trade linkages were addressed in chapter II.

The economic models that explain changes in bearing acreage in Florida as well as in California-Arizona orange industries were developed in chapter III. The general *a priori* hypothesis used in this study to formulate the model was that orange bearing acreage changes are a function of yield, nonbearing acreage, profitability, and international trade variables. The international link was assumed to exist between Brazil and the U.S.

MAJOR CONCLUSIONS

Chapter IV described the statistical procedure and results. Florida bearing acreage difference from one year to the next (FLBAD) is a function of Brazilian orange production lagged one year (BORPDT1), Florida on-tree prices lagged two years (FLTPRT2), freezes (FREZ), and Brazil's export average price for FCOJ to the U.S.A. lagged one and two years (BXPUSV). These variables were found to be statistically significant.

The results showed three relevant factors for the Florida bearing acreage difference (FLBAD) model. The first factor is the domestic market, represented by Florida's on-tree prices. The second factor is international competition from Brazil. Brazil's FCOJ production is a major factor affecting decisions in the U.S. orange industry. Brazilian factors enter the Florida bearing acreage difference model (FLBAD) with two variables: Brazilian orange production and Brazilian FCOJ export prices to the U.S. Finally, the third factor, world demand for U.S. FCOJ, is described in the Florida bearing acreage difference (FLBAD) model by U.S. exports of FCOJ to the rest of the world. Strong statistical relationships were found between these factors and the dependent variable.

Current and previous Florida on-tree prices and Brazilian FCOJ export prices to the U.S. are important in explaining Florida growers' decisions for new plantings and removals. The analysis indicated that a 1 percent increase in on-tree prices lagged two years is likely to cause Florida bearing acreage (FLBA) to have a positive change of 2,043 acres. The study showed that Brazilian FCOJ export prices to the U.S. are a reflection of U.S. and European demand for FCOJ. Therefore, these export prices have repercussions on Florida prices. If Brazilian prices are high, then Florida prices tend to be high. Therefore, growers will tend to slow the removal of old trees for at least one or two seasons. Thus, more removals will be present in the near future, explaining the negative change in bearing acreage and the inverse relationship between the dependent variable and Brazilian FCOJ export prices.

The direct effects of freezes on bearing acreage are great. The magnitude of the parameter (26,520) suggests that for every major freeze that occurs in Florida, the industry should experience a reduction in bearing acreage of 26,520 acres.

Brazilian orange production was found to be positively related to changes in Florida bearing acreage. U.S. FCOJ exports did not affect FLBAD appreciably. Thus, growers' concerns appear to be primarily the domestic market. In contrast, processors seem to have a major interest in the overseas market.

In the theoretical model the California-Arizona bearing acreage difference (CZBAD) was found to be a function of California-Arizona nonbearing acreage lagged four and five years (CAZNBT4, CAZNBT5). The rest of the variables tested were found to be not significant. These were California-Arizona on-tree prices lagged two years (CATPRT2), California-Arizona yield lagged five years (CZYIDT5), U.S. exports of fresh oranges lagged one year (USXTFT1), and Brazil FCOJ exports to the U.S. lagged three years (BRXUST3).

California-Arizona nonbearing acreage lagged four and five years were expected to play key roles in bearing acreage changes. The results were as expected for California-Arizona nonbearing acreage lagged five years. Therefore, the study concluded that this variable had major impact on bearing acreage difference. However, California-Arizona nonbearing acreage lagged four years had a different signsfrom what expected. The variable lagged four years was negatively related to the dependent variable, while the variable lagged five years was positively related to bearing acreage difference and showed a coefficient of (8.05). This indicates that for every 1 percent increase in nonbearing acreage lagged five years there will be an increase of 8.05 percent in the change of bearing acreage from the last year.

The estimated coefficient found for yield was consistent with the _a priori_ hypothesis. In addition the study concluded that the California-Arizona bearing acreage difference was sensitive to changes in the yield variable. The results may have shown yield as a major factor in bearing acreage changes because for the past 20 years technological advancements have been a substitute for land expansion. The study results show for the variable California-Arizona yield lagged five years that for every increase in 1,000 cartons/acre yield, bearing acreage in California-Arizona changes negatively by 798 acres.

California on-tree prices were not found to be a major variable affecting bearing acreage difference. California on-tree prices were found to have an inelastic response (.6733). Brazil FCOJ exports were not found to have a major relation to or impact on the western bearing acreage changes. Despite this finding, the study found that Brazilian

FCOJ exports to the U.S. was still the best variable available to measure the relationship between Brazilian trade elements and the western citrus region. Hence, the study concluded that no major link exists between the West and the Brazilian orange industry and their international trade in FCOJ.

U.S. exports of fresh oranges were found to be elastic. The magnitude of the coefficient (-1.68) suggests that for each 1 percent decrease in U.S. exports of fresh fruit, an increase in bearing acreage difference of 1.68 percent will be expected.

Analysis of the international link by using the Irias model suggests that California-Arizona bearing acreage changes have no major relationship with Brazil's devaluation of its currency. This verifies this study previous findings. A weak relationship was demonstrated between the dependent variable and U.S. orange production because California-Arizona represents such a small proportion of total production comparing with Florida. On the other hand, the Florida bearing acreage difference model was found to be very sensitive to changes in both the Brazilian currency rates and U.S. orange production.

SUGGESTION FOR FUTURE STUDIES

Further research could concentrate on obtaining better estimates for bearing acreage differences, thereby correcting deficiencies in the Brazilian trade data, Florida nonbearing acreage, U.S. yield statistics, and tree inventories in the Florida and California-Arizona regions. Alternative approaches used to measure the bearing acreage changes may also improve the overall performance of the model. Expansion of the data could result in expansion of the models without losing any degrees of freedom.

Some variables did not respond as expected. For instance the data for nonbearing acreage lagged four years, U.S. export of fresh oranges, and U.S. FCOJ exports lagged one year yielded surprising results. More research would provide a better understanding of the effect of these variables on bearing acreage changes in the U.S. orange industry.

Further researchers should try to work with bearing acreage instead of bearing acreage difference to determine if the same factors affect total bearing acreage and changes in bearing acreage. A better understanding of the movements in perennial crops would result.

This study was limited to Brazil, a producer nation as the link with the international FCOJ market. It would be interesting to determine if the activities of an importer nation like Japan may affect bearing acreage in the U.S. A study conceived from this perspective could make a contribution to the analysis of the effects of new markets on bearing acreage.

BIBLIOGRAPHY

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Behr, R.M., Economic and Market Research Director, (1988). Personal interview, Florida Department of Citrus, University of Florida, Gainesville.

Behr, R.M., Florida Citrus Outlook Update 1987-1988. Florida Department of Citrus, Gainesville, Florida, March 1988.

Behr, R.M., A review of Florida Fresh Fruit Production, Utilization and Movement. Florida Department of Citrus, University of Florida, Gainesville, Florida, March 1988.

Behr, R.M., Brazil Citrus Situation and Outlook Seasons 1986-87, 1987-88, 1988-89. Florida Department of Citrus, University of Florida, Gainesville, Florida, May 1988.

Brown, M. G., World Orange Juice Trends. Florida Department of Citrus, Florida Citrus Commission, Lakeland, Florida, January 1987.

Citrus Reference Department of Florida, Citrus-EMRA. Statistical Reference Book, University of Florida, April 1987.

Citrus Fruit Industry, Statistical Bulletin. Sunkist growers, Inc. Information System Department 1987.

Dean, G.W., and N.R. Collins, (1967). "World Trade in Fresh Oranges: An Analysis of the Effect of European Economic Community Tariff Policies." Giannini Foundation Monograph Number 18, University of California, Davis.

Drummond, H. Evan, Research Report. Estimated Value of Florida Citrus Fruit Loss Caused by the January, 1985 Freeze. Institute of Food and Agricultural Sciences. University of Florida, Gainesville.

Dunn, J., Beilock, R., Unpublished paper; Estimation of the supply of a perennial. University of Penn State, University Park, Pennsylvania 1979.

Florida Agriculture Statistics. Citrus Summary, Various volumes Orlando, Florida, January 1988.

Florida Crop and Livestock Reporting Service. Commercial Citrus Tree inventory, Florida Department of Agriculture and Consumer Services, Orlando, Florida, December 1986.

Florida Crop and Livestock Reporting Service. Florida Agricultural Statistics, Citrus Summary, Orlando, Florida 1987 1988.

Food and Agricultural Organization of the United Nations. Production Yearbook, various volumes. Rome, Italy 1970-1986.

French, B.C. and J. Matthews (1971). "A Supply Response Model for Perennial Crops." American Journal of Agricultural Economics, 53(August): 478-490.

Gunter, Dan, Economic Report 85-3. Brazilian Citrus Outlook Season 1985-86, Florida Department of Citrus, University of Florida Gainesville, Florida, July 1986.

International Monetary Fund. International Financial Statistics, various volumes. Washington, D.C., 1960-1986.

Irias, L.J.M. (1981) "An Econometric Model of International Trade of FCOJ." Ph.D. Dissertation, University of Florida, Gainesville.

Lee, J-Y, (1977). "A Study of Impacts of Three Party Program on European Demand for U.S. FCOJ." Economic Research Department Circular, CIR 77-2, University of Florida, Gainesville.

Lee, Jonq-Ying, Tilley, D. S.: Irreversible Import Shares for FCOJ in Canada. Southern Journal of Agricultural Economics University of Florida, Gainesville, Florida, December 1983.

Malick, W. M.: "A Simultaneous Equation Model of the Florida Retail Orange Juice Marketing System". M.S. thesis, University of Florida, Gainesville, Florida, 1980.

Mantaya, C. S.: Optimal Storage levels: The case of Florida Frozen concentrate orange juice. M.S. thesis, University of Florida, Gainesville, Florida, 1983.

McClain, E. Student candidate for a degree of Doctor of Philosophy, (1988). Personal interview. University of Florida, Gainesville.

Morias, E.L. de, and M. del Madeiros (1978). "A Partipaco Brazileira Mercado Internacional de Laranja e de Suco de Laranja." Comportamento Recente e Perspectivas. Ministerio de Agricultura, Secretaria Nacional de Planjamento Agricola, Brasilia, D.F.

Moretti, V.A. "Demand for Brazilian FCOJ Exports." M.S. Thesis, University of Florida, Gainesville, 1978.

Myers, L. H., Tilley,D. S., Lee, J-Y, Fairchild, G. F., and Brooks, T. L.: FCOJ import-export policies and programs: An overview. Economic Research Department, Florida Department of Citrus, working paper 79-5, University of Florida, Gainesville, Florida, 1979.

Navel and Valencia Orange administrative committees. annual reports California Arizona citrus league G.E. tempo cost survey, UCR and UAT; Sunkist records Los Angeles 1985.

Polopolous, L.: Foreign Imports of Orange Concentrate and the Florida Citrus Industry. Florida Department of Citrus, University of Florida, Gainesville, Florida, 1968.

Priscott, R. H.: Demand for citrus products in the European markets. M. S. thesis, University of Florida, Gainesville, Florida, 1969.

Roberts, R., et al. (1986). "The Effects of Changing Imports and Tariffs on the Hawaii Papaya Industry." Research Series 046, College of Tropical Agriculture and Human Resources, University of Hawaii.

Tilley, D.S. and J-Y Ying (1981). "Import and Retail Level Demand for Orange Juice in Canada." Canadian Journal of Agricultural Economics, 29:2, 171-186.

United Nations, Estudios e Informes de la CEPAL (1985). Trade Relations Between Brazil and the United States. Santiago de Chile, Chile.

United States Department of Agriculture. Foreign Agriculture Service Report #M295. Brazil Orange Juice Industry, April 1980.

United States Department of Agriculture. Foreign Agricultural Service, Horticultural products review circular series FHORT June 1988.

United States Department of Agriculture. United States Foreign Agricultural Trade; Economic Research Service. various volumes 1964-1968.

United States International Trade Commission investigation No 731-ta326. FCOJ from Brazil Washington D.C. May 1986.

Ward, R. W.: The Economics of Florida's FCOJ imports and exports: An econometric study. Economic Research Department, Florida Department of Citrus, ERD Report 76-1, University of Florida, Gainesville, Florida, 1976.

Ward, R. W.: A Two-pricing System for Exporting Frozen Concentrated Orange Juice. Southern Journal Agricultural Economics 8: 1976.

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