DYNAMICS OF THE FLORIDA
FROZEN ORANGE CONCENTRATE INDUSTRY

by

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SUBMITTED IN PARTIAL FULFILLMENT OF THE
REQUIREMENTS FOR THE DEGREE OF
MASTER OF SCIENCE
at the
MASSACHUSETTS INSTITUTE OF TECHNOLOGY

Signature of Author.
Department of Electrical Engineering, September 1, 1962

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-1-
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ABSTRACT

This Industrial Dynamics study is concerned with the design of cooperative marketing policies to improve the stability of the Florida frozen orange concentrate industry, in both the short and the long term. The first phase of the study involves the identification of the system structure underlying the industry's over-all dynamic behavior. The second phase is concerned with precise description of this structure in the context of a dynamic model. In the third phase the dynamic performance of the system is analyzed with the aid of computer simulation. The fourth phase is concerned with the design of policies to improve this dynamic performance. Here, the effects of a number of alternative policies are investigated experimentally, again with the aid of simulation.

With respect to the lack of short-term stability, several conclusions emerge. Processors' attempts to control concentrate disappearance through adjustment of the FOB price are frustrated by response transients in the distribution system and by an only gradual adjustment to new price levels on the part of consumers. A tendency to over-adjust prices leads to fluctuating behavior in the short term. Underlying this sensitivity in the price control mechanism is the practice of carrying over only minimum concentrate inventories from one season to the next.

In the long term, the lack of industry stability traces to a highly responsive relationship between grower profits and the planting of new groves, which does not properly account for the long delay before new groves become productive. Under the influence of weather disturbances, this system structure creates major long-term fluctuations in supply.

Toward improving short-term stability, a policy involving larger concentrate carry-over from one season to the next shows promise on the basis of simulations of industry behavior. Improvements in long-term stability are indicated through the use of a cooperative advertising policy, with advertising expenditure geared to grower profits.

Thesis Supervisor: Jay W. Forrester
Title: Professor of Industrial Management
ACKNOWLEDGMENTS

I wish to express my gratitude to Professor Jay W. Forrester for his assistance throughout this study. He has provided support, guidance, and most important, a challenging personal example.

My thanks also go to Mr. F. Helmut Weymar. His research activities, in some respects parallel, have enabled him to make many valuable suggestions.

The Minute Maid Company, division of the Coca-Cola Company, has provided financial support for this study. Mr. Hugh W. Schwarz, Vice President, The Minute Maid Company, has contributed his personal support and broad experience.

I wish to thank Miss Jean VanDerlip and Miss Joan Surprenant who typed the final manuscript, and also Miss Sally Orcutt who assisted with an earlier draft.

This work was done in part at the Massachusetts Institute of Technology Computation Center.
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Chapter 1

INTRODUCTION

The Florida frozen orange concentrate industry extends from the planting of orange groves and the growing of oranges to the distribution of concentrate through retail and institutional outlets. In many respects, this industry is typical of agricultural commodity industries. In the short run, the supply of oranges is relatively inflexible, yet uncertain because of the influence of weather. In the long run, the supply of oranges is highly responsive to the level of profits which orange growers have previously enjoyed. These supply characteristics, together with the low elasticity of consumer demand for frozen orange concentrate, underlie much of the instability which has characterized the industry since its inception.

This study is concerned with the design of policies to improve the stability of the Florida frozen orange concentrate industry, in both the short and the long term. The first phase of the endeavor involves the identification of the system structure underlying the industry's over-all dynamic behavior. The second phase is concerned with precise description of this structure in the context of a dynamic model. In the third phase, the dynamic performance of the system is analyzed with the aid of computer simulation. The fourth phase is concerned with the design of policies to improve this dynamic performance. Here, the effects of a number of alternative policies are investigated experimentally, again with the aid of simulation.

Throughout this investigation the approach of Industrial Dynamics
has been followed.\textsuperscript{1} Industrial Dynamics offers a philosophy and a methodology for improving the management of industrial and economic enterprises. It is an integrated approach to managerial problems which relate to the over-all performance characteristics of systems. Central to the approach is the notion that the over-all performance of industrial and economic enterprises is determined by an underlying system structure. This structure can be viewed as a complex information feedback system. Its influence on the enterprise's performance can be analyzed with the aid of the concepts and principles of information feedback system behavior. Hence, Industrial Dynamics is concerned with identification and analysis of the system structure underlying the over-all performance characteristics of interest in industrial or economic situations. Once this foundation has been developed, attention is focused on the design of structural changes to improve the system's performance. These structural changes may involve revision of managerial policies within the existing configuration of relationships, or they may involve alteration of the system configuration itself.

This study of the Florida frozen orange concentrate industry serves to clarify many of the reasons for the industry's fluctuating behavior. Within the industry, individuals attempt to minimize the risk of inventory losses by carrying over minimum concentrate inventories from one year to the next. In doing so, they tend to further

destabilize prices in the short run. This short-term instability appears in addition to a more critical long-term instability which is caused by the highly responsive relationship between grower profits and the planting of new orange groves. Failure to properly take into account the newly planted orange groves which have not yet begun production leads to wide fluctuations in orange prices with a period of fifteen or twenty years. If these dynamic characteristics were better understood by individuals within the industry, some improvement in stability might result. However, there is little guarantee that an attempt to solve the industry's problems through education will be effective. A more promising approach is the implementation of policies, either by individuals within the industry or by the industry as a whole, to effect the desired improvements.

Toward such an end, this study has been concerned with the design of cooperative marketing policies involving both advertising and the maintenance of buffer inventories. A number of policies have been explored. The conditions under which these policies could be successful have been examined. Two major conclusions result from the investigation. First, the maintenance of buffer inventories shows promise of improving short-term stability. Second, long-term stability may well be significantly improved through cooperative advertising if a high degree of consumer sensitivity to advertising can be realized.
Chapter 2
THE FLORIDA FROZEN ORANGE CONCENTRATE INDUSTRY

The Florida frozen orange concentrate industry will here be defined in terms of a broad system of relationships extending from the planting of orange groves to the purchase of frozen orange concentrate by consumers. This channel constitutes the major outlet for Florida oranges. Over 70 percent of Florida's orange production reaches the consumer in concentrate form. Because of its size relative to the other channels of utilization, the frozen orange concentrate sector has, in recent years, strongly determined the dynamic behavior of the entire Florida orange industry. Florida frozen orange concentrate also dominates the retail concentrate market. In 1958-59, over 90 percent of the total frozen orange concentrate production in the United States utilized Florida oranges.¹

2.1 History

The Florida frozen orange concentrate industry came into existence in 1945 with the incorporation of the Vacuum Foods Corporation, forerunner of Minute Maid. Competition within the industry began to develop in 1948 with the entry of General Foods (Birdseye) and Clinton Foods (Snow Crop). By the end of 1949, Minute Maid, Snow Crop, and Birdseye together sold 80 percent of the ten million gallons of juice produced that year.

¹Florida Citrus Fruit, Annual Summary, 1959, United States Department of Agriculture, Agricultural Marketing Service.

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2.1

Figure 2.1 illustrates the rapid growth in concentrate production which took place during the 1950's. Much of this growth occurred in new markets as suggested by Figure 2.2, which compares fresh orange consumption with processed orange consumption. Frozen orange concentrate accounts for the major share of the processed category.

Until 1954, the frozen orange concentrate market was dominated by nationally advertised brands. In a relatively short period of time, nonadvertised brands and private label brands came into prominence in the supermarket. Today, it is estimated that nationally advertised brands together share less than one third of the retail orange concentrate market.

It is difficult to locate frozen orange concentrate at a particular point in a product life cycle. On the basis of price-volume data for the period 1955-60, there appears to be an increase of about 4 percent per year in the quantity which can be sold at a given price. This rate of growth can be partially explained in terms of increases in population and per capita income. Data collected by the Market Research Corporation of America for the Florida Citrus Commission indicates that the number of families buying frozen orange concentrate is remaining steady at about 30 percent.\(^2\)

Frozen orange concentrate prices have tended to be unstable during the entire history of the industry. Figure 2.3 shows wholesale prices for the years 1953-59. Variations in crop size due to

Figure 2.1

FLORIDA PRODUCTION OF FROZEN ORANGE CONCENTRATE
Figure 2.2

FLORIDA ORANGES: PRODUCTION AND UTILIZATION

Figure 2.3

FROZEN ORANGE CONCENTRATE: FOB QUOTATIONS

weather and uncertainty in the estimates of crop size have been the major external influences on prices. Such external disturbances are amplified by the industry's internal characteristics to produce fluctuating modes of behavior in many of the key variables. An example of the effect of a major weather disturbance, a freeze, can be observed in Figure 2.3. Between June, 1957, and June, 1958, FOB prices increased by more than 100 percent, primarily the result of a freeze in December, 1957. This freeze reduced the 1958 crop by an estimated 20 percent. However, the net change in crop size from 1957 to 1958 was only 11 percent.

Accompanying the fluctuations in frozen orange concentrate prices are fluctuations in the prices paid to growers for fruit. Figure 2.4 illustrates the degree of price instability which has typically been experienced by growers. It should be observed that there is a significant lack of correlation, in the short term, between concentrate price and fruit prices. Figure 2.5 more clearly indicates the nature of fruit price behavior in the long run. It would appear that the general characteristics of fruit price behavior have not been changed by the introduction of frozen orange concentrate. A tendency toward long-term periodicity continues.

This brief historical description has touched on some of the superficial aspects of industry growth and stability. Before narrowing the focus to more specific problems, it will be useful to describe, in general terms, the structural and behavioral characteristics of the industry.
Figure 2.4

FLORIDA ORANGES: MONTHLY PRICES
Figure 2.5

ON-TREE VALUE OF FLORIDA ORANGES
2.2 Structural and Behavioral Characteristics

It is useful to view the Florida frozen orange concentrate industry in terms of a number of sectors including orange growers, concentrate processors, retailers, and consumers. These sectors are functionally separate although, to some extent, integrated in terms of ownership. To cite one example, many orange growers are organized into cooperatives which maintain processing operations. Linking these sectors are both physical flows and flows of information.

The major physical flows are the flow of oranges from orange growers to processors, the flow of concentrate from processors to retailers, and the flow of concentrate from retailers to consumers. The flows of information are less clearly defined. A highly developed information network provides weekly information about many of the key variables. However, informal channels often have an equally important influence on decisions within the industry.

In this study, the frozen orange concentrate industry will be viewed as the core of the over-all Florida orange industry. Other channels of utilization will be regarded as somewhat peripheral. This view would seem quite reasonable in light of the overshadowing size of the concentrate channel relative to any other. In 1961, for instance, nearly 65 percent of the crop went to concentrate, while less than 20 percent was sold in fresh form. Realizing that some orange varieties are grown primarily for sale in fresh form, it can be concluded that the dynamic influence of fresh orange sales on the concentrate industry is small.
2.2.1 Orange Grower Sector

- Organization

Scattered throughout the state of Florida, there are almost 500,000³ acres of bearing orange groves. The ownership of these groves is widely distributed. Minute Maid, the largest orange grower, owns or holds under long-term lease approximately 18,000⁴ acres of bearing orange groves, less than 4 percent of the total. Most of the acreage is in the hands of a large number of small growers. Even the homeowner with trees in his backyard enters into the picture.

As an over-all body, orange growers are loosely knit. Perhaps the most influential general organization is the Florida Citrus Mutual. This association, with over 12,000 members, distributes market information and champions the cause of the orange grower. At a regional level, growers are, in many cases, more closely organized into cooperatives. These cooperatives perform marketing services, often to the extent of maintaining processing facilities.

Under state law, growers must adhere to certain standards and practices. Also under state law, growers can impose collective agreements on all orange growers within the state. These agreements may involve tax assessments for advertising, product research, etc. In recent years a tax of 3 cents per box of oranges has been levied and used to support advertising and promotion programs.


2.2.1

- Seasonal Characteristics

Oranges are a seasonal commodity. The season, which extends from November through June, is broken in March by the change-over from early and midseason varieties to late varieties (Valencia). There is a considerable degree of time flexibility in picking the crop. Oranges can usually be picked at any time during an eight-week period following maturity. However, once picked, they must be used within a few days.

- Weather and Care

The productivity of an orange grove is influenced by care and by weather. Poor care, such as underfertilization and underspraying, for a period of three years will reduce production by 15 percent or more. If neglected for a longer period, the reduction in productivity will be proportionately greater. A neglected grove can be rejuvenated in one or two years, depending on the degree of deterioration.

Weather has a more dramatic influence on orange production. Freezes may reduce the crop size by 10 or 20 percent during a given year, after which recovery to normal production occurs gradually over a period of two or three years, depending on the severity. Another weather disturbance is the hurricane which quite frequently strikes the state. In this case, recovery is more rapid unless trees are permanently damaged. In addition to major disturbances such as freezes and hurricanes, minor weather variations typically cause 5 or 10 percent variations in crop size and concentrate yield. Together, these various weather influences help to keep the industry in a continual state of fluctuation.
2.2.1

- Grove Development

The planting of orange groves is a long-term investment. Between the planting of a new tree and the time when harvesting becomes economical, there is a delay of approximately five years. Following this, there is another period of roughly ten years during which time the tree's productivity is constantly increasing. An orange tree does not reach peak productivity until it is about twenty years old. Then, with proper care, a tree will maintain this level of productivity almost indefinitely. Figure 2.6 illustrates these characteristics.

- Planting Decisions

In spite of the long-term nature of the decision to invest in orange groves, there is a strong tendency toward a high rate of planting when profits to orange growers are high and a low rate of planting when profits are low. To be sure, there are other factors which are mentioned by those contemplating planting. Some may look at trends in prices or profits. Others may look at statistics on existing acreage and new plantings, although it is difficult to say how this information should be interpreted. Yet, it seems that the allure of recent grower profits has, by far, the most important influence on the rate at which new orange groves are planted. Many of these other factors may simply serve as a basis for rationalization. It is a brave man who will plant orange groves in the face of grower losses.

One potentially important influence on orange grove planting, the availability of suitable land, does not seem to be a significant
Figure 2.6

LATE ORANGE YIELD IN BOXES PER TREE

Source: Savage, Zach; Citrus Yield Per Tree By Age, Economics Series 60-8, November 1960, Agricultural Extension Service, Univ. of Florida, Gainesville, Florida.
factor at the present time. Surveys indicate that the supply of suitable land will not be seriously reduced in the foreseeable future.\(^5\) Moreover, new techniques are making possible the reclamation of presently unusable land for citrus purposes.

Figure 2.7 provides some insight into the relationship between grower profits and new tree planting. The upward trend from one year to the next throughout the period can perhaps be attributed to expectations about the continued growth of frozen orange concentrate. Now that the product is more mature, this trend should be diminished.

On the other side of the picture is the rate at which bearing acreage is lost from production due to conversion to other uses. Little data is available on this attrition. However, it should be expected that the rate of loss is inversely related to grower profits. If grower profits are high, grove values will be high and conversion to other uses less likely. The importance of this loss factor was recently emphasized by a prediction in the Triangle "that new plantings will be offset more than ever before by urbanization, industrialization, spreading decline, etc."\(^6\)

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YEARLY MOVEMENT OF ORANGE TREES FROM FLORIDA NURSERIES
MEASURED AS A FRACTION OF BEARING TREES*

* Assuming 65 trees per acre
** Two year average of on-tree returns less $.80 per box growing costs

Disposition

Over 50 percent\textsuperscript{7} of the oranges used for frozen orange concentrate are passed directly from grove to processor without a market transaction. Included in this captive fruit category are oranges processed by grower cooperatives as well as oranges grown by concentrate processors. The remainder of the orange supply is transacted through advance contract sales or spot market sales. The split between fruit sales contracted in advance and spot market sales has varied, depending on the relative attractiveness of each channel during previous seasons.

Fruit Prices

The behavior of spot market prices is of greater importance than might be expected on the basis of volume transacted. A considerable portion of the advance contract fruit is priced on the basis of the season's average for all priced fruit to date of delivery. Hence, the spot market price has a leverage effect on the price of advance contract fruit.

Spot market prices are subject to a large number of influences. These include crop size estimates, the rate of concentrate shipments from Florida, concentrate prices, price trends, fruit inventories, concentrate inventories, and many others. The degree of price instability which is typically experienced was indicated in Figure 2.4.

Even though there are often major variations in fruit prices within a given season, a large portion of the industry feels that the season's average price is determined by the crop size. When the crop size estimate changes within a season, a new season's average price is somehow indicated. On the basis of this new season's average figure and information about the fraction of the crop remaining to be sold, a "proper" price for the remaining fruit is determined. These beliefs are not well supported by historical experience. It might be more reasonable to say that the season's average fruit price is closely related to crop size when there is little change in crop estimates within the season.

The motivation for this season's average sort of thinking arises from the characteristics of consumer demand. Here, the quantity sold during a given year is more often closely related to the average retail price during the year. If the grower is to receive his "fair share" of the consumer's dollar, a similar relationship should pertain at the grower level. Hence, the belief in a season's average price relationship arises.

- Profits

Needless to say, the profits of growers and processors alike are quite dependent on fruit prices. If the crop size is initially underestimated, the processor may pay more for fruit than he can later realize through the sale of concentrate. Similarly, if the crop size is initially overestimated, growers may receive much less than their normal share of the consumer's dollar. The sensitivity of profits
to errors in crop size estimates is greatly increased by the lack of buffer inventories.

Although the fruit market may distort the balance between processor profits and grower profits within a given year, these distortions are usually averaged out over a period of two or three years. From a longer-term point of view, it is reasonable to say that fruit prices and grower profits are determined by the price of frozen orange concentrate.

- Crop Estimating

A major source of uncertainty within the industry is the crop size estimate. And because the industry, for the most part, operates on a year-at-a-time basis, many key variables are highly responsive to these uncertain estimates. The crop estimates prepared by the United States Department of Agriculture on a monthly basis have a great deal of influence on industry behavior. Figure 2.8 illustrates the uncertainty which typically has been present.

2.2.2 Concentrate Processor Sector

- Organization

Frozen orange concentrate processors fall into two major categories: advertised brand processors, and nonadvertised or private brand processors. Most are in the latter category. Only a few, Minute Maid and Snow Crop, Birds-Eye, and Libby, are nationally advertised. Together, the advertised brands account for less than one third of total volume.
United States Department of Agriculture Orange Crop Estimates (Millions of Boxes)

Many of the nonadvertised and private brand processing operations are owned by grower cooperatives. These have been established by growers to ensure a marketing outlet for their fruit and are operated on a nonprofit basis. Some may purchase additional fruit on the open market, but again the profits are returned to the members of the cooperative under the guise of payment for fruit.

- Competition

Concentrate processors operate in a highly competitive environment. In most cases, competing products are highly uniform, with little or no brand identification. Consequently, competition occurs primarily on the basis of price. The advertised brands are, of course, in a somewhat different position, but here again price competition is extremely important.

Competitive price cutting is a common occurrence. Even when the general price level seems appropriate given the crop size, some processors will reduce their prices. Such behavior is to be expected, perhaps, in a situation characterized by so many uncertainties. Price cutting on the part of one processor is usually followed by the rest. In addition to competition on the basis of posted prices, many processors offer other incentives to buyers such as partial protection against price changes.

The competition among processors for fruit supplies is equally keen. Most will attempt to buy fruit so long as they feel that they can realize a profit. It is also quite likely that many tend to think in terms of marginal returns as the season approaches an end.
During years when the crop is relatively short, processors seem to be much more concerned with how much they can buy at a reasonable price than with how much they can sell. Although the rationale for this kind of attitude may be somewhat illusive, the attitude, nevertheless, reflects the competitive pressures which exist.

• Capacity

The industry has traditionally had excess processing capacity. Some of this overcapacity has been deliberate. Many cooperatives prefer to run a short season in order to utilize fruit supplies at peak maturity. Other processors prefer additional flexibility with respect to the timing of fruit purchases. In any case, an important effect of this overcapacity is the strengthening of competition among processors.

• Processing Season

In October, just as the crop is beginning to ripen, the United States Department of Agriculture releases its first monthly crop estimate for the new season. The first of December, eight weeks later, marks the beginning of the new concentrating season. During December, concentrators gradually build up to full production.

Between October and the beginning of December, processors gradually shift their attention to the new crop and give more and more consideration to the marketing problems anticipated for the new concentrating season. These expectations likely exert some influence on their marketing activities during the final weeks of the old season. However, the major change-over in industry thinking occurs rather
suddenly around the first of December. In a sense, a new chapter is opened, and a new year begins.

- Inventories

Because of the seasonal nature of orange production, processors must at certain times carry large inventories of frozen orange concentrate. At other times they carry only a minimum amount. Typically, processors attempt to enter a new concentrating season with only enough inventory to last until processing is in full swing. During most years the carry-over inventory on the first of December has been roughly an eight-week supply. Many processors actually run out of inventory at the end of each season.

There has been some tendency for the industry to adjust the amount which they desire to carry-over on the basis of expectations about the crop size. However, this flexibility has been small. Most of the historical variation is explained in terms of the industry's lack of absolute control on demand. The strong tendency to view each season as a new game and to minimize the continuity from one season to the next is perhaps attributable to the uncertainties which accompany each new crop. On the other hand, it can be said that the uncertainties which accompany each new crop can exert a much greater effect under policies which diminish the continuity from one season to the next.

- Quality

The degree of quality differentiation between different brands of frozen orange concentrate is, for the most part, small. Process
improvements, on the part of some advertised brands, have recently changed this situation to some extent. However, for most of the industry, quality is not an important competitive factor. In the absence of quality competition, price competition becomes even more severe.

- Price Structure

The FOB prices of private and nonadvertised brands of frozen orange concentrate tend to be relatively uniform. Moreover, the advertised brands typically maintain a constant price differential above this basic price level. Hence, it is both common and meaningful to talk in terms of an average FOB price for frozen orange concentrate.

Industry-wide price changes are most often initiated by a recognized price leader, who has traditionally been a member of the private and nonadvertised brand category. When substantial price undercutting occurs in isolated quarters, it usually leads to an over-all decrease. Here again, the price leader is most apt to signal the over-all change.

Posted prices are not, however, the whole story as far as prices are concerned. Additional factors, such as partial protection for the customer against price changes, have an important influence. Through special incentives of various sorts, processors may attempt to obtain a competitive advantage without triggering an over-all price decline. But again, when these concessions become significant, an over-all price decline will most often follow.
Influences on Prices

The most important single influence on FOB prices for frozen orange concentrate is the rate of disappearance of concentrate from processor inventories, relative to the rate needed to move the season's crop, taking into account carry-over inventories. If the disappearance rate is less than desired and no price change has recently been made, most of the industry will expect an eventual decrease in FOB prices. Some may begin to undercut prices in the hope of gaining a competitive advantage, and thereby trigger a decrease. Or the price leader may respond without this pressure. Similarly, when disappearance is above the desired level and processors realize that they may run out of inventories, a price increase is induced.

Another potential influence on prices is the profit position of the processor. If his profits are being squeezed, he may be more reluctant to decrease his price. Nevertheless, here is a situation where prices are generally expected to adjust to a level which will clear the crop. It will be to the processor's advantage to decrease his prices early rather than late. Hence, it should be expected that the processor's profit position will exert only a minor influence. Historically, this seems to have been the case. During some years, processors have reduced concentrate prices to a level which implied substantial losses on fruit purchased on the open market.

Competition, another influence on prices, has already been mentioned. In the absence of other pressures, there is a tendency for processors to reduce prices in order to sell the bulk of their inventories early, and thereby reduce some of the risks and costs of
inventory carrying. When prices are cut below the appropriate level, an increase later in the season typically results.

Large retail chains, who account for the major share of concentrate sales, are in a position to bring about a price decline. By threatening to hold off on purchases, or actually holding off, when a decrease is indicated on the basis of the current disappearance rate, they can force the change to occur.

The magnitude of a typical price change is 15 cents per dozen cans (FOB). This corresponds to a retail price change of roughly 1 cent. Once a price change has occurred, processors will wait for its effects before initiating a further change. Their notions of how a given price change will affect demand are based on historical experience. Needless to say, these notions do not provide accurate predictions. Growth influences, the delay in consumer response, and many other factors limit the industry's ability to clearly understand the eventual response to a particular price adjustment.

- Profits

The profit structure found in frozen orange concentrate processing is somewhat unusual. Many cooperative processing operations are essentially nonprofit. They return all profits to their grower members in the form of payment for fruit. This situation both confuses and distorts the over-all profit structure. Many individuals within the industry feel that the major source of profits in the concentrate industry lies in the area of fruit growing and fruit procurement. Historically, at least, this seems to be true.
As a result of large growing profits in recent years and a desire to insulate profits from the short-term fluctuations in fruit prices, many processors have attempted to hedge their position. They have invested heavily in orange groves. Consequently, growing and concentrating have become partially integrated, and the distinctions between growing profits and processing profits have become less clear. However, notions of a "fair profit" for processors are still prevalent. These serve mainly to suggest a "fair" fruit price on the basis of FOB prices for concentrate.

2.2.3 Retail Sector

- Volume

Over 80 percent of the total frozen orange concentrate volume flows through retail outlets. Here, as in most food items, the retail food chains are responsible for the major share. It is estimated that chains account for 75 percent of the retail total. Most important among the chains are A and P, Safeway, and Kroger. These national concerns may together share as much as one third of the total retail market.

- Brands

Frozen orange concentrate packed under private label is a major item in most food chains. On a national basis, it is probable that over two thirds of the concentrate sold by chains carries a private label. In the independent outlets, advertised brands are relatively stronger. Here, advertised brands compete with unadvertised brands, and only occasionally with a private label.
Private brands are usually supplied under an annual contract between the retail chain and the processor. These contracts specify quantity and a deadline for acceptance of this quantity. No price is specified. It might seem that the chain would place itself in a vulnerable position with respect to price under this arrangement. However, the processor's desire to maintain customers and his desire to have the chain accept the contract quantity as early as possible diminish this possibility. Private label processors are perhaps the most competitive of all.

- Inventories

The inventories maintained by retail outlets are relatively small. On the average they may represent two or three weeks of sales. Most of the supply of concentrate remains in the hands of the processor until it is needed. Retailers usually withdraw their short-term requirements from the processor's regional warehouse, or perhaps from stocks in Florida.

The inventory level which retailers maintain on hand may vary from its normal value of two or three weeks of sales, depending on price expectations. If a retailer expects a price decrease, he may tend to hold off on orders. Or if he expects an increase, he may order more heavily. In either case, the inventory level will be affected. The large chains, in particular, are in a position to anticipate price changes on the basis of disappearance figures. By varying the order rate in response to this sort of information, the retail sector is in a position to force an impending price change.
Prices

Retail prices for frozen orange concentrate are quite predictable on the basis of the FOB price, once any transients have disappeared. In general, retail prices are kept in a close line by competitive pressures. Most retailers simply apply a standard markup. If the FOB price is changed, retail prices will gradually settle into a new level after two or three weeks. Figure 2.9 illustrates the relationship which is believed to exist between retail prices and FOB prices. It is also interesting to note here the "fair share" relationships which were discussed in Section 2.2.1.

Promotions

Promotions, involving special price and advertising inducements, are frequently used in marketing frozen orange concentrate. These promotions generally benefit both retailer and consumer and are used by processors as an additional competitive tool. Just as posted prices did not tell the whole story in the case of FOB prices, the posted retail price may be only part of the retail picture. Coupons, trading stamps, etc., must also be considered in assessing the retail "price" of frozen orange concentrate.

2.2.4 Consumer Sector

Purchasing Habits

Approximately 30 percent of the families in the United States purchase frozen orange concentrate on a regular basis. On the average, these families consume slightly more than 6 six-ounce cans
GROWER'S FAIR SHARE OF CONSUMER'S FROZEN

ORANGE CONCENTRATE DOLLAR

Number of Pounds of Solids per 90 lb. Box ............... 6

<table>
<thead>
<tr>
<th>FOB Price Quotation (dozen 6 oz. cans)</th>
<th>Average Retail Price (6 oz. can)</th>
<th>Average Pounds of Solids Price (del'd) lb.</th>
<th>Reflected Avg. On-Tree Value at Various Yields and Finished Product Prices (in terms of dollars per box)</th>
</tr>
</thead>
<tbody>
<tr>
<td>$1.25</td>
<td>15.5¢</td>
<td>29.3¢</td>
<td>$1.31</td>
</tr>
<tr>
<td>1.30</td>
<td>16.1</td>
<td>31.5</td>
<td>1.44</td>
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<td>1.65</td>
<td>19.3</td>
<td>45.7</td>
<td>2.29</td>
</tr>
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</table>

RELATIONSHIP BETWEEN RETAIL PRICE AND FOB PRICE


Figure 2.9

RELATIONSHIP BETWEEN RETAIL PRICE AND FOB PRICE
per month. This volume represents over one third of total consumer purchases of juices (concentrated, chilled, and canned single strength) and canned fruit drinks. Frozen orange concentrate is used primarily as a breakfast beverage.

- Price-Volume Relationship

Consumer purchases of frozen orange concentrate are somewhat inelastic with price. That is, a decrease in price tends to decrease total sales revenue. On the other hand, the demand for this item is more elastic than the demand for many food commodities. Figure 2.10 illustrates the dynamic nature of the relationship between price and volume. It cannot be said that retail volume is related in some simple way to the current price level. Seasonal factors as well as variability in display space are almost certainly involved. On the other hand, there does appear to be an adjustment to a change in retail price which occurs over a period of one or two months.

- Advertising Effect

A major portion of the consumer advertising of frozen orange concentrate is performed by the advertised brands. The primary intent of this component of industry advertising is to affect the market share for a particular brand. There is considerable evidence in support of its success in this regard.

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AVERAGE RETAIL VOLUME AND RETAIL PRICE

MONTHLY AVERAGE VOLUME (000 gal.)

1100

1000

900

800

700

1958

1959

RETAIL PRICE

RETAIL PRICE (6-oz. can)

$0.25

$0.20

$0.15

Source: 1960, What's Next?; Florida Citrus Mutual, presented at the Advisory Committee and Board of Directors meetings, Jan. 20, 1960. (based on data collected by Market Research Corp.)
The remaining component of industry advertising is a cooperative venture. It is supported by a tax assessment of 3 cents per box of oranges. Here, the intent is to increase the over-all demand for frozen orange concentrate. Undoubtedly, both components of industry advertising do tend to increase the over-all demand. The unanswered question is how much. Some contend that the effect is negligible, while others strongly disagree. There is very little basis for anything more than a guess.

Some studies have been performed which pretend to determine the effectiveness of commodity advertising, including the advertising of oranges. A study, by Meissner⁹, of the effect of advertising on the demand for lettuce produced few conclusive results. Another study, by Nerlove and Waugh¹⁰, of the effect of advertising on the returns to orange growers fails to consider that advertising is highly correlated with volume through an advertising tax assessment of 3 cents per box. This writer is unaware of any investigation performed to date which sheds much light on the question of commodity advertising effectiveness. However, controlled experiments to determine such relationships are certainly possible.

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2.3.1 Income Growth

Consumer demand for frozen orange concentrate is continually increasing with the growth in national income. It is difficult, however, to isolate this trend from the growth trend in the industry. Together these effects seem to have produced an average yearly growth of about four percent per year between 1954 and 1959. The industry growth component has probably decreased since this time. A rough estimate would place the influence of growth in national income between two and three percent per year.

2.3 Industry Problems

The problems which continue to confront the Florida frozen orange concentrate industry relate to the dynamic behavior of key variables such as prices, sales, and profits. They relate to the industry's over-all performance characteristics. In a sense, they are all part of the same problem ... a general lack of stability in both the short term and the long term.

In describing these problems it will be useful to differentiate between the short term and the long term. However, it should be remembered that short-term behavior and long-term behavior are not entirely independent. It will be necessary to clarify the nature of the relationship between them.

2.3.1 Short-Term Behavior

Within a given crop year, and from one year to the next, concentrate prices tend to fluctuate widely in response to small variations in crop size estimates. Processors attempt to adjust the disappear-
ance rate to a level which will clear the estimated crop by varying the FOB price. However, the disappearance rate does not quickly adjust to a new level. Instead, there are deceiving transients introduced by the distribution system, followed by a gradual adjustment to the new prices on the part of consumers. These transient effects frustrate attempts to control the disappearance rate and lead to unnecessary fluctuations in FOB prices. Adding to these difficulties is the competitive tendency to reduce prices below the clearing level, only to create the need for an increase later in the season.

Unstable industry behavior of this sort is undesirable from the point of view of grower and processor alike. In some years growing profits suffer, while in other years processing operations turn in a loss. Equally important is the net loss which is incurred by both when retail chains realize profits from inventory speculation. A greater degree of stability would be generally preferred.

As an illustration of the lack of short-term stability it will be instructive to trace through the events of the present crop season, 1961-1962. To capture the tone of industry thinking, comments will be drawn from the Triangle, a weekly industry report, published by Florida Citrus Mutual.

On October 13, 1961, following the first U.S.D.A. crop estimate of 99 million boxes, Robert W. Rutledge of the Mutual stated that "a happy combination of high quality Florida citrus, the national citrus supply in favorable balance with demand, an upswinging U.S. economy and increasing consumer purchases" gives the Florida citrus grower
"good reason for optimism as he goes into the 1961-1962 season."
FOB prices per dozen cans of concentrate were $1.75 at that time.

On October 20, Triangle estimated the season's average FOB price for concentrate (non-advertised brands) at $1.47, based on a crop estimate of 99 million boxes. The impression presented at this time was that the 99 million box estimate was perhaps high, and that the average FOB price might well be higher.

Later, on December 1, Rutledge, in a letter to Mutual members, presented a plea for price stability. "We must sincerely call on all segments of the industry at this time...from growers to retailers ...to recognize the wisdom of sensible product pricing and to recognize, understand, and put into motion the price and utilization facts presented by Florida Citrus Mutual, and to understand and accept their accuracy as Mutual acts to guide the rudder...straight line forward...in fair and consistent price stabilization."

On December 29, Mutual predicted that "1962 will be a year of stable pricing for Florida citrus with irrational price speculation at an all time low." In addition, they predicted that "actual pick-out of Florida orange and grapefruit crops this season will be somewhat less than now estimated by the government."

Following a slight freeze on December 29-30, the U.S.D.A performed a special citrus survey and on January 25 indicated a crop reduction of 4.5 - 8 million boxes. On January 25, Mutual's best estimate of the average FOB price for the remainder of the season was $1.63. At that time the actual FOB price for concentrate was $1.50, while prices paid to orange growers were 40¢-42¢ per pound of solids
(delivered in). By February 9 the price paid to growers rose to 45¢ - 47.5¢ per pound of solids (delivered in).

Then, on February 16, following the U.S.D.A. estimate of 96 million boxes, Mutual indicated an average FOB price of $1.55 for the remainder of the season. Accompanying this estimate was a statement of optimism, "the marketing outlook for the remainder of the Florida orange crop is excellent." FOB prices were still at $1.50 and prices paid to growers were back down to 40¢ - 42.5¢ per pound of solids.

On March 14, following a U.S.D.A. estimate of 100 million boxes, Triangle predicted an average FOB price for the remainder of the season of $1.45 and a grower price of 37.5¢ per pound of solids. Just prior to this time the actual FOB price was reduced to $1.35, and, according to Mutual, this reduction was made because of the "competitive situation" wherein several concentrators had been underquoting the stabilized $1.50 price.

Later, on April 19, with a crop estimate of 101 million boxes, Triangle predicted an average FOB price of $1.39 for the remainder of the season, with prices paid to growers at 35¢ per pound of solids. Prices actually being paid to growers were 30¢ per pound of solids.

On April 30, Rutledge, in an open letter, reflected the state of panic which was developing in the industry. "Today some of our so-called industry leaders are trembling and quaking not only with their own fear, but in some mysterious way are succeeding in spreading their fear...this must stop...this is not right...this is not our Florida Citrus Industry."
By June 13 the crop estimate was up to 109 million boxes, and prices paid to growers were down to about 20¢ per pound of solids. This was less than half the price paid just four months earlier!

The events of the 1961-62 season have spurred the industry to search for a means to profitably market crops and stabilize industry behavior. In an attempt to sell their large inventories of concentrate, processors are working toward a cooperative promotional program involving an expenditure of over 3 million dollars during the remainder of 1962. Other proposals under consideration involve: an increase in the advertising tax, an emergency reserve advertising fund, activation of the Stabilization Act, introduction of a higher density concentrate, and the establishment of a futures market.

2.3.2 Long-Term Behavior

In the long run the problems which confront the frozen orange concentrate industry relate to the stability of orange supply relative to demand. Periods of short supply and high prices are followed by periods of excess supply and low prices. Figure 2.5 illustrated this tendency toward long-term periodicity.

Underlying these long-term fluctuations in supply is the influence of weather. Freezes, in particular, have been dramatic in their effects on the supply situation. A severe freeze may distort the supply for three years or more. But weather influences alone are not the cause of long-term supply instability. Rather they represent a driving force with certain properties to which the industry is par-
particularly sensitive. They lead to high profits during certain periods which lead to a high rate of planting of new orange groves. Heavy planting, in turn, leads to oversupply and low profits in subsequent periods, perhaps five or ten years later. And low profits lead to low planting, which produces a short supply and high profits still farther into the future. As long as those planting orange groves do not properly take into account the number of trees already planted but still not fully productive and the number of trees which are lost due to various external influences, this type of behavior will persist.

During the years preceding 1957, when a severe freeze occurred, the rate of planting of new orange groves was quite high. This increase in planting activity was perhaps as much due to expectations about continued growth in the demand for frozen orange concentrate as it was due to the profits enjoyed by growers during this period. In any case, by 1957 the supply of oranges was reaching enormous proportions. The initial crop estimate for the 1957-58 season was 102 million boxes, exceeded only by the 1961-62 season.

If it had not been for the December 1957 freeze, concentrate prices would have dropped to an all time low. Instead, they climbed to an all time high. This served to restore optimism. Prices remained high through the 1960-61 season and many individuals within the industry fully expected these price levels to continue indefinitely. Many new orange groves were planted.

By 1962 the industry was beginning to have its doubts about continued prosperity. And by the end of the 1962 crop season the industry
was sobered by a major condition of over-supply. Looking at the years leading up to this situation, W. Max Acree, president of Florida Citrus Mutual, stated that, "comparable to stock market psychology, some people have paid as much as $5000 per acre for citrus groves, evidently based on the belief that oranges would always bring $3.00 or more per box on the tree."\(^\text{11}\) During the latter part of the 1962 crop season, orange growers were paid less than $1.00 per box on the tree.

The problem of over-supply is with the industry to stay, until the next major freeze or until demand and reduced planting reverse the picture and start a new cycle on its way. Benjamin H. Oehlert, Minute Maid president, views the problem as "basic" and "far reaching."\(^\text{12}\) In the meantime, the industry continues to search for a way to sell this year's crop and the even larger crops expected in the years to come.


\(^\text{12}\) From statement made before gathering of industry leaders to discuss a futures market for concentrates, reported by \textit{Quick Frozen Foods}, July 1962, p. 141.
Chapter 3

OBJECTIVES OF INDUSTRIAL DYNAMICS STUDY

Preceding chapters have described the structural and behavioral characteristics of the Florida frozen orange concentrate industry in general terms. Emerging from this description is the problem of industry stability in both the short term and the long term. This instability, which has characterized the industry throughout its history, has not been the result of peculiar combinations of events. Rather, it is a basic performance characteristic of the broad system of relationships extending from the planting of orange groves to the consumption of frozen orange concentrate.

The ultimate objective of this Industrial Dynamics study is the design of policies to improve the industry's over all performance, and more specifically, to improve both short term and long term stability. This chapter will serve to define the path to be followed in pursuing this ultimate goal.

3.1 Description of System Structure

The problems confronting the concentrate industry relate to the performance characteristics of a dynamic system. Underlying these performance characteristics is a particular system structure which creates the behavior which is observed. This system structure can perhaps be best described as a complex information feedback system, where decisions and actions influence the environment, which in turn influences decisions and actions.
In order to design policies which will improve the behavior of this system it will be necessary to identify and to understand the system structure which underlies the behavior characteristics of interest. This does not imply that it is necessary to consider each and every relationship which might relate to the industry. Rather, it is necessary to isolate the limited set of relationships which underlie the problems at hand. Hence, it will be necessary to distill from the vast body of descriptive information about the orange concentrate industry the system structure which is relevant to industry stability.

It will be particularly useful to arrive at a precise description of the system structure which pertains to the problems of stability. This can be best accomplished if the description is phrased in terms of a system of mathematical relationships. The very process of developing such a description will be rewarding. It will help to clarify many hazy notions. Once the description, or mathematical model, is developed, it can be used to explore industry behavior, and eventually to experiment with various policies for the improvement of behavior. Simulation will aid in both these steps.

The first objective of this study will therefore be to develop a dynamic model of the frozen orange concentrate industry, which captures the aspects of system structure underlying the problems of instability. This model will in itself provide insight. But, more important, it will later aid in the exploration of behavior and the design of new policies.
3.2 Analysis of System Behavior

Once a dynamic model has been developed and verified, analysis of the industry's dynamic behavior will become possible. By simulating this behavior over many years and under different conditions, a better understanding of the factors producing instability can be developed.

The advantages of performing this sort of analysis are twofold. First, if individuals within the industry can be provided with additional insight into the fundamental characteristics of their industry, they may well be influenced to act in such a way that industry behavior is improved. Second and perhaps more important, this additional insight will serve as a guide in the development of policies to be tested with the aid of the model. The second objective of this study will therefore be to analyze the dynamic behavior of the concentrate industry.

3.3 Design of Policies

Last and most important among the objectives of this study of the Florida frozen orange concentrate industry is the design of policies to improve both short term and long term stability. This will involve experimentation with various alternatives which seem promising from an intuitive standpoint and which make sense on the basis of the analysis of system behavior.

In order to restrict the scope of the present study to some extent, attention will be focused on cooperative marketing policies. Cooperative industry advertising of frozen orange concentrate will
be one area of exploration. In recent years the industry has cooperatively supported such a program to the extent of 3c per box of oranges, or about 3 million dollars per year. It is unlikely that this advertising has helped to stabilize prices and profits. The amount spent in years of over-supply has not been significantly different from the expenditure in years of under-supply. Moreover, remembering that the effect of such advertising on consumer demand is delayed by perhaps one or two years, it may well be that any influence has been a destabilizing one.

As for the effect of a more or less steady level of advertising on long-run profits, this writer is inclined to feel that the influence is negligible. If profits are increased through advertising, they will probably be decreased again by the resulting increases in the rate of planting.

Questions of this sort relating to cooperative advertising will be explored in the search for an effective policy. Investigation of such questions is particularly timely. The industry is currently considering proposals to boost the advertising tax assessment and to establish an emergency reserve advertising fund.

As mentioned earlier, little is known about consumer responsiveness to advertising for frozen orange concentrate. This situation will prevent the development of firm conclusions. However, it will be most useful to determine which kinds of advertising policies are likely to succeed. And it will also be useful to determine under what conditions these policies are likely to succeed. If these goals
can be accomplished they will narrow the field of possibilities and provide a basis for further research into the effectiveness of orange concentrate advertising.

Another area of exploration will be the establishment of buffer inventories of frozen orange concentrate. Under present policies inventories are maintained at minimum levels. Moderate buffer inventories might significantly improve stability within a given year and from one year to the next. Here there are many questions to be explored. Improper policies might well create fluctuations which are more prolonged and more severe than those presently experienced. Again, these investigations are timely. The industry is currently considering proposals for the establishment of buffer concentrate inventories.

In developing a dynamic model of the concentrate industry, it will be essential to keep in mind the purposes for which the model is intended. These purposes have been outlined above. They relate to the stabilization of industry behavior through cooperative marketing programs. The model which is developed will be adequate only if it serves to answer the questions which this group of policy alternatives might pose.
Chapter 4

MODEL DESCRIPTION

This chapter describes a dynamic model of the over-all frozen orange concentrate industry. The purpose of this model is to clarify notions of the relationships which lie within the industry, to permit analysis of industry behavior, and to facilitate investigation of cooperative marketing policies.

The system of relationships represented extends from the planting of orange groves to the consumption of frozen orange concentrate. A single major flow channel links these two extremities of the system. No distinction is drawn between advertised-brand processors and private or nonadvertised brand processors. Also, no distinction is drawn between captive fruit, fruit purchased on an advance contract basis, and fruit purchased on the spot market. Short-term fruit price behavior is taken to have little effect on either processor prices or on new tree planting. A block diagram of the over-all system is presented in Figure 4.1. This model is intended to aid in the exploration of policies relating to the advertising of frozen orange concentrate and the maintenance of buffer concentrate inventories. Hence, it must represent the effects of advertising on consumer behavior, the effects of consumer behavior on processor prices, the effects of buffer inventories on processor prices, the effects of processor prices on returns to orange growers, and the effects of these returns on new tree planting.

The model description will tend to be brief. Since the model represents a distillation of the verbal description presented in

-48-
Figure 4.1

BLOCK DIAGRAM: F.O.C. INDUSTRY
Chapter 2, the reader should refer to the discussion presented there. An attempt will be made to draw attention to the more crucial aspects of the translation process.

4.1 Consumer Demand

The major influences on consumer demand for frozen orange concentrate are retail price, advertising, and growth in population and national income. Equation 1 establishes the relationship between these various influences and consumer demand. If advertising and growth in national income together have a net influence of unity, then consumer demand is solely a function of price and is determined by the first term in this equation. However, if advertising and growth in national income have a nonunity influence, consumer demand will be modified accordingly. The levels of advertising or growth in national income which produce influence values of unity will be regarded as reference points. They will be chosen on the basis of conditions existing in the recent past.¹

\[
CD_K = (CDVP_K)(AI_K)(IGI_K)
\]

CD = Consumer Demand (cases/week)
CDVP = Consumer Demand Versus Price (cases/week)
AI = Advertising Influence (dimensionless)
IGI = Income Growth Influence (dimensionless)

Equation 2 represents the relationship between consumer demand and retail price when advertising and national income growth together

¹An Industrial Dynamics flow diagram of the model developed in this chapter appears in Figure 4.17.
have a net influence of unity. Since consumers respond only gradually to a change in price, this relationship chooses the average retail price over recent weeks as the relevant influence variable.

Figure 4.2 illustrates the relationship between consumer demand and retail price. This relationship was derived from historical data applying a growth adjustment factor of 4 percent per year (see Figure 4.3).

\[
\text{CDVP.K = TABHL(CDVPT,ARP.K,.10,.30,.05)} \\
\text{CDVPT* = 1.07E6/.82E6/.56E6/.50E6} \\
\text{CDVP -- Consumer Demand Versus Price (cases/week)} \\
\text{CDVPT -- CDVP Table} \\
\text{ARP -- Average Retail Price (dollars/can)}
\]

Equation 3 defines the average retail price as an exponential average retail price over the past TARP weeks. As discussed earlier in Section 2.2.4, most of the adjustment to a new price level seems to occur in a month or so.\(^2\) Hence, TARP will be chosen as 5 weeks.

\[
\text{ARP.K = APR.J + (DT)(1/TARP)(RP.J - ARP.J)} \\
\text{TARP = 5} \\
\text{ARP -- Average Retail Price (dollars/can)} \\
\text{TARP -- Time for Averaging Retail Price (weeks)} \\
\text{RP -- Retail Price (dollars/can)}
\]

In equation 4, the influence of advertising on consumer demand is represented. Since a sudden increase in the rate of advertising

\(^2\) In addition to this short-term adjustment, there may well be a longer-term transient involving changes in traditional buying habits. This long-term characteristics has not been represented here.
Figure 4.2

CONSUMER DEMAND VERSUS PRICE
<table>
<thead>
<tr>
<th>SEASON</th>
<th>TOTAL MOVEMENT</th>
<th>GROWTH ADJ.</th>
<th>ADJ. RATE</th>
<th>AVG. RETAIL PRICE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1956-57</td>
<td>74 mil.</td>
<td>.64 mil.</td>
<td>1/24</td>
<td>15.0¢</td>
</tr>
<tr>
<td>1957-58</td>
<td>62</td>
<td>33 mil.</td>
<td>1/28</td>
<td>22.4</td>
</tr>
<tr>
<td>1958-59</td>
<td>70</td>
<td>70</td>
<td>1/26</td>
<td>21.2</td>
</tr>
<tr>
<td>1959-60</td>
<td>85</td>
<td>85</td>
<td>1/23</td>
<td>18.3</td>
</tr>
<tr>
<td>1960-61</td>
<td>30</td>
<td>30</td>
<td>1/20</td>
<td>20.4</td>
</tr>
</tbody>
</table>

1 625 gallons per case


Figure 4.3
TOTAL MOVEMENT AND RETAIL PRICE
expenditure will cause a gradual increase in demand over a period of several years, the relevant influence variable has been chosen as the average level of advertising during the previous one or two years.

Figure 4.4 illustrates the advertising influence relationship. This particular advertising effectiveness curve will be used in initial model runs. However, a range of such relationships will eventually need to be explored.

\[ AI_*K = TABHL(AIT, AA_*K, 0, .32E6, .04E6) \]  

\[ AIT* = 1/1.031/1.047/1.056/1.061/1.062/1.062/1.062 \]  

Equation 5 represents average advertising as an exponential average of advertising over the past TAA weeks. TAA has initially been chosen as two years, or 104 weeks.

\[ AA_*K = AA_*J + (DT)(1/TAA)(A_*J - AA_*J) \]  

\[ TAA = 104 \]  

The influence of growth in population and national income on consumer demand is represented in equation 6. Since these factors are exogenous to the system under consideration, they are represented as a function of time. As discussed earlier in Section 2.2.4, this rate of growth may be roughly 2 percent per year in the years to come. Figure 4.5 illustrates the relationship defined by equation 6.
Figure 4.4

ADVERTISING INFLUENCE

AVERAGE ADVERTISING
(million dollars per week)
Figure 4.5
INCOME GROWTH INFLUENCE
4.2 Retail Sales and Retail Inventory

Retail sales of frozen orange concentrate depend both on consumer demand and on the availability of concentrate in retail outlets. Low availability will leave a portion of the consumer demand unsatisfied. Equation 7 describes the influence of demand and availability on retail sales.

\[ RS_{KL} = (CD_{K})(RA_{K}) \]  

**RS**—Retail Sales (cases/week)  
**CD**—Consumer Demand (cases/week)  
**RA**—Retail Availability (dimensionless)

Equation 8 indicates the effect of aggregate retail inventories on retail availability or ability to satisfy consumer demand. The number of weeks of retail inventory has been chosen as the relevant measure for determining availability. Figure 4.6 illustrates the availability relationship. Complete satisfaction of consumer demand is approached only in the limit of large retail inventories.

\[ RA_{K} = \text{TABHL}(RAT, WRI_{K}, 0, 5, 1) \]  
\[ RAT^{*} = 0.85/0.98/1.0/1.0/1.0 \]

**RA**—Retail Availability (dimensionless)  
**RAT**—Retail Availability Table  
**WRI**—Weeks of Retail Inventory (weeks)

Equation 9 defines the number of weeks of retail inventory in
Figure 4.6

RETAIL AVAILABILITY
terms of the current inventory level relative to average consumer demand.

\[ WRI.K = RI.K / ACD.K \]

- **WRI**—Weeks of Retail Inventory (weeks)
- **RI**—Retail Inventory (cases)
- **ACD**—Average Consumer Demand (cases/week)

In equation 10, the average consumer demand is taken as an exponential average of consumer demand over the prior TACD weeks. This averaging interval has been chosen as 10 weeks, suggesting that the average level of activity over a period of two or three months is the relevant factor in determining how much inventory is needed.

\[ ACD.K = ACD.J + (DT)(1/TACD)(CD.J - ACD.J) \]

- **TACD** = 10

- **ACD**—Average Consumer Demand (cases/week)
- **TACD**—Time for Averaging Consumer Demand (weeks)
- **CD**—Consumer Demand (cases/week)

Equation 11 defines retail inventory as a level, being increased by the flow of concentrate from processor inventories, and being decreased by the flow of concentrate to consumers.

\[ RI.K = RI.J + (DT)(PD.JK - RS.JK) \]

- **RI**—Retail Inventory (cases)
- **PD**—Processor Disappearance (cases/week)
- **RS**—Retail Sales (cases/week)

### 4.3 Retail Price

The retail price of frozen orange concentrate typically adjusts to a level suggested by the processor price. When the processor price is changed, the retail price is usually corrected within two
or three weeks. The current retail price can therefore be represented as an exponential average of the retail price suggested during recent weeks. The averaging period can be viewed as the time to correct the retail price. Equation 12 describes this relationship.

\[ \text{RP}_K = \text{RP}_J + (\text{DT})(1/\text{TCRP})(\text{RPS}_J - \text{RP}_J) \]  

12a

TCRP = 2  

12b

\text{RP} -- \text{Retail Price (dollars/can)} \\
\text{TCRP} -- \text{Time to Correct Retail Price (weeks)} \\
\text{RPS} -- \text{Retail Price Suggested (dollars/can)}

In equation 13, the traditional relationship between retail price and processor price is described. Figure 4.7 illustrates this relationship.

\[ \text{RPS}_K = \text{TABHL}(\text{RPST}, \text{PP}_K, .00, 2.80, .40) \]  

13a

\[ \text{RPST} = .115, .153, .188, .225, .260, .290 \]  

13b

\text{RPS} -- \text{Retail Price Suggested (dollars/can)} \\
\text{RPST} -- \text{RPS Table} \\
\text{PP} -- \text{Processor Price (dollars/dozen cans)}

4.4 Retail Demand

Retail demand has been defined as the demand for concentrate placed upon processors by retail outlets. This retail demand is influenced by consumer demand, retail inventories, and information available to retailers about processor disappearance relative to the clearing rate. Equation 14 represents the relationship between these various influences and retail demand.

\[ \text{RD}_K = (\text{ACD}_K)(\text{RII}_K)(\text{DIR}_K) \]  

14

\text{RD} -- \text{Retail Demand (cases/week)} \\
\text{ACD} -- \text{Average Consumer Demand (cases/week)}
Figure 4.7

RETAIL PRICE SUGGESTED

RII--Retail Inventory Influence (dimensionless)
DIR--Disappearance Influence on Retailers (dimensionless)

Average consumer demand has been adequately defined by equation 10. The influence of retail inventories on retail demand is described by equation 15. When retail inventories are at their normal level, two weeks of average consumer demand, there is no inventory influence on retail demand. If retail inventories are above or below this normal level, there will be a strong tendency to, respectively, decrease or increase retail demand. Figure 4.8 illustrates this relationship. From the curve it can be seen that retail demand will be reduced to 80 percent of normal when retail inventories rise to a three-week supply instead of the normal two weeks. This decrease in demand will tend to correct retail inventory levels at the rate of 20 percent per week.

\[ \text{RII.K} = \text{TABHL(RIIT, WRI.K, 0, 5, .5)} \]

\[ \text{RIIT*} = 2.5/1.4/1.0/0.8/0.5/0.3 \]

RII--Retail Inventory Influence (dimensionless)
RIIT--Retail Inventory Influence Table
WRI--Weeks of Retail Inventory (weeks)

Information regarding expected aggregate processor disappearance relative to the disappearance required to move the current crop is available to major retail outlets. These outlets use this information as an indication of impending price changes. If a price decrease is indicated, there will be a tendency to order less; or if a price increase is indicated, there will be a tendency to order more. Such speculation tends to force the impending price change. The disappear-
Figure 4.8

RETAIL INVENTORY INFLUENCE
ance influence relationship is described in equation 16 and Figure 4.9.

\[
\text{DIR} \cdot K = \text{TABHL(\text{DIRT}, \text{EDRD}.\text{K}, 6, 1.4, 2)}
\]

16a

\[
\text{DIRT}^* = 0.97/1.0/1.03/1.1
\]

16b

**DIR**—Disappearance Influence on Retailers (dimensionless)

**DIRT**—Disappearance Influence on Retailers Table

**EDRD**—Expected Disappearance Relative to Desired (dimensionless)

### 4.5 Processor Disappearance and Processed Inventory

The disappearance of concentrate from processor inventories depends on both the retail demand and the availability of processed concentrate. If aggregate processor inventories of concentrate are low, a portion of the retail demand will remain unsatisfied. Equation 17 describes the influence of retail demand and processor availability on processor disappearance.

\[
\text{PD} \cdot Kl = (\text{RD}.\text{K})(\text{PA}.\text{K})
\]

17

**PD**—Processor Disappearance (cases/week)

**RD**—Retail Demand (cases/week)

**PA**—Processor Availability (dimensionless)

Equation 18 represents the influence of the processed inventory level on the ability to satisfy retail demand. The number of weeks of processed inventory has been chosen as the relevant influence variable. Only in the limit of large processed inventories will the retail demand be completely satisfied. The nature of the availability relationship is indicated in Figure 4.10.

\[
\text{PA} \cdot K = \text{TABHL(\text{FAT}, \text{WPI}.\text{K}, 0, 30, 5)}
\]

18a

\[
\text{FAT}^* = 0.84/0.97/1.0/1.0/1.0/1.0
\]

18b
Figure 4.9

DISAPPEARANCE INFLUENCE ON RETAILERS
Figure 4.10
PROCESSOR AVAILABILITY
PA--Processor Availability (dimensionless)
PAT--Processor Availability Table
WPI--Weeks of Processed Inventory (weeks)

Equation 19 defines the number of weeks of processed inventory in terms of the average retail demand.

\[ WPI. K = \frac{PI. K}{ARD. K} \]  

WPI--Weeks of Processed Inventory (weeks)
PI--Processed Inventory (cases)
ARD--Average Retail Demand (cases/week)

Equation 20 represents processed inventory as a level, being increased by the flow of newly processed concentrate, and being decreased by the disappearance of concentrate from processor inventories.

\[ PI. K = PI. J + (DT)(PR. JK - PD. JK) \]  

PI--Processed Inventory (cases)
PR--Processing Rate (cases/week)
PD--Processor Disappearance (cases/week)

Average retail demand, as it enters into the relationship for the number of weeks of processed inventory, has been represented as an exponential average of retail demand over the past TARD weeks. The averaging interval has been chosen as 10 weeks.

\[ ARD. K = ARD. J + (DT)(1/TARD)(RD. J - ARD. J) \]  

\[ TARD = 10 \]

ARD--Average Retail Demand (cases/week)
TARD--Time for Averaging Retail Demand (weeks)
RD--Retail Demand (cases/week)

The rate at which concentrate is processed corresponds to the rate at which fruit is used. The rate of fruit usage is dependent on the level of ripe fruit. On the average, fruit is likely used
about 3 weeks after it becomes ripe. However, a conversion factor, the
number of cases of concentrate per box of oranges, must be con-
sidered. The normal yield from a box of oranges is about .625 cases
of concentrate. Equation 22 describes this relationship.

PR.KL=(FU.JK)(CPB)
FU.KL=RFR.K/DPRF
CPB=.625
DPRF=3

PR--Processing Rate (cases/week)
FU--Fruit Usage (boxes/week)
CPB--Cases Per Box (cases/box)
RFR--Ripe Fruit Remaining (boxes)
DPRF--Delay in Processing Ripe Fruit (weeks)

4.6 Processor Price

The FOB price of frozen orange concentrate gradually adjusts
toward levels suggested by influences within the industry. Of the
many influences now and again mentioned, it appears that processor
disappearance relative to the clearing rate, competition, and pro-
cessor inventories are the major factors. In equation 23 the pro-
cessor price is represented as an exponential average of the price
suggested by these influences. The averaging period may be viewed
as the length of time required for processors to correct their prices
to the suggested level. It is felt that this delay is roughly four
weeks.

PP.K=PP.J+(DT)(1/TCPP)(PPS.J-PP.J)
TCPP=4

PP--Processor Price (dollars/dozen cans)
TCPP--Time to Correct Processor Price (weeks)
PPS--Processor Price Suggested (dollars/dozen cans)
The suggested processor price may be above or below the current price level, depending on the net effect of the various price influences. Equation 24 defines the price influence relationship.

\[ PPS.K=(PP.K)(DIP.K)(CI)(PII.K) \]

*PPS*—Processor Price Suggested (dollars/dozen cans)
*PP*—Processor Price (dollars/dozen cans)
*DIP*—Disappearance Influence on Processors (dimensionless)
*CI*—Competitive Influence (dimensionless)
*PII*—Processed Inventory Influence (dimensionless)

Equation 25 and Figure 4.11 describe the influence of processor disappearance on processor price. If the expected disappearance is greater than the disappearance required to move the remainder of the crop, processors will tend to increase their prices. The processor failing to behave in this manner might find himself without adequate inventory during a period of higher prices later in the season. Conversely, processors will tend to decrease prices when expected disappearance is below the desired level, or run the risk of large inventories at the end of the season. The relationship chosen reflects the tendency of processors to think in terms of possibly several price changes rather than one large change. If expected disappearance is 60 percent of the desired rate, the influence on price will be less than twice as great as when expected disappearance is 80 percent of the desired rate.

\[ DIP.K=\text{TABHL}(\text{DIPT}, \text{EDRD}.K, .6, 1.4, .2) \]

\[ \text{DIPT}*=.50/.70/1.0/1.30/1.50 \]

*DIP*—Disappearance Influence on Processors (dimensionless)
*DIPT*—Disappearance Influence on Processors Table
*EDRD*—Expected Disappearance Relative to Desired (dimensionless)
Figure 4.11
DISAPPEARANCE INFLUENCE ON PROCESSORS
When the FOB price of orange concentrate is changed, processors do not expect disappearance to respond immediately. Through experience they have learned that the response to a change in prices occurs over a period of a month or two. Hence, when viewing the current disappearance rate to see if a price change is suggested, they are influenced by price changes which have occurred recently. For example, if the price has recently increased, they will expect the disappearance rate in the weeks to come to be somewhat less than the current average. Equation 26 describes this influence relationship.

\[ \text{EDRD}_K = (\text{PDRD}_K)(\text{PCI}_K) \]

EDRD—Expected Disappearance Relative to Desired (dimensionless)
PDRD—Processor Disappearance Relative to Desired (dimensionless)
PCI—Price Change Influence (dimensionless)

The price change influence discussed above is related to the price change which has occurred during recent months. Equation 27 and Figure 4.12 describe this relationship.

\[ \text{PCI}_K = \text{TABHL}(\text{PCIT}, \text{PC}, K, = .50, .50, 10) \]

\[ \text{PCIT} = 1.45/1.27/1.17/1.10/1.04/1.0/0.96/0.90/0.83/0.73/0.55 \]

PCI—Price Change Influence (dimensionless)
PCIT—PCI Table
PC—Price Change (dollars/dozen cans)

Figure 4.12 suggests that the influence of a recent price change increases more than proportionately with the magnitude of the change. This characteristic might alternately be described as an increasing tendency to "wait and see" or an increasing degree of optimism toward the eventual outcome.
Figure 4.12

PRICE CHANGE INFLUENCE
Equation 28 defines price change, as discussed above, in terms of the difference between the current price and the average price over the past month or two.

\[
PC \cdot K = PP \cdot K - APP \cdot K
\]

PC—Price Change (dollars/dozen cans)
PP—Processor Price (dollars/dozen cans)
APP—Average Processor Price (dollars/dozen cans)

Average processor price, as it enters into the comparison with current price above, is defined by equation 29. It is represented as an exponential average of prices over the past TAPP weeks. The averaging interval has been chosen as eight weeks, corresponding roughly to the length of time required for disappearance to adjust following a price change.

\[
APP \cdot K = APP \cdot J + (DT) \left(1/TAPP \right) \left(PP \cdot J - APP \cdot J \right)
\]

TAPP=8

APP—Average Processor Price (dollars/dozen cans)
TAPP—Time for Averaging Processor Price (weeks)
PP—Processor Price (dollars/dozen cans)

Equation 30 defines processor disappearance relative to desired in terms of the recent average rate of disappearance.

\[
PDRD \cdot K = APD \cdot K / PDD \cdot K
\]

PDRD—Processor Disappearance Relative to Desired (dimensionless)
APD—Average Processor Disappearance (cases/week)
PDD—Processor Disappearance Desired (cases/week)

The average disappearance figures usually considered by the industry are in the form of an eight-week moving average. Since there is a tendency to place extra weight on more recent figures, average
disappearance will here be defined as an exponential average of the
disappearance rate over the past eight weeks.

\[ APD.J = APD.J + (DT)(1/TAPD)(PD.JK - APD.J) \] 31a
\[ TAPD = 8 \] 31b

**APD**—Average Processor Disappearance (cases/week)  
**TAPD**—Time for Averaging Processor Disappearance (weeks)  
**PD**—Processor Disappearance (cases/week)

Within the industry, there is fairly widespread agreement on the
processor disappearance desired. It is generally felt that the sup-
ply remaining should be cleared within the season, with the exception
of a small carry-over inventory. Equation 32 defines the processor
disappearance desired. Here, the period over which the estimated
remaining supply is to be moved is taken as the number of weeks re-
mainin in the season plus the number of weeks of carry-over desired.

\[ PDD.K = SRE.K / (WPY - WP.K + WCO) \] 32a
\[ WPY = 52 \] 32b

**PDD**—Processor Disappearance Desired (cases/week)  
**SRE**—Supply Remaining Estimate (cases)  
**WPY**—Weeks Per Year (week)  
**WP**—Weeks Passed (weeks)  
**WCO**—Weeks Carry-Over (weeks)

Equation 33 defines the number of weeks which have passed in the
present season. Weeks gradually accumulate during the season, and
then are discarded from consideration as the next season begins.

\[ WP.K = WP.J + (DT)(1 - WD.JK) \] 33a
\[ WD.KL = PULSE(WDP, 0, 52) \] 33b
\[ WDP = WPY / DT \] 33c
WP—Weeks Passed (weeks)
WD—Weeks Discarded (weeks/week)
WDP—Week: Discarded Pulse (weeks/week)
WPY—Weeks Per Year (weeks)

The supply-remaining estimate includes both the current processed inventory level and the estimated quantity of fruit remaining. Equation 34 defines this supply-remaining estimate.

\[ SRE_K = PI_K \times (FRE_K)(FRE_K)(CPB) \]

SRE—Supply Remaining Estimate (cases)
PI—Processed Inventory (cases)
FRE—Fruit Remaining Estimate (boxes)
CPB—Cases Per Box (cases/box)

For the moment, the number of weeks of carry-over desired will be regarded as a constant. This agrees quite well with industry tradition. It is interesting to note how nearly constant the actual carry-over has been.³

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Weeks of Carry-over</td>
<td>9.4</td>
<td>5.8</td>
<td>9.4</td>
<td>7.3</td>
<td>9.9</td>
<td>8.9</td>
</tr>
</tbody>
</table>

Here, the desired carry-over will be taken as eight weeks. Later it may be instructive to experiment with a variable carry-over policy.

WCO=8

WCO—Weeks of Carry-Over (weeks)

Two of the price influences included in equation 24 remain to be defined. The competitive influence will be discussed first. When processor disappearance is at the desired level, some tendency to reduce prices still exists. Because of the uncertainty in crop estimates and other variables, processors feel reluctant to carry large inventories. Some processors would prefer to sell their concentrate inventory earlier rather than later. As a result, price cutting usually disturbs the balance between disappearance and the remaining supply. Equation 36 defines the competitive influence. This influence may also be related, to a lesser extent, to the profit levels which processors expect from their operations. However, it is not felt that this secondary factor is of sufficient importance to be included in this model.

\[ CI = .99 \] 36

CI—Competitive Influence (dimensionless)

When processed inventories drop to extremely low levels, there will be a tendency to increase processor prices. Moreover, this upward pressure will exist even in the face of expectations for a large crop. Equation 37 describes this processed inventory influence in terms of the number of weeks of processed inventory. It should be expected that this influence will be important during the early weeks of a new crop season before processing operations begin. Figure 4.13 illustrates the influence relationship.

\[ PI_{II,K} = TABHL(PI_{IT,WPI,K,0,30,5}) \] 37a

\[ PI_{IT,*} = 1.1/1.05/1.01/1.0/1.0/1.0/1.0 \] 37b
Figure 4.13
PROCESSED INVENTORY INFLUENCE
4.7 Fruit Supply and Fruit Supply Estimates

An important component in the estimate of the total supply remaining at any point in the season is the estimate of fruit remaining. This estimate, issued on a monthly basis, is based on a survey of orange groves. The remaining quantities of both ripe fruit and unripe fruit are reflected within some margin of error. Equation 38 represents the fruit-remaining estimate in terms of the total level of fruit remaining modified by an error factor.

\[ \text{FRE}_K = (\text{RFR}_K + \text{UFR}_K)(\text{EI}_K) \]  

\[ \text{FRE} = \text{Fruit Remaining Estimate (boxes)} \]

\[ \text{RFR} = \text{Ripe Fruit Remaining (boxes)} \]

\[ \text{UFR} = \text{Unripe Fruit Remaining (boxes)} \]

\[ \text{EI} = \text{Error Influence (dimensionless)} \]

Equation 39 defines the error influence affecting estimates of the quantity of fruit remaining. Figure 2.8 provides some insight into the nature of this error. Although new estimates are issued each month, there is considerable continuity in the error from month to month. Another characteristic is perhaps the lack of an average bias in the long term. Also, the average error seems to be on the order of 5 percent. These considerations enter into equation 39.

\[ \text{EI}_K = \text{EI}_J + (\text{DT})(1/\text{TAEN})(\text{EN}_J - \text{EI}_J) \]  

\[ \text{TAEN} = 26 \]  

\[ \text{EN}_K = \text{SAMPLE(ENG}_K, 52) \]  

\[ \text{ENG}_K = \text{NORMRN(ENM}, \text{ENSD}) \]
ENM=1
ENSD=.05

\text{EI}--\text{Error Influence (dimensionless)}
\text{TAEN}--\text{Time for Averaging Estimating Noise (weeks)}
\text{EN}--\text{Estimating Noise (dimensionless)}
\text{ENG}--\text{Estimating Noise Generator (dimensionless)}
\text{ENM}--\text{Estimating Noise Mean (dimensionless)}
\text{ENSD}--\text{Estimating Noise Standard Deviation (dimensionless)}

Equation 40 defines ripe fruit remaining as a level, being increased as additional fruit ripens, and being decreased as ripe fruit is used.

\[ \text{RFR}.K = \text{RFR}.J + (\text{DT})(\text{FR}.J - \text{FU}.J) \]  \hspace{1cm} 40

\text{RFR}--\text{Ripe Fruit Remaining (boxes)}
\text{FR}--\text{Fruit Ripening (boxes/week)}
\text{FU}--\text{Fruit Usage (boxes/week)}

Similarly, unripe fruit remaining has been defined as a level, being increased with the addition of a new crop, and being decreased as fruit ripens.

\[ \text{UFR}.K = \text{UFR}.J + (\text{DT})(\text{NCA}.J - \text{FR}.J) \]  \hspace{1cm} 41

\text{UFR}--\text{Unripe Fruit Remaining (boxes)}
\text{NCA}--\text{New Crop Added (boxes/week)}
\text{FR}--\text{Fruit Ripening (boxes/week)}

In this formulation the addition of a new crop at the beginning of the season will be viewed as a more or less instantaneous occurrence. In Section 2.2.2 the characteristics of the change-over were discussed. For the purposes at hand, such a view seems adequate. Equation 42 represents the instantaneous addition of a new crop.

\[ \text{NCA}.KL = \text{PULSE}(\text{NCP}.K,0,52) \]  \hspace{1cm} 42a

\[ \text{NCP}.K = (\text{PT}.K)(\text{BPT}.K)/\text{DT} \]  \hspace{1cm} 42b
NCA—New Crop Added (boxes/week)
NCP—New Crop Pulse (boxes/week)
PT—Productive Trees (trees)
BPT—Boxes Per Tree (boxes/tree)

On the average, an orange tree produces about five boxes of oranges per year. However, from year to year this yield may vary substantially under the influence of weather. Equation 43 defines the productivity of orange trees in terms of the average value and a weather influence.

\[ BPT \cdot K = (BPTN)(W.I.K) \]  \hspace{1cm} 43a

\[ BPTN = 5 \]  \hspace{1cm} 43b

BPT—Boxes Per Tree (boxes/tree)
BPTN—Boxes Per Tree Normal (boxes/tree)
W.I—Weather Influence (dimensionless)

Equation 44 describes the influence of weather on orange tree productivity. Although weather may be quite uncorrelated from season to season, its influence on yield will be characterized by some continuity. This characteristic arises as a result of the fact that freezes, etc., may influence productivity for several seasons. On the average, weather will cause yield to deviate from its average value by perhaps 10 percent. These considerations enter into equation 44.

\[ W.I.K = W.I.J + (DT)(1/TAWN)(W.N.J - W.I.J) \]  \hspace{1cm} 44a

\[ TAWN = 104 \]  \hspace{1cm} 44b

\[ W.N.K = \text{SAMPLE}(W.NG.K, 52) \]  \hspace{1cm} 44c

\[ W.NG.K = \text{NORMRN}(W.NM, W.NSD) \]  \hspace{1cm} 44d

\[ W.NM = 1 \]  \hspace{1cm} 44e
WNSD=0.20

WI—Weather Influence (dimensionless)
TAWN—Time for Averaging Weather Noise (weeks)
WN—Weather Noise (dimensionless)
WNG—Weather Noise Generator (dimensionless)
WNM—Weather Noise Mean (dimensionless)
WNSD—Weather Noise Standard Deviation (dimensionless)

Equation 45 represents the ripening process as a third-order delay. The response of this delay to the instantaneous addition of a new crop satisfactorily describes the aggregate ripening rate when the time for ripening is chosen as 12 weeks.

FR.KL=DELAY3(NCA.JK,TR)  \hspace{1cm} 45a
TR=12 \hspace{1cm} 45b

FR—Fruit Ripening (boxes/week)
NCA—New Crop Added (boxes/week)
TR—Time for Ripening (weeks)

4.8 G rower Returns and New Tree Planting

So far in this model development, there has been no mention of the fruit market where a significant portion of the orange crop is sold to processors. The influence of this market on the flow of ripe fruit to processors has been omitted. This omission is not intended to suggest that the dynamic behavior of the fruit market has little effect on processors. It does suggest that this market has little influence on the processor variables represented here, such as processor price. It is true that variations in the crop size estimate within a given season, as a result of either estimating error or a change in the size of the crop, may lead to abnormally high or abnormally low profits for some processors. However, the aggregate
effect will be less pronounced because many processors are hedged by captive fruit supplies.

It is also true that the dynamic behavior of the fruit market will influence returns to some orange growers. Others, who are also processors, will be affected to a lesser extent. It is unlikely that the dynamic behavior of the fruit market within a given crop year will significantly affect the level of productive trees in the long run.

In this formulation the returns to orange growers have been defined in terms of the processor price. A level of grower returns is suggested on the basis of the current processor price. Equation 46 and Figure 4.14 describe the traditional relationship between these variables.

\[
\begin{align*}
GRS.K &= TABHL(GRST, PF.K, .80, 2.80, .40) \\
GRST* &= .10/1.10/2.10/3.10/4.10/5.10 \\
GRS &= \text{Grower Returns Suggested (dollars/box)} \\
GRST &= \text{GRS Table} \\
PP &= \text{Processor Price (dollars/dozen cans)}
\end{align*}
\]

Corresponding to the level of returns suggested by the processor price, there will be a suggested level of grower profits. Profits will be regarded as the difference between returns and operating costs. Operating costs include both growing costs which average about 80 cents per box and the advertising tax assessment.

\[
\begin{align*}
GRS.K &= GRS.K - GC - AT.K \\
GC &= .80
\end{align*}
\]
Figure 4.14: Grower Returns Suggested

Grower Returns Suggested (dollars per box) * on tree

Processor Price (dollars/dozen cans)

Assuming 30 cans per 90-pound box

Source: Grower's Part Share of Consumer's Frozen Orange

VOL. 11, NO. 19, December 1, 1961
Concentrate Dollar; Florida, Produce Citrus Mutual
In equation 48, average grower profits are described as an exponential average of suggested grower profits. This average profit level will be the major influence on the rate at which new trees are planted. It would appear that planting is affected by profits over a two- or three-year period. Hence, the averaging interval will be chosen as two years. Since this averaging period is relatively long, the suggested grower profit will be a satisfactory basis for determining the average profit level, as it affects new tree planting.

\[ \text{AGP}_K = \text{AGP}_J + (DT)(1/\text{TAGP})(\text{GPS}_J - \text{AGP}_J) \]  
\[ \text{TAGP} = 104 \]

AGP—Average Grower Profit (dollars/box)  
TAGP—Time for Averaging Grower Profits (weeks)  
GPS—Grower Profit Suggested (dollars/box)

With grower profits at a normal level, it is to be expected that the number of new trees planted each year will represent a relatively constant fraction of the level of bearing trees. However, when profits are either high or low, the planting rate will vary accordingly. This tendency was discussed in Section 2.2.1, and an approximate relationship was developed. Equation 49 describes the planting relationship.

\[ \text{NTP}_{KL} = (\text{PT}_K)(\text{FA}_K)/\text{WFY} \]

NTP—New Trees Planted (trees/week)  
PT—Productive Trees (trees)  
FA—Fraction Added (l/years)  
WFY—Weeks Per Year (weeks/year)
Equation 50 and Figure 4.15 describe the influence of average profits on planting. Figure 2.7 provides the basis for this relationship.

$$\text{FA.K} = \text{TABHL(FA.T, AGP, K, 0, 2.00, 0.50)}$$  
$$\text{FA} = 0.015 / 0.041 / 0.070 / 0.10 / 0.13$$

Once new trees have been planted, there is a delay of roughly ten years before trees begin to approach full productivity. This development process was described in Section 2.2.1. Equation 51 represents the growing process as a sixth-order delay.\(^4\)

$$\text{TBP, KL} = \text{DELAY6(NTP, JK, DG)}$$  
$$\text{DG} = 520$$

TBP--Trees Becoming Productive (trees/week)  
NTP--New Trees Planted (trees/week)  
DG--Delay in Growing (weeks)

Equation 52 defines productive trees as a level, being increased by the flow of trees becoming productive, and being decreased as productive trees are lost.

$$\text{PT.K} = \text{PT.J} + (\text{DT})(\text{TBP.JK - PTL.JK})$$

PT--Productive Trees (trees)  
TBP--Trees Becoming Productive (trees/week)  
PTL--Productive Trees Lost (trees/week)

Each year a certain fraction of the productive trees is lost due to various influences including weather, poor care, and real

\(^4\)In DYNAMO, two cascaded third-order delays substitute for this relationship.
Figure 4.15

FRACTION ADDED

AVERAGE GROWER PROFITS (dollars/box)
estate development. This fraction lost will vary with grower profits. If recent profits have been high, the land will likely be kept in orange production; but if profits are low, the attrition rate will be large. Equation 53 describes the loss relationship.

\[ \text{PTL} \times \text{KL} = (\text{PT} \times \text{K}) (\text{FL} \times \text{K}) / \text{WPY} \]

PTL—Productive Trees Lost (trees/week)
PT—Productive Trees (trees)
FL—Fraction Lost (1/years)
WPY—Weeks Per Year (weeks/year)

Equation 54 and Figure 4.16 describe the influence of average profits on the rate at which productive trees are lost.

\[ \text{FL} \times \text{K} = \text{TABHL} (\text{FLT}, \text{AGP}, \text{K}, 0, 2.00, .50) \]

\[ \text{FLT}^* = .20 / .10 / .055 / .032 / .020 \]

FL—Fraction Lost (1/years)
FLT—FL Table
AGP—Average Grower Profits (dollars/box)

4.9 Advertising and Advertising Costs

In this section, advertising policies similar to those currently in effect within the industry will be described. Later, in the exploration of marketing policies, other advertising policies will be developed.

In recent years, there have been two components of advertising expenditure. The first, expenditure by advertised brands, seems to have remained relatively constant. It is difficult to determine how large this component has been or how effective it has been in increasing the over-all demand for frozen orange concentrate. A rough estimate would place its effect, in this respect, in the same neighbor-
Figure 4.16

FRACTION LOST

AVERAGE GROWER PROFIT (dollars per box)
hood as the effect of the cooperative advertising component. Hence, advertised-brand advertising will be described as a constant level of three million dollars per year.

It is likely that the actual dollar expenditure has been somewhat higher than this figure. Over 35 million dollars was spent on advertising Snow Crop and Minute Maid labels during the fourteen years preceding 1959. However, not all of this expenditure or the expenditure of other advertised brand processors was directed toward increasing over-all demand.

CA=3,000,000/WPY
CA—Constant Advertising

The advertising component discussed above and the cooperative advertising spending supported by the industry advertising tax, together constitute the total advertising of frozen orange concentrate. Equation 56 defines this relationship.

A.K=ATS.JK+CA

A—Advertising (dollars/week)
ATS—Advertising Tax Spending (dollars/week)
CA—Constant Advertising

Advertising tax revenues accumulate and are spent within a period of roughly one year. Equation 57 defines the rate of advertising tax spending as a fraction of the current accumulation of tax revenues.

ATS.KL=(ATRA.K)(FSPW)

5The Road to Profit, brochure distributed by Florida Orange Marketers, Inc., Winter Park, Florida, 1959.
ATS--Advertising Tax Spending (dollars/week)
ATRA--Advertising Tax Revenue Accumulated (dollars)
FSPW--Fraction Spent Per Week (1/weeks)

In equation 58, the fraction of accumulated tax revenues spent per week is described as a constant, 2 percent per week. This agrees quite well with current policies which spend most tax revenues during the year in which they are collected. Later, a variable spending policy will be explored.

FSPW=.02

FSPW--Fraction Spent Per Week (1/weeks)

Advertising tax collections correspond to the rate at which fruit is used. Equation 59 describes the collection of these tax revenues.

ATR,KL=(AT)(FU. JK)

ATR--Advertising Tax Revenue (dollars/week)
AT--Advertising Tax (dollars/box)
FU--Fruit Usage (boxes/week)

In equation 60, the advertising tax is described as 3 cents per box of oranges, the current assessment figure. Later, other assessment policies will be examined.

AT=.03

AT--Advertising Tax (dollars/box)

Equation 61 defines the level of accumulated advertising tax revenues.

ATRA,K=ATRA,J×(DT)(ATR,JK-ATS,JK)

ATRA--Advertising Tax Revenue Accumulated (dollars)
4.10

ATR—Advertising Tax Revenue (dollars/week)
ATS—Advertising Tax Spending (dollars/week)

Figure 4.17 presents a flow diagram for the model developed in this chapter.

4.10 Initial Conditions

The initial conditions chosen as the starting point for simulation of industry behavior roughly approximate the state of affairs within the industry at the beginning of the 1959 season. The initial processor price is $2, and demand is nearly in balance with supply. The supply for the upcoming season is fifty million boxes of concentrate oranges, corresponding to ten million productive trees.

The initial rate of planting new trees is based on the profit level corresponding to a processor price of $2. This amounts to 1.3 million trees per year, which is perhaps slightly above the actual rate at which orange trees were being planted for concentrate orange production during the period from 1953 to 1959. Also, the number of trees planted but not yet bearing is based on this planting rate and is therefore somewhat overestimated.

Other initial conditions, of lesser importance, required to begin simulation of industry behavior are described in the listing of model equations, Appendix 1.

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During the 1958-59 season, total movement of concentrate was 70 million gallons at an average retail price of 21.2 cents per can. These figures suggest 50 million boxes of concentrate oranges and an average processor price of $1.85.
Chapter 5

ANALYSIS OF SYSTEM BEHAVIOR

In this chapter, the dynamic behavior of the Florida frozen orange concentrate industry will be analyzed. Several simulation runs of the model developed in Chapter 4 provide the basis for this analysis. For the moment, system behavior will be explored under policies similar to those currently in effect within the industry. Later, in Chapter 6, other policies will be explored toward the improvement of industry behavior.

5.1 Industry Behavior Without Noise

In Figure 5.1 (RUN 5664) industry behavior is simulated for a period of 936 weeks or 18 years. The state of affairs within the industry at the beginning of this period is established by the initial conditions described in Chapter 4. Each major division on the horizontal scale of this figure marks the beginning of a new concentrating season.

All elements of noise or uncertainty have been deliberately omitted in this initial simulation. The influence of error on crop estimates and the influence of weather on production have both been removed. By considering industry behavior in the absence of noise, it will be possible to more clearly recognize the fundamental performance characteristics of this system. Moreover, when these fundamental characteristics are exposed, judgments as to the model's validity can be more readily made.

-93-
Figure 5.1

BEHAVIOR WITHOUT NOISE (RUN 5664)
5.1.1 Long-Term Behavior

Perhaps the most notable characteristic of industry behavior in this simulation is the long-term cycle which appears in many of the key variables. Processor prices (P) and average grower profits ($), for example, fall during the first nine years of the period and then gradually begin to rise. To be sure, the decline is most dramatic. But even the upswing is significant in that grower profits rise by almost a factor of two. This long-term cyclical tendency which appears in the absence of noise should forewarn of more severe fluctuations when the influence of weather is considered.

At the beginning of the period considered in this simulation, processor prices were at $2.00 per dozen cans and grower profits were similarly high at about $2.25 per box. Also, disappearance was close to the proper level for a concentrate crop of 50 million boxes. However, the number of trees planted in the preceding ten years was almost 13,000,000, reflecting an average planting rate of about 1,300,000 trees per year. This high rate of planting corresponds to an average grower profit level of about $2.25 per box.

The concentrate orange crop during the second year of the period rose by over ten percent to 55 million boxes and processor prices for the season fell to around $1.85. This increase in crop size reflected the high rate of planting during preceding years and the low rate of grove attrition during the same period. This rate of attrition had been around 2 percent per year as a result of high prices and high grower profits.
Between the second and eighth years the crop continued to rise. The average yearly increase for this period was about four percent. With these increases in crop size well ahead of the exogenous growth in demand, processor prices continued to fall. The FOB price during the eighth season averaged about $1.25 per dozen cans.

Accompanying decreasing prices was a decrease in the rate of planting and an increase in the rate at which trees were being lost. At the beginning of the ninth season, trees were being planted at the rate of about 700,000 per year, just about half the planting rate nine years earlier. This planting rate corresponded to grower profits averaging around 60¢ per box in recent seasons. Moreover, at the beginning of the ninth year, trees were being lost from production at the rate of nearly 1,400,000 per year, reflecting the low level of grower profits.

The crop for the eleventh season was actually less than the season before by about one percent. Low planting, high losses, and increasing demand had finally turned the trend around. During following seasons, prices and profits continued to rise. The upgrade was, however, much slower, and its levelling off point well below the beginning of the cycle many years before.

It should be noted that the end of the simulation period does not represent a balanced state of affairs. At the end of the eighteenth year new trees are being planted at the rate of over 1,200,000, while losses of productive trees amount to about 850,000 per year. Remembering that the exogenous growth in demand is only 2 percent
per year, it should be expected that prices and profits will again begin a slow decline.

This simulation has served to illustrate the fundamental characteristics of long-term industry behavior. To be sure, the pattern of behavior observed here is less complex and more readily recognizable than the actual industry time pattern described in Chapter 2. Nevertheless, the basic characteristics are the same. Long periods of high prices and long periods of low prices are alternately observed. While the fluctuations in the simulation are gradually diminishing, it should be expected that the driving influence of weather will, in later simulations, tend to keep them alive.

The reasons for this characteristic behavior should, by now, be clear. When profits are high, planting policies which fail to take into account the number of trees not yet fully productive lead to over-planting and eventually to over-supply. Later, in the face of such over-supply, the rate of planting of new trees falls behind demand growth and grove attrition, leading eventually to a new condition of short supply. This type of instability is typical of information-feedback systems involving pipelines which are not properly considered by those controlling rates of flow. In this case, new tree planting is the most critical flow.

5.1.2 Short-Term Behavior

A number of short-term characteristics of industry behavior can also be observed in this simulation. Most noticeable is the tendency for prices to fluctuate seasonally. This is hardly surprising in a seasonal industry, but the underlying reasons for these fluctuations
should be more deeply explored.

During the early years of the simulated period, prices dropped sharply following the beginning of the season and then climbed sharply again toward the season's end. This characteristic was due to a number of factors. During these early years the crop was increasing rapidly. Each new crop implied lower prices than the year before. In order to boost disappearance to the desired level, processors had to lower their prices. Because disappearance responded only gradually to these price changes, there was a tendency to decrease prices too far.

As the end of the season approached, it became obvious that disappearance was too high and prices were therefore raised. Prices were extremely sensitive to the disappearance rate toward the end of each season because so little time remained to correct the imbalance. Or, in other words, when inventories were small relative to disappearance, the delay in adjusting these inventories to desired levels also needed to be small. Since inventory adjustment could only be effected through price adjustment in this case, prices were highly responsive and climbed rapidly. When the following season began, prices were again too high, and a similar process repeated.

Another factor causing mid-season price troughs was the competitive influence which led processors to decrease prices more than necessary. Although this factor was small compared to some of the others, it was nevertheless operative in a manner quite typical of the industry. Still another factor, extremely low inventories at the
end of each of these early years, tended to force prices even higher.

During the years when the crop was remaining steady, or even decreasing slightly, the seasonal fluctuations were less pronounced and in some cases reversed. This observation emphasizes the importance of crop size changes from year to year as a driving force tending to keep the industry in a continual state of fluctuation.

In the latter years of the simulation period the seasonal behavior resembles the earlier years. Here again the crop size is increasing and acting as a driving force on processor prices.

Another characteristic worthy of note is the tendency for disappearance (D) to drop just before the season's end and then to climb high for a short period of time after the season has begun. Again, this is a characteristic which is often observed in the industry. It results from low processor availability followed by a build-up of retail inventories when concentrate production begins.

5.2 **Industry Behavior With Historical Crop Estimates**

In Figure 5.2 (RUN 5676) industry behavior is simulated for a period of 312 weeks or 6 years. During this simulated period, the size of the total orange crop and the related crop estimates, as well as the yield in cases of concentrate per box of oranges, correspond to historical data for the years 1952-1958. These data serve as exogenous inputs to the model. The purpose in performing such an experiment was to observe general characteristics of the model's short-term performance under the influence of uncertainty similar to that experienced by the industry. The characteristics
Figure 5.2

BEHAVIOR WITH HISTORICAL CROP ESTIMATES
(RUN5676)
of interest include periodicity, degree of stability, amplitude and phase. Comparison of these characteristics with those historically observed will help to suggest limitations to be placed on the interpretation of model results.

There is a temptation to become concerned with the model's ability to predict the behavior of key industry variables over a long period of time. This is not the purpose for which the model was developed, and is not the basis on which its validity should be judged. Since this model was developed to help explain causes of the industry's instability and to explore policies for improvement of this situation, its performance must be viewed with these purposes in mind.

It will be useful to point out a number of reasons why this simulated behavior should differ in some respects from historical data. First, the crop size and crop estimate data used here correspond to the over all orange crop. The concentrate crop has been determined as a constant fraction of these figures. Since the fraction of the total crop going to concentrate was changing throughout this growth period of the industry, considerable error has been introduced.

Another characteristic of the model, hardly representative of the period, is a constant rate of growth in demand. This growth rate, chosen as 7 percent per year, is not an adequate description of the combined influences of growth in the popularity of a new product and growth in national income.
Also important to consider are the changing characteristics of consumer demand. In the early years of the industry there was most likely a pronounced seasonal relationship between the consumption of orange concentrate and the consumption of fresh oranges. This factor is not considered here. Moreover, the price sensitivity of consumers was probably changing as the product became more commonly used.

Following the start of the 1952-53 season, simulated processor prices (P) fell slightly in response to the December crop estimate of 77 million boxes and then began to rise as the crop estimate was reduced. Throughout the season both simulated prices (P) and actual prices (Y) rose together as the crop estimate dropped toward 72.8 million boxes, the actual crop size. At the end of the concentrating season the FOB price was about $1.45. The estimating error (E), based on a comparison between the monthly crop estimate and the actual crop size, decreased gradually as more and more of the fruit was used.

At the beginning of the 1953-54 season the new crop was estimated at 80 million boxes, suggesting an increase of 10 percent over the year before. In response to this increase, both simulated prices and actual prices began to fall. By June, 1954, the crop estimate was up to 90 million and FOB prices were down to $1.00. However, during June and July processors increased prices rapidly, up to $1.35. Simulated prices climbed only gradually and by the end of the season reached about $1.25. In each case, the ending inventories were about ten weeks of demand.
The average processor price for the 1953-54 season under simulated conditions was below the historical figure, but this comparison is not important to the purposes at hand. Such differences may arise from misrepresentation of the fraction of the crop used for concentrate. They may also arise from an underestimated consumer demand. More important to note is the dynamic nature of price behavior. In each case, prices were decreased during the first half of the season, and then later were raised. The climb in actual prices began earlier, possibly due to more rapid growth in demand.

Another dynamic characteristic which should be noted is price behavior as the season approached an end. Simulated prices were changing most rapidly during the latter months of 1954. The situation in other years was very much the same. In comparison, actual prices tended to be most stable at this time. This observation suggests that the model does not fairly describe the transition from one season to the next. Hence, the reasons for these differences should be examined.

The tendency for simulated prices to change most rapidly around the end of each season and the beginning of the next results from an overemphasis on the discontinuity between the seasons. The model, as a description of the industry, views the desired number of weeks of carry-over as a rather inflexible goal.¹ As each season approaches an end, there is less and less time to adjust disappearance and prices

¹In RUN 5675 the desired number of weeks of carry-over varies between 5 and 11 weeks depending on the difference between the estimated crop size and the average crop size over the preceding two years. However, this does not provide flexibility as each season draws to a close.
must respond rapidly in order to leave the desired number of weeks of carry-over. This tends to produce an imbalance as each new season begins.

Within the industry, processors are more flexible with respect to the desired carry-over inventory. They are reluctant to change prices sharply in the final weeks of a season, and more willing to see ending inventories larger or smaller than desired. These considerations are not reflected by the model. As a result, simulated prices are less stable around the time of the changeover from one season to the next.

In the 1954-55 season, price behavior was similar to the year before. Actual prices, beginning at $1.25, fell to $1.00 and later rose to $1.35. Simulated prices also fell to $1.00 and then started to climb. At first, the increases in simulated prices were quite gradual. But as the season neared an end they rose rapidly, trying to bring disappearance into line.

At the start of the 1955-56 season, simulated prices were clearly too high. Although the initial crop estimates were only slightly larger than the previous crop size, prices fell sharply. In contrast, actual prices remained steady through most of 1956. These differences in behavior relate mainly to the flexibility in carry-over already discussed. Actual carry-over to the 1956-57 season exceeded carry-over in the simulation by roughly 2 weeks of disappearance. However, they may also suggest that processors look ahead somewhat further than the model describes. If simulated prices had been
raised earlier in the 1954-55 season, the increases would not need to have been so large. And if these increases had been smaller, the major imbalance at the start of the new season might not have occurred.

During the 1956-57 season, prices again dropped to mid-season lows. Actual prices went lower largely because of the above normal carry-over from the season before. Then, at the start of the 1957-58 season, simulated prices responded briefly to the estimate of a 102 million box crop. Actual prices, already quite low, held steady for almost a month. Then came a freeze at the end of December and a major reduction in the size of the crop. In each case, prices climbed and remained at high levels through most of 1958.

This simulation of industry behavior using historical crop estimates has provided additional insight into the industry's dynamic characteristics. It has also suggested many areas where the model is descriptive of industry behavior and several areas where it is not. Further refinements have been suggested and should eventually be explored. However, the model does provide an adequate basis for proceeding toward policies to improve industry behavior if the limitations suggested here are kept clearly in mind.

5.3 Industry Behavior With Noise

In Figure 5.3 (RUN 5665) industry behavior is simulated for a period of 18 years. The state of affairs within the industry at the beginning of this period is again established by the initial conditions described in Chapter 4. Each major division on the
Figure 5.3

BEHAVIOR WITH NOISE (RUN 5665)
horizontal scale of this figure marks the beginning of a new concentrating season.

Earlier in Section 5.1, industry behavior was examined in the absence of uncertainty. Here, noise in the form of a weather influence and an estimating influence has been included. Hence, the model developed in Chapter 4 is used without alteration. In examining this simulation, it will be useful to make comparisons with the industry behavior which was observed in the absence of noise.

5.3.1 Long-Term Behavior

In this simulation, the most notable characteristic of industry behavior is again the long-term cycle which appears in many of the key variables. However, now that uncertainty has been included, the cycle is much more pronounced. In the case where no random weather influence was present, the crop increased steadily until the ninth year. At this time the concentrate crop size (*) was 77.6 million boxes. But with the weather influence included, the crop size increased further and longer to 87 million boxes at the tenth year. This difference was due to very favorable weather conditions which led to yields 12 percent above normal in the tenth year.

The decline in processor prices (P) and average grower profits ($) which occurred with the weather influence included was similarly prolonged. In the tenth year, the FOB price averaged roughly $1.10, suggesting a grower profit of less than 5¢ per box. On the other hand, in the earlier simulation the FOB price averaged roughly $1.35, suggesting grower profits of 60¢ per box.
With the decline in profits so severe, it might be expected that the subsequent increases in prices and profits would also be more pronounced. Indeed this was the case. Because grower profits fell so low, the rate of planting was virtually stopped and the losses of orange groves to other uses were large. As a result the supply of oranges for concentrate fell far behind the growing demand. And prices and profits, during the latter part of the period, rose to levels not far below the levels at the beginning of the cycle, 18 years before.

At the end of the simulated period, the industry was still in an unbalanced state of affairs. The rate at which new trees were being planted was much greater than the rate at which trees were being lost. Large increases in the supply of oranges and corresponding declines in prices and profits were not too far off.

This examination of the industry's long-term behavior has demonstrated the effects of random weather disturbances on a system which is inherently somewhat unstable. The weather influence served as a driving force, tending to keep the industry in a continual state of fluctuating behavior. Moreover, the particular mode of behavior, a cycle over 15 or 20 years, was a characteristic, not so much of the weather, but of the system on which it impinged.

5.3.2 Short-Term Behavior

The short-term industry behavior which occurred in this simulation differed from that examined in Section 5.1.2 because of the influence of uncertainty in weather and in the estimates of the size of
the crop. The most interesting characteristic to note is the seasonal behavior of prices. In the earlier simulation, prices tended to have mid-season lows. Here, a seasonal periodicity was still evident, but the pattern was more complex. If the crop was initially estimated to be smaller than the year before, prices tended to rise. Then, if the estimates were later increased, prices tended to fall. On the whole, prices were less correlated with the time of the year than observed in the absence of noise.

Although the pattern of industry behavior in this simulation was less clearly defined, the underlying characteristics remained unchanged. Because disappearance responded only gradually to changes in the FOB price, processors tended to adjust prices too far. In an environment of random disturbances as well as yearly changes in crop size, this sensitive characteristic of system behavior helped to keep the industry in a continual state of fluctuation.
Chapter 6

DESIGN OF POLICIES

This chapter will be concerned with the design of policies to improve both the short-term and long-term stability of the Florida frozen orange concentrate industry. A number of cooperative marketing policies will be explored. The choice of alternatives to be tested will be, in part, based on the insights gained through the preceding analysis of system behavior. However, other alternatives which correspond to current industry proposals will also be investigated.

Since a number of refinements in the description of system structure have been suggested, the results of this chapter should be regarded as somewhat tentative. Nevertheless, the kinds of policies most likely to succeed will be indicated, and unpromising alternatives will be exposed. It is unlikely that policies, here found to have a destabilizing influence or no influence at all, will, in the end, produce significant improvements in industry behavior.

Another major benefit of this exploration of cooperative marketing policies will be to suggest in which direction further research should proceed. One area, in particular, the effectiveness of orange concentrate advertising, has not been investigated. By determining under what conditions cooperative advertising policies are likely to succeed, this study will suggest a direction for controlled experiments to determine consumer response characteristics.

6.1 Policy Characteristics

At this point it will be useful to consider what general char-
acteristics of policies make them most likely to succeed. Perhaps the most important requirement for an effective policy is that it be based on an understanding of system behavior. A policy where advertising expenditure was inversely related to short-term price levels would not meet this requirement, for example. With prices tending to fluctuate seasonally and consumer response to advertising involving a delay, the advertising effect would probably be greatest when prices were already high.

Another important policy characteristic is insensitivity to system parameters. A policy which depends on the accuracy of parameter estimates will have a rather low chance of success. This insensitivity requirement, more often applied in the design of reliable equipment than in the area of management policies, suggests that system performance, under a new policy, should be explored over the probable range of parameter values before firm conclusions are drawn.

Also to be considered in policy design is the cost if a new policy fails to succeed. Most desirable, of course, is the policy which costs nothing unless an improvement results, but this kind cannot always be found. In the case of cooperative advertising, there is some promise in this regard. Even if the effect of the advertising is negligible, the advertising tax expense may be partially compensated. A reduction in the rate of planting and an eventual decrease in supply, occurring as a result of the tax, will tend to restore profits to their original levels.
The problems of policy implementation must also be kept in mind. A policy which is difficult to understand may fail to gain acceptance. This may well be for the better, since over-complexity is often indicative of poor design. In the end, a policy must be understood and accepted as reasonable by all those concerned.

Together, these characteristics help to define the kinds of policies which are most likely to succeed. Although the above list is by no means all inclusive, it should serve as a guide.

6.2 Industry Behavior With Increased Advertising

In RUN 5666 (not shown) industry behavior was again simulated for a period of 18 years. The first 2 years of this simulation corresponded exactly to the behavior observed in Section 5.3. In each of these simulations the influences of uncertainty in weather and crop estimates were included.

At the start of the third year, the industry changed its advertising tax assessment from 3 cents to 9 cents per box. The policy for spending tax revenues remained unchanged. That is, most of the revenue collected was spent within one year. The immediate effect of the new tax was to decrease grower profits by 6 cents per box.

By the beginning of the fifth year, FOB prices were only 3 cents higher than under the old policy of 3 cents per box. This insignificant difference traces back to the advertising influence relationship chosen in Chapter 4. Under the new policy advertising expenditure
during the fourth year was almost 4 million dollars greater than previously. However, this increased level of advertising increased demand by only one percent. As can be seen from Figure 4.4, advertising was already close to a saturation point. This may or may not have been a realistic description of consumer sensitivity to concentrate advertising.

Looking ahead farther to the eleventh year where average grower profits in each case reached their low, it was found that grower profits under the new policy were only 1 cent less than before. The original 6 cent additional advertising expense had been compensated, by the eleventh year, by a slight reduction in the rate of planting and a slight increase in losses of orange groves.

On the whole, industry behavior under this new advertising policy was not noticeably changed. This observation is quite relevant at a time when the industry is contemplating an increase in the advertising tax to 9 cents per box. However, before reaching any conclusions, behavior under a different set of assumptions about advertising effectiveness must be explored.

Industry behavior was again simulated with advertising policies identical to those discussed above. The advertising tax was again raised to 9 cents per box at the start of the third year. However,

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1 On August 17, 1962, the Triangle reported that the Florida Legislature had recently increased the excise tax on oranges by 5 cents per box for the purpose of supporting additional advertising and promotional efforts.
in this simulation a different advertising influence relationship was explored. This revised relationship is shown in Figure 6.1. In Figure 6.2 (RUN 5670), industry behavior may be observed.

Under greater consumer responsiveness to advertising, the additional advertising expenditure beginning in the third year led to more than a ten percent increase in demand. During the early years of the simulation period, this increase in demand tended to keep prices and profits above the levels which were observed in the absence of increased advertising in Figure 5.3. However, this served only to prolong the decline. The same underlying mechanisms still led to a condition of over-supply. And then with profits at low levels planting again fell behind the attrition of orange groves and growth in demand. Thus, in the later years of the period, the imbalance was once more reversed.

Here the effects of the increase in advertising were, on the whole beneficial. By adopting the new policy when supply was increasing, the depth of the impending price decline was somewhat lessened. However, the improvement was only temporary. By the end of the period conditions in the industry were not significantly different from those which would otherwise have been observed. A high rate of planting suggested that still another period of over-supply was to follow.

It should be remembered that a saturation in the effectiveness of advertising will, at some point, be reached. A further increase in advertising during some future period of crisis might no longer
Figure 6.1
ADVERTISING INFLUENCE (REVISED)
Figure 6.2

BEHAVIOR WITH INCREASED ADVERTISING (RUN 5670)
help to remedy a condition of over-supply. On the basis of the preceding observations it is suggested that a simple increase in the advertising level will not significantly improve industry stability in the long run. The benefits of such a policy, if any, will occur as a transient following its implementation, and will be of a temporary nature.

6.3 **Industry Behavior With Increased Carry-Over**

In the earlier analysis of system behavior it was suggested that a larger carry-over inventory might produce major improvements in short-term industry stability. Toward this end a new policy involving a larger carry-over inventory was explored. In the industry simulations so far observed, the desired carry-over from one year to the next was only an 8-week supply. The simulation to follow is based on a larger desired carry-over inventory amounting to a 32-week supply.

In Figure 6.3 (RUN 5659) industry performance under this new carry-over policy may be observed. In the long term, the dynamic behavior of prices and profits was essentially unchanged. This result was not unexpected. The long-run character of industry behavior was earlier found to be somewhat insensitive to yearly fluctuations in prices and disappearance.

However, under a policy of increased carry-over, the short-term stability of processor prices was substantially improved. On the average, the amplitude of short-term fluctuations was reduced
Figure 6.3

BEHAVIOR WITH INCREASED CARRY-OVER (RUN 5659)
by almost 50 percent. Since processors could adjust to a change
in crop size over a longer period of time, they no longer needed to
correct prices so sharply. The changeover from season to season did
not need to be so abrupt.

This policy of increased carry-over appears to result in im-
provement. However, this improvement must be weighed against the
costs of larger inventories. Processors might well be reluctant to
agree to a cooperative arrangement involving such an expense. On
the other hand, it could probably be shown that the process of
building such a buffer inventory would, by temporarily decreasing
the supply, provide additional revenue sufficient to finance the
investment. But this might, under some circumstances, have an un-
desirable long-term effect.

In connection with an increased carry-over policy it is impor-
tant to consider the problems of implementation. It might be very
difficult to establish a significant buffer inventory without the
collective agreement of most processors. Nevertheless, such a
cooperative arrangement is within the realm of possibility. The
industry is currently studying a similar proposal. In the case of
product promotion processors have, on occasion, developed almost
total participation in programs involving major expenditures.

Perhaps the most important conclusion to draw at this point
is that a policy of increased carry-over shows promise, as far as
the problem of short-term stability is concerned. With further
exploration of other similar alternatives much greater improvements may well be found. Although this policy increases continuity from one season to the next, it is still characterized by a certain inflexibility which could perhaps be reduced.

The idea of buffer inventories to stabilize commodity prices is not new. It has often been tried and often has failed. One common problem is the tendency for these inventories to continually grow. When inventories are being built, prices are either raised or supported and more planting is induced. When later crops flood the market there are strong pressures to build the buffer inventories even further to avoid a price decline. Also, because the demand for most commodities is inelastic, inventory building is profitable in itself, and therefore tends to occur.

Still another difficulty with stabilization inventories is the lack of a sound basis for deciding whether the inventory should be increased or depleted during a given year. In the absence of firm policies, pressures of the moment are the determining factors, and decreased price stability often results. All of these considerations suggest strongly that policy testing such as performed here should precede serious consideration of any stabilization proposals.

6.4 Industry Behavior With Variable Advertising

Under current industry policies, with a 3 cents per box advertising tax, advertising expenditure increases only proportionately in the face of a large crop. This degree of variability in advertising is not sufficient to noticeably improve the long-term instability which has been observed. In Section 6.2 it was found that a
simple increase in the expenditure level led to a temporary improvement but would have little effect in the long run.

On the basis of these observations, a tempting policy alternative is the use of advertising in a transient sense. If changes in the level of advertising tend to have a significant, although temporary influence on industry behavior, then this characteristic can perhaps be used to advantage in a stabilization policy. Toward such an end an advertising policy involving variable expenditure was explored.

Under this new policy, advertising expenditure will be variable, depending on the level of grower profits. The revenues to support the advertising program will again be derived from an increase in the advertising tax to 9 cents per box. When profits are high, expenditure will be low and revenues will tend to accumulate. Then, when profits are low, the accumulated tax revenues will support a high level of advertising, with the objective of increasing demand. In Figure 6.4 the relationship between grower profits and the fraction of the accumulated tax revenues spent each year is illustrated.

In Figure 6.5 (RUN 5679), industry behavior under this variable advertising policy may be observed. During this simulation the revised advertising influence relationship shown in Figure 6.1 was in effect. For the first two years of the period the industry operated with its original spending policy and a tax assessment of 3 cents per box. At the start of the third year the new advertising pol-
Figure 6.4

FRACTION SPENT PER YEAR
Figure 6.5

BEHAVIOR WITH VARIABLE ADVERTISING (RUN 5679)
icy was implemented. Also, throughout the period, the new 32-week carry-over policy discussed in Section 6.3 was used.

Under the new advertising policy, average grower profits fell to 55 cents per box during the oversupply situation in the middle of the period. This figure should be compared with the behavior under original policies discussed in Section 5.3, where average grower profits fell to 34 cents per box in the eleventh year. Moreover, the lowest season's average FOB was about $1.35. A low of $1.10 would otherwise have occurred.

The general character of industry behavior remained essentially unchanged during the simulated period. High prices and high planting at the beginning led to over-supply and depressed prices roughly ten years later. This situation, in turn, was the basis for still another period of high prices and profits near the end of the simulation. However, industry behavior under this policy does differ in that the amplitude of the long-term cycle has been substantially reduced.

At the end of the simulation, average grower profits had risen to about $1.85. But under original policies, average grower profits had risen to about $2.10 near the end of the period. In each case the crop size was again beginning to increase, foretelling of a further condition of over-supply.

It should perhaps be noted that the behavior observed under this policy of variable advertising does not, on the surface, differ significantly from that found in the case of a simple increase
in the per box advertising expenditure. However, an important difference does lie in the fact that the effectiveness of the latter policy was largely exhausted by the time the 18-year period had passed. The variable spending policy, on the other hand, will continue to press against low prices and profits when orange concentrate is in excess supply.

In considering industry behavior under this new policy it should be remembered that a considerable degree of advertising effectiveness has been assumed. If the advertising influence relationship described in Chapter 4 had been in effect, no noticeable improvement would have been observed. However, on the basis of explorations such as these involving different degrees of consumer sensitivity to advertising, it can be decided whether controlled experiments to develop further knowledge will be worthwhile.

A variable advertising policy does seem to show some promise, but it is too early to draw any firm conclusions. Industry behavior under many more conditions must be explored, and for longer periods of time.

Another variable advertising policy of a similar nature was also explored. Under this alternate policy the fraction of accumulated advertising tax revenues spent per year was made more sensitive to the level of grower profits suggested. Figure 6.6 illustrates the revised relationship. In all other respects the situation was identical to the one discussed above.
Figure 6.6

FRACTION SPENT PER YEAR (REVISED)
In Figure 6.7 (RUN 5680) industry behavior under this more sensitive policy may be observed. On the whole, there is a slight improvement, but not of sufficient magnitude to make this alternate policy clearly more desirable. If a choice had to be made between the two policies, it would have to be based on behavior observed under other conditions.

This more sensitive variable advertising policy was also explored under a different sequence of random disturbances, and for a longer period of time. In Figure 6.8 (RUN 5681) industry behavior is simulated for a period of 72 years. When observed over such a long period, the fundamental behavior characteristics become clear. Influenced only by random disturbances, the industry experienced long-term fluctuations in prices and profits with an average period of about 20 years.

Although long-term stability under this policy leaves much to be desired, it is significantly improved over that which would otherwise have been observed. It is interesting to note the influence of advertising on demand at successive peaks and troughs during this period.

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1The exogenous growth in demand during this simulation was 2 percent per year during the first 50 years. After this time, the exogenous growth ceased.
Figure 6.7

BEHAVIOR WITH VARIABLE ADVERTISING (RUN 5680)
Figure 6.8

BEHAVIOR WITH VARIABLE ADVERTISING (RUN 5681)
The advertising policy was clearly acting in a stabilizing sense. However, it should also be noted that the advertising influence was increasing throughout the period, even though the exogenous growth in demand stopped after the 50th year. This occurred as a result of the tendency for advertising to increase profits, profits to increase planting and later the crop size, and crop size to increase advertising. Because of the regenerative feedback involved, the industry proceeded toward advertising saturation. At this point a variable advertising policy would no longer be effective. And saturation will occur sooner or later, depending on the nature of the advertising influence relationship.
Chapter 7

CONCLUSIONS

This study has been concerned with the problems of short-term and long-term instability faced by the Florida frozen orange concentrate industry. With respect to the lack of short-term stability, several conclusions emerge. Processors' attempts to control disappearance through adjustment of the FOB price of concentrate are frustrated by response transients in the distribution system and by an only gradual adjustment to new price levels on the part of consumers. A tendency to over-adjust prices leads to fluctuating behavior in the short term. Underlying this sensitivity in the price control mechanism is the practice of carrying over only minimum inventories from one season to the next. As the end of each season approaches there is less and less time to bring disappearance into balance with supply.

In the long term, the lack of industry stability traces to the highly responsive relationship which, in spite of a long delay in groves becoming productive, exists between grower profits and new tree planting. By not properly taking into account the number of trees still not fully productive, growers tend to plant many more trees than needed to correct a condition of short supply. Under the uncertain influence of weather, which has a prolonged effect on productivity, the industry tends to oscillate between a condition of short supply with high profits and a condition of excess supply during which losses often occur. These fluctuations have an average period of roughly 20 years.
Toward improving short-term stability, a policy involving larger carry-over from one season to the next shows promise. With a 32-week desired carry-over, a reduction in the amplitude of seasonal price fluctuations was observed in simulations of industry behavior. It is felt that further exploration of similar policy alternatives will lead to further improvements in stability. In particular, a more flexible carry-over policy is likely to be more effective. However, this possibility has not yet been adequately explored.

Improvements in long-term stability may well be realized through the use of a cooperative advertising policy, with advertising expenditure geared to the level of grower profits. Simulations of industry behavior with such a policy in effect produced encouraging results under certain conditions of advertising effectiveness. Further research into the sensitivity of consumers to orange concentrate advertising will be needed to determine whether these conditions can be realized. This study has served to suggest a direction for controlled experiments toward providing the needed information.

The results of this investigation will serve a two-fold purpose. First, they will provide individuals within the Florida frozen orange concentrate industry with greater insight into the fundamental nature of their situation. And secondly, they will provide a basis for further development of policies toward improving industry stability.
Appendix 1

LISTING OF MODEL EQUATIONS
RUN 5678TJ
NOTE
NOTE
NOTE
NOTE
NOTE
NOTE
NOTE
NOTE
NOTE
NOTE
MODEL EQUATIONS

NOTE CONSUMER DEMAND

NOTE 13A CD*K=(CDPV*K)(AI*K)(IGI*K)
58A CDVP*K=TABHL(CDVP*ARP*K,10,30,50)
C CDVP*1=0.7E6/2E6/6E6/6E6/6E6/506
3L ARP*K=ARP*J+(UT)(1/TARP)(RP*J-ARP*J)
C TARP=5
58A AI*K=TABHL(AIT,AK,0,32E6,04L6)
C AIT*=0,91,947,961,962,962,962,962,962
3L AA*K=AA*J+(UT)(1/TAA)(AA*J-AA*J)
C TAA=104 WEEKS
58A IG1*K=TABHL(IGIT,TIMF,K,0,2600,520)
C IGIT*=0,1,1,2,1,4,1,6,1,8,2,0
NOTE RETAIL SALES AND RETAIL INVENTORY

NOTE 12R RS*KL=(CD*K)(RA*K)
58A RA*K=TABHL(RAT,WRI*K,0,5,1)
C RAT*=0,95,98,1,0,1,0,1,0,1
20A WRI*K=RJ*K/ACU*K
3L ACU*K=ACU*J+(UT)(1/TACU)(CU*J-ACU*J)
C TACU=10 WEEKS
1L RJ*K=RJ*J+(UT)(PD*J-RS*J)
NOTE
NOTE RETAIL PRICE
C TCRP=2
58A RPS*.K=TAUHL(RPST*.PP*.K*,.80,.2,.80,.40)
C RPST**=.115,.153,.188,.225,.260,.290
NOTE RETAIL DEMAND
58A RII*.K=TAUHL(RIIT*.RII*.K*,.0,.5,.1)
C RIIT**=.2,.5/1,.4/1,.0/1,.85/1,.3
58A DIR*.K=TAUHL(DIR*.EDR*.K*,.6,.1,.4,.2)
C DIR**=.9,.97,.1,.03,.1,.1
NOTE PROCESSOR DISAPPEARANCE AND PROCESSED INVENTORY
NOTE 12R PD*.KL=(RU*.K*(PA*.K)
58A PA*.K=TAUHL(PAT*,.P1*.K*,.33).5)
C PAT**=.0,.84,.97,.1,.0,.1,.0,.1,.0
20A WP*.K=PI*.K/ARD*.K
1L PI*.K=PI*.J+(UT)*(PR*.JK-PP*.JK)
C TARDU=10 WEEKS
C CP*.K=.625 CASES/.33X
C DPRF=3 WEEKS
20R FU*.KL=RFR*.K/DPRF
NOTE
NOTE

PROCESOR PRICE

NOTE

C TCPP=4 WEEKS
12A PPS.K=(PP.K)(XPPS.K)
13A XPPS.K=(DI.P.K)(PII.K)(CI)
58A DI.P.K=TA0H(L(DIPT*EUR)K*6/1.4/2)
C DIPT*=50/70/1.0/1.30/1.50
12A EURD.K=(PURU.K)(PCI.K)
20A PDUR.K=APU.K/PUD.K
3L APU.K=APU.J+(UT)(1/TAPU)(PD.JK-APU.J)
C TAPU=8 WEEKS
26A PDJ.K=(SRE.K+U+O)/(WPY-WPK+WC0.K)
58A PCI.K=TA0H(L(PCIT*PCK-50)/50/10)
C PCIT*=1.45/1.27/1.17/1.10/1.04/1.0/0.96/0.90/0.83/0.73/0.55 PCI TABLE
7A PCK.K=PP.K-APK.K
3L APP.K=APP.J+(UT)(1/TAPP)(PP.J-APP.J)
C TAPP=8 WEEKS
14A SRE.K=P1.K+(FRE.K)(CP0)
C WPY=52 WEEKS/YEAR
1L WP.K=WPK+(UT)(1-WD.JK)
41R WD.KL=PUL5c(WUP+O/52)
20N WDP=WPY/UT
6A WC0.K=32
58A PII.K=TA0H(L(PIIT*WP1.K/O,30,5)
C PIIT*=1.1/1.05/1.01/1.0/1.0/1.0/1.0
C CI=.99
NOTE

PROCESSOR PRICE
TIME TO CORRECT PROCESSOR PRICE
PROCESSOR PRICE SUGGESTED (1)
PROCESSOR PRICE SUGGESTED (2)
DISAPPEARANCE INFLUENCE ON PROC
DIP TABLE
EXPECTED D. RELATIVE TO ULTR
PROC. D. RELATIVE TO ULTR
AVERAGE PROG. DISAPPEAR
TIME FOR AVG. PROC. DIS.
PROC. DISAPPEARANCE DESIRED
PRICE CHANGE INFLUENCE
PRICE CHANGE
AVERAGE PROCESSOR PRICE
TIME FOR AVG. PROC. PRICE
SUPPLY REMAINING ESTIMATE
WEEKS PER YEAR
WEEKS PASSED
WEEKS DISCARDED
WEEKS DISCARDED PULSE
WEEKS CARRY OVER
PROCESSED INVENTORY INFLUENCE
PII TABLE
COMPETITIVE INFLUENCE
NOTE  FRUIT SUPPLY AND FRUIT SUPPLY ESTIMATES
NOTE
18A  FREQK=(E1K)(RFRK+UFRK)
3L   E1K=E1J+(UT)(1/TAEN)(ENJ-E1J)
C    TAEN=26 WEEKS
43A  ENK=SAMPLE(ENGK,52)
34A  ENGK=(1)NORMRN(ENM+ENSD)
C    ENM=1
C    ENSD=0.05
1L   RFRK=RFRJ+(UT)(FRJK-FUJK)
1L   UFRK=UFRJ+(UT)(NCAJK-FRKJ)
41R  NCAKL=PULSL(NCPK,0.52)
44A  NCPK=(BTKK)(5BTKK)/UT
12A  BTKK=(BTRAN)(K1K)
C    BTRAN=5
3L   W1K=W1J+(UT)(1/TAAN)(WNJ-W1J)
C    TAAN=104 WEEKS
43A  WNK=SAMPLE(WNKK,52)
34A  WNGK=(1)NORMRN(WNMM+WNSD)
C    WNMM=1
C    WNSD=0.20
39R  FRL=DELY3(NCAJK,DR)
C    DR=12 WEEKS
NOTE  FRUIT REMAINING ESTIMATE
NOTE  ESTIMATING INFLUENCE
NOTE  TIME FOR AVG. ESTIMATING NOISE
NOTE  ESTIMATING NOISE
NOTE  ESTIMATING NOISE GENERATOR
NOTE  ESTIMATING NOISE MEAN
NOTE  ESTIMATING NOISE STD. DEVIATION
NOTE  RIPE FRUIT REMAINING
NOTE  UNRIPE FRUIT REMAINING
NOTE  NEW CRUPE 1NDU
NOTE  NEW CRUPE PULSE
NOTE  BOXES PER TREL
NOTE  BOXES PER TREE NORMAL
NOTE  WEATHER INFLUENCE
NOTE  TIME FOR AVG. WEATHER NOISE
NOTE  WEATHER NOISE
NOTE  WEATHER NOISE GENERATOR
NOTE  WEATHER NOISE MEAN
NOTE  WEATHER NOISE STD. DEVIATION
NOTE  FRUIT RIPENING
NOTE  DELAY IN RIPENING
NOTE

GROWER RETURNS AND NEW TREE PLANTING

58A  GRST=K+TABHL(Grst+pp*K, 80, 280, 40)

C  GRST*=.10/1.10/2.10/3.10/4.10/5.10

8A  GPS•K=GRS•K-6C-AT•K

C  GC=0.80 DOLLARS/DOX

3L  AGP•K=AGP•J+1(UT)(1/TAVP)(GPS•J-AGP•J)

C  TAGP=104 WEEKS

44R  NTP•KL=(PT•K)(FA•K)/WRY

58A  FA•K=TABHL(FAT•AVP•K, 0, 2, 00, 50)

C  FAT•*=.015/.041/.070/.10/.13

39R  TBP•KL=DELY3(XTP•JK, XUG)

39R  XTBP•KL=DELY3(NTP•JK, XUG)

20N  XUG=DUG/2

C  DUG=520 WEEKS

1L  PT•K=PT•J+1(UT)(TBP•JK-PTL•JK)

44R  PTL•KL=(PT•K)(FL•K)/WRY

58A  FL•K=TABHL(FL•AVP•K, 0, 2, 00, 50)

C  FLT*=.20/.10/.059/.032/.020

NOTE

GROWER RETURNS SUGGESTED

GRS TABLE

GROWER PROFITS SUGGESTED

GROWING COSTS

AVERAGE GROWER PROFIT

TIME FOR AVG. GROWER PROFIT

NEW TREES PLANTED

FRACTION ADDED

FA TABLE

TREES BECOMING PRODUCTIVE (1)

TREES BECOMING PRODUCTIVE (2)

TREES BECOMING PRODUCTIVE (3)

DELAY IN GROWING:

PRODUCTIVE TREES

PRODUCTIVE TREES LOST

FRACTION LOST

FL TABLE
NOTE AUSTRALIAN AND AUSTRALIAN CURRENCY

NOTE

12R ATR•KL=(AT•K)(FU•JK)
7A AT•K=IAT+ATC•K
C IAT=.03 DOLLARS/¥X
45A ATC•K=STEP(ATCC,104)
C ATCC=0
1L ATRA•K=ATRA•J+(UT)(ATR•JK-ATS•JK)
12R ATS•KL=(ATRA•K)(FSPY•K)
20A FSPY•K=FSPY•K/wPY
51A FSPY•K=CLIP(XSPY•K,1,TIME•K,104)
59A XSPY•K=TABHL(FSPYT,GPS•K,6,3,00,1,00)
C FSPYT*=1/50/25/125
7R A•KL=ATS•JK+CA
20N CA=3E6/wPY

NOTE

ADVERTISING AND ADVERTISING COSTS

ADVERTISING TAX REVENUE
ADVERTISING TAX
INITIAL ADVERTISING TAX
ADVERTISING TAX CHANGE
ADVERTISING TAX CHANGE CONSTANT
ADV. TAX REVENUE ACCUMULATED
ADV. TAX SPENDING
FRACTION SPENT PER WEEK
FRACTION SPENT PER YEAR (1)
FRACTION SPENT PER YEAR (2)

ADVERTISING
CONSTANT ADVERTISING
NOTE  INITIAL CONDITIONS

NOTE
6N ARPD=RP
6N AA=A
6N ACD=CD
12N RI=(2)(ACU)
6N RP=RPS
12N PI=(WC)(A,DU)
6N ARD=RD
6N PP=2.00
6N APP=PP
6N APO=PDV
6N WP=52
6N WD=0
6N EI=ENM
6N EN=ENM
6N RFR=0
6N UFR=0
6N NCA=0
6N w1=WNM
6N wN=WNM
6N AGP=GPS
6N PT=1PT
C IPT=10E6
13N ATRA=(IAT)(PT)(A)PTN
6N EURD=1

NOTE
NOTE
NOTE

SUPPLEMENTARY EQUATIONS

NOTE

43A YK=SAMPLE(TY,K,52)
20A TY,K=TIME,K/WR
43A CK=SAMPLE(CPC,K,52)
12A CPC,K=(PT,K)/(P.K)
7A CSE,K=FUTD,K+FRE,K
1L FUTD,K=FUTD,J+(UT)(FJ-JK-FDK)
41R FDKL=PULSE(FDP,K,J,52)
20A FDP,K=FUTD,K/UT
6N CS=CPC
6N CSE=CS
6N FUTD=0
6N FK=0

NOTE

NOTE
NOTE PRINT AND PLOT INSTRUCTIONS

NOTE PRINT 1) YEAR(0.0), CS(6.3)
PRINT 2) CUD(6.3), CVPD(6.3), A1(0.2), ASI(0.2), AR1(0.3), AN(6.3)
PRINT 3) RIS(6.3), RA(0.2), R1RI(0.2), ACD(6.3), R1(0.3)
PRINT 4) RP(0.3), RPS(0.3)
PRINT 5) RD(6.3), R11(0.2), LIR(0.2), PCL(0.2), APP(0.2)
PRINT 6) PD(6.3), PA(0.2), WPI(0.2), P1(6.3), ARD(6.3), PR(6.3), FD(6.3)
PRINT 7) PP(0.2), PPS(0.2), V1(0.2), CI(0.2), LDUR(0.2), PDR(0.2), PC(0.2)
PRINT 8) APD(6.3), PDD(6.3), SRE(6.3), F(0.1), P11(0.2)
PRINT 9) FRE(6.3), RFR(6.3), JFR(6.3), E1(0.2), FR(6.3), MPT(0.2), I(0.2)
PRINT 10) GRS(0.2), GPS(0.2), AC(0.2), RTP(3.1), FA(0.3), TSP(3.1)
PRINT 11) PT(6.3), PTL(3.1), FC(0.3)
PRINT 12) ATR(6.3), AT(0.3), ATRA(6.3), A(6.3)

NOTE PLOT CJ=(3.15636)/RD=5, PD=(0.2), RP=R(0.3), /ASPI=0, PP=P(0.3), ANR=1
X1 (0.3), /ASPI=0, P=0.3, /RUR=U(0.1.5), /A=A(0.46)

NOTE
NOTE NOTE MODEL SIMULATION RUNS

NOTE
BIBLIOGRAPHY


