ECONOMIC IMPACTS OF FROZEN CONCENTRATED ORANGE JUICE FUTURES TRADING ON THE FLORIDA ORANGE INDUSTRY

By

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

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Frank Arthur Dasse

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Chairman: Lester H. Myers
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The Florida orange industry has had and continues to have a major concern over how the futures market in frozen concentrated orange juice (FCOJ) has affected the price structure in this industry. The concern exists because a number of growers and some processors sense, but cannot observe, that the pricing structure has been altered to their detriment. Because the futures market has existed enough years, because the structure of the industry has remained relatively stable and because of this felt need by industry participants, a relatively unique opportunity existed to probe the economic impact of the FCOJ futures market.

A framework was established which showed the benefits of stability of prices paid to the producers of oranges. Thus, if it should be determined that the futures market in FCOJ was a stabilizing influence, the market would be judged as being beneficial. Also, a theoretical framework was es-

tablished showing the benefits that could be gained if an owner of product inventory could hedge risks of price variation in another market. Two models were indicated as guides depending upon the certainty of an owner's stock.

An analysis of the seasonal variation of cash prices for a number of years was the first economic impact studied. A model was developed to measure the contributions that a number of variables made to intraseasonal price variation. It was established that the futures market had a stabilizing influence upon price variation. As an adjunct to the price variation analysis, an effort was made to assess the contributions of the futures market to carrying inventory. Hedging behavior was theorized and measured. An analytical framework for the inventory carrying capabilities of hedging was established; however, there were not enough data to accomplish any meaningful statistical estimations.

There are different methods for growers to market their fruit. These different marketing methods may generate different values for a box of fruit. The second area of this study analyzed these differential prices to determine if a futures market impact could be measured. It was found that the futures market appeared to contribute to the lessening of differential prices. The coefficient values of the model used in this analysis were not statistically significant so the opinions derived can not be defended with vigor. What may be said more strongly than the above statement is that there is no evidence to indicate that the futures market has caused the cash fruit seller segment of the industry to suffer relative to the pool fruit seller.

The last area of study covered the "basis" in FCOJ. A basis represents the difference between a price in a futures market and the cash price of a commodity. Existing basis theory was abstracted and supplemented by some influences unique to the Florida orange industry to develop a basis model for FCOJ. The empirical results indicate that the FCOJ futures market conforms to the developed theory. The futures market acts rationally and appears to be a useful medium upon which the Florida orange industry may hedge.

Finally, some policy suggestions were forwarded for individuals, industry associations or governmental bodies to consider. Fundamentally, they suggested abandoning the antagonist role and assuming a role of being a protagonist for the futures market.

CHAPTER I
INTRODUCTION

Gray and Rutledge state:

> The literature on futures trading owes more than any similar body of literature to the fact that the institution has been periodically attacked in the political arena. These attacks have been based largely upon misunderstanding, particularly the aforementioned misconception that futures markets serve the whims of speculators rather than the needs of hedgers. There have been in consequence numerous efforts to legislate against futures trading (successfully on occasion) and several official investigations which have frequently contributed significantly to better understanding. (11, Pg. 61)

Statement of the Problem

A recurring argument made against futures markets is that they give rise to price instability by facilitating speculation in a commodity. This recurring argument is certainly prevalent in the Florida orange industry.

That this is true can be demonstrated in a recent letter to the Florida Citrus Commission chairman from one of the commission members:

> April 9, 1974
>
> Mr. Danforth K. Richardson
> P. O. Box 370
> Vero Beach, Florida 32960
>
> Dear Dan:
>
> I am very concerned about citrus futures and the way it is influencing the price of FCOJ. I have recent, first-hand experience that the price at which processors are able to buy top-quality orange concentrate from the futures market has lowered the price per lb. solids on Valencia oranges.

> Just as soon as possible, I would like the staff and/or our legal counselor, and whatever or whoever else it takes, to make a full and comprehensive investigation as to the citrus futures' benefit to the Florida citrus industry. This investigation should be so thorough that we, as the Florida Citrus Commission, can help effect whatever changes are necessary for the good of the Florida citrus industry.
>
> I think this should be on our agenda at the earliest date possible.

The above sentiment is by no means an isolated incident. This and similar comments can be elicited from other members of the industry or have been recorded elsewhere.

The problem appears to be that certain elements of the orange industry, principally growers, believe that the pricing and, therefore, the profitability structure of the industry is being detrimentally affected by futures trading.

Should the belief be true, then a problem clearly exists for which remedial action should be taken to retrieve the more equitable market and profit conditions. If this supposed intrusion is not fact, then an education and/or extension program is needed to relieve the rather extensive concern of industry participants. Given that the futures market has not been detrimental to the industry, it would further quiet the trepidation against the frozen concentrated orange juice (FCOJ) futures market to be able to explain the behavior of the FCOJ futures prices in relation to the cash prices being paid to members of the industry.

This project therefore focuses upon two areas. One area is an analysis of the variation in prices per pound of orange solids[1] paid to a grower before and after the introduction of FCOJ futures trading. The second area of emphasis will be a definitional study of the relationship between prices in the cash market and the futures market.

The relative newness of the FCOJ futures market offers an opportunity to advance the hypothesis that the prices paid to orange producers for a pound solid have become less variable since and because trading in FCOJ futures began. Eight years of data are available to test this hypothesis, which appears adequate.

Prices in the cash market represent an equilibrium price between demand for oranges and the available supply at the present time; whereas, a futures price is a collective judgement between buyers, sellers, and speculators as to the value of orange concentrate deliverable some time in the future. For many reasons, therefore, including form and time dimension changes, the prices in the two markets are and should be different. This difference is defined in the trade as "the basis." The FCOJ basis will be the second area of inquiry in this study. As a result of the empirical study of this portion of the project, it is expected that the influences upon the FCOJ basis will be defined. Knowledge of these influences, such as strength and duration of influence, could aid in the formulation of widespread, more efficient hedging programs.

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[1]A pound of orange solids describes what is left after all water is removed from orange juice. It is composed of soluble sugars, citric acid and vitamin D.

Research Objectives

To be able to help guide policy it is necessary that there is an understanding of the subject matter upon which the policy focuses. It is the general objective of this study, therefore, to help with the understanding of the FCOJ futures market. Whatever benefits the Florida orange industry has derived from the futures market will become evident and the future course of industry involvement in the futures market will be suggested.

To fulfill these general objectives the following specific objectives are formulated:

(1) To analyze the variation in prices paid to growers for oranges before and after the introduction of FCOJ futures trading with the purpose of isolating the effect of futures trading on price stability.

(2) To develop an explanatory model of the FCOJ "basis" for use in:

  (A) Understanding the relationship and

  (B) Developing strategies for futures market usage by a larger segment of the industry.

Organization of the Study

There are seven chapters. Chapter 1 provides the general introduction. Chapter II provides a discussion of the historical development of futures markets. It also presents specific information pertaining to the development of futures market for FCOJ. Chapter III probes the reason and importance of this study to the Florida orange industry. It will deal first with a study of price risk represented by price variation and what its implications are to the industry and second with possible methods of risk avoidance through a hedging program using a futures market. Chapter IV outlines the model which will assess the contribution that the futures market has made to the price variability of the cash commodity. Chapter V will probe the changes which may have occurred in the price relation of cash fruit compared to pool or participation fruit since the introduction of futures trading. Chapter VI will describe a theoretical relationship between prices in the cash market and prices in the futures market. Once that goal has been accomplished, suggestions will be offered to members of the industry regarding the advisability of entering into hedging programs utilizing the futures market for FCOJ. Finally, Chapter VII will summarize the study, offer policy suggestions and suggest areas where further research may be fruitful.

CHAPTER II
BRIEF BACKGROUND INFORMATION

Prior to formulating any sort of theoretical framework or econometric models of the Florida orange industry and how it may have been influenced by the introduction of a futures market in FCOJ, some knowledge of the structure of the industry is necessary. A discussion of the agricultural aspects and the marketing methods is attached as Appendix A to fulfill that need. It will be the purpose of this chapter to very briefly introduce the concept of futures trading and discuss briefly some specifics of the FCOJ futures market.

Futures Markets

Contracting for future delivery in many commodities has for centuries been a normal, customary way of doing business. The existence of future contracting developed over the centuries as a method of forestalling to a degree the price swings that many commodities were typically exposed to. The feature of the development of this early future contracting was that title or ownership of the commodity in question was expected to change hands. As time progressed and as this method of future contracting expanded, there developed also the concept of buying or selling the rights and responsibilities of these contracts to third parties. These actions were highly informal, however legal and binding. It became apparent in the midwest, particularly Chicago, that the developments of standards, inspection, weights and measures, etc., were necessary for orderly, lawful, and relatively simple transfer of ownership rights of commodities. The Chicago Board of Trade was organized in 1848 to facilitate the efficiency of transferring ownership of various commodities typically shipped from the midwest to the rest of the country by rail and the rest of the world via the Great Lakes shipping routes.

One of the features of contracting through futures markets was that specific quantities of a specific quality of a commodity could be traded for delivery in a specified time period set openly in the future. The exchanges would, in a public place and by open outcry, pass these transferable contracts from buyer to seller with but a small fee for such a service . Anyone who met the financial responsibility required by the exchanges could participate.

A participant in a futures contract always has two options. He can honor the terms of the contract during the specified time period or he can sell his rights to another through the exchanges. The futures markets typically experience relatively low delivery rates, usually less than 2 percent (17, pg. 17). This indicates that futures exchanges volume of physical commodity is but a small percentage of the total contracts traded.

Futures trading has historically been justified for its ability to cover all or a portion of the market or price risks not covered by other means of doing business. Price risks or uncertainty in agricultural commodities comes about due to lags in time between production and consumption. The lags or gaps are attributed to weather variability, seasonality, processing times, shipping uncertainty or any other similar problem which delays consumption. These delays cause unplanned and often undesired fluctuations in the pricing of the commodity. The practice of hedging therefore has developed where individuals or firms having business risks in the cash market may take offsetting risks in the futures markets.

Those engaged in the cash market of a commodity usually deal in that commodity in some form. The price in the marketplace represents the collective judgement of those engaged in the supply and demand of the cash commodity. Those engaged in the futures markets may or may not be interested in the physical commodity. The prices that exist in the futures market represent during period t the traders expectations of the conditions that will exist in period t + n. The tie between the two markets is the ability to deliver or take delivery of the commodity being traded. This option will usually cause the two markets, cash and futures, to come into reasonable consonance at or near delivery time.

It is the intent of this discussion to generally acquaint the reader with some general background information regarding futures trading. A more detailed exposure may be gotten from Heironymus (13), Gold (7), or Tewles *et al*. (28). New terms will be explained as they are introduced.

Futures Market in FCOJ

In 1966 the New York Cotton Exchange decided, after consultation with members of the orange industry in Florida, that a need for a futures contract in FCOJ did in fact exist. The Citrus Associates was formed and trading was begun on October 26, 1966, with a total of 92 contracts being traded.

The following contract definition information is taken from the By-Laws and Rules of the Citrus Associates of the New York Cotton Exchange:

> Contract Grade. "U.S. Grade A" with a Brix value of not less than 51° having a Brix value to acid ratio of not less than 13 to 1 nor more than 19.0 to 1, with the factors of color and flavor each scoring 37 points or higher and minimum defect score of 19 with total score of not less than 94, is the quality of frozen concentrated orange juice that is deliverable under Exchange contracts, provided that frozen concentrated orange juice with a Brix value of more than 65° shall be calculated as having 7.135 pounds of solids per gallon delivered.
>
> The United States Standards for Grades of concentrated orange juice for manufacturing effective November 17, 1964, shall be used as the Standards for the grade and quality of all frozen concentrated orange juice delivered on contract for future delivery. In the event of an amendment to the official U.S. Standards for Grades of concentrated orange juice for manufacturing, such amended Standards shall become effective for deliveries on and after the effective date of such Standard. Frozen concentrated orange juice with pulp wash solids is not deliverable on contract.
>
> Contract Weight. The contract for Frozen Orange Concentrate is a unit of 15,000 pounds of orange solids, with an allowable variation of three percent more or less. In addition, the lot must be uniform, and in this connection, the Brix range of the delivery may not exceed three degrees of Brix. Each Drum shall be numbered. Also, as Juice is placed in a public licensed warehouse approved by Stock Exchange, each lot receives a warehouse lot number. Generally, the drums contain approximately 52 gallons of concentrate, however, this is not a requirement of the contract and greater or less quantities are acceptable on delivery.

A quantity of concentrate complying with the above requirements may be certified for delivery by arranging for an inspection by the USDA for a nominal fee. This inspection must take place at the time the concentrate is placed or while it is in a licensed warehouse. The Exchange certificate, when issued, is good for one year from the date of inspection or as long as the product remains in the licensed warehouse whichever occurs first. There are presently 28 such delivery warehouses located throughout the orange-producing section of Florida. It has been calculated that the cost to deliver on contract is about $75 above the cost of processing the concentrate into the bulk containers.[1] This amounts to 0.5 cents per pound solid of concentrate.

Trading is regularly conducted in the contract months of January, March, May, July, September, and November. Contracts can be traded as far away as 18 months from delivery although most active trading occurs in the contracts maturing in less than 12 months. The November contract is considered the last contract of the old season. That means that the November contract usually reflects conditions at the end of the harvest and marketing period for that particular season. It is also a transition contract in that the first supply estimates for the coming season are available prior to its maturation so that it may also reflect some of the conditions for the new season during its last few weeks of trading.

The background for the ensuing discussions has been

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[1]This estimate was taken from a cost booklet compiled by the Citrus Associates of the New York Cotton Exchange, dated February, 1974.

covered briefly enough so that the objective of this study may be pursued. For more detail on the FCOJ futures market the reader may consult the USDA Commodity Exchange Authority booklet "Futures Trading in Frozen Concentrated Orange Juice." (30)

CHAPTER III
REASON AND IMPORTANCE OF THE STUDY

The objectives of this study implicitly make some assumptions that will be the object of some theoretical review in this chapter. Analysis of price variation is a task that is not complete until some judgment is made on whether the observed changes in price variation, if indeed there were some, were good for the industry. The implicit assumption in this case is that a decrease in price variability of orange solids is both desirable and beneficial to the orange industry. Therefore, the first portion of this chapter deals with that assumption. The reason for the study of the relationship between prices paid to growers for orange solids and the prices quoted on the FCOJ futures markets is to define an economic link between the two markets. If a link between the two price series can be established and some causality variables can be identified, then a solid base exists to build a hedging program that can be beneficial in reducing price risks within the industry. The assumption here is that there exist methods to hedge that will reduce risks and, therefore, will be beneficial to the practitioners of such programs. The second part of this chapter deals with the general concept of hedging and explores some theory showing the benefits of proper programs.

On the Desirability of Price Stability

A persistent question in the literature on futures trading is "What is its effect upon price variability?" The implicit assumption is that price stability is desirable and that if futures markets contribute to price instability then they are bad.

That question is the first objective of this study. It is expected that some statement will be capable of being made regarding the FCOJ futures market contribution to orange solids price stability. The contribution will be judged as beneficial if it can be shown to be stabilizing in nature. It will be judged as detrimental if it contributes to price instability. A case needs to be made, in a theoretical sense, that price stability is good for the orange industry to serve as the substance behind these judgements.

One can argue the case against uncertainty with some observations. First of all, production and storage involve uncertainty if for no other reason than mortals cannot foresee and foretell the future with certainty. Recognizing this uncertainty, producers and storers will need to spend considerable time and thought estimating future production and consumption at the expense of their more normal activities. It can be argued that uncertainty will result in restricted capital usage either by internal decision or by external rationing. With the opportunity to tie up purchases and/or sales well in advance, the functions of price formation and uncertainty or risk bearing can be transferred from the producer/seller to the buyer. A forward market thus offers the transference of these responsibilities to those willing and possibly more capable of undertaking them. Having transferred uncertainty, the capital rationing problem would be lessened and very likely the availability of capital in such situations would be larger than a situation with uncertainty. The transference of price formation and risk also allows the producer to concentrate upon his main activity with the attendant increase in efficiency.

The economic community is not by any means in agreement on the benefits of price stability. Oi (21) developed an argument that showed that producers would indeed benefit by price instability, that benefit being producers' surplus or profit. His assumptions however were that producers would adjust their production immediately to the prices that exist in the market.

Those assumptions do not fit well with the Florida orange industry. The supply conditions are not altered by management decision in the short run. Because of the nature of the marketing of oranges, the prices received are only estimable so that typically production plans are quite stable. The acreage is slow to change. Thus the supply function for oranges can be assumed to be price independent and in any specific season the supply of oranges is a function of a number of exogenous influences.

Under these conditions price stability can be shown to be beneficial to an individual producer compared to a situation where prices vary. Consider a producer who produces with two possible exogenous outputs Q_1 and Q_2 each having a probability of occurrence of 0.5. Assume a stable price exists: say P_n. His revenue would be in the long run represented by

$$(3.1) \quad E(R) = .5\ P_n\ Q_1 + .5\ P_n\ Q_2 = P_n\ \frac{Q_1 + Q_2}{2}$$

$$\text{or} \quad E(R) = P_n\ Q_{ave}.$$

Now assume that there is a correlation between his output and the output of the industry such that prices vary inversely with his output. That can be depicted by Figure 1.

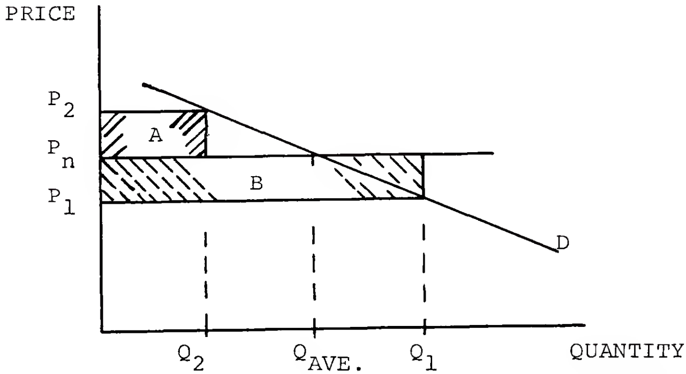

Figure 1. Producers surplus with price stability

When Q_2 is being produced, the crop is short and P_2 would ordinarily prevail. Revenue proportional to area A would be lost in a situation where prices were to be held stable rather than reaching an equilibrium price as the demand situation requires. However, when Q_1 is being produced, P_1 would prevail. In this situation there would be a revenue proportional to area B to be gained by price stability. It is clear that area B is larger than area A, such that in the long run a revenue gain proportional to 1/2 (B - A) would be the benefit to this producer by a program of price stabilization.

The preceding argument may not necessarily be used for the Florida orange industry because there has not been a buffer stock program for this industry. A buffer stock would need to be maintained with inflow or outflow of goods to maintain the hypothesized nominal or stable price.[1]

The case will be considered where there has been a decrease in the price flexibility at the producer level resulting in less price variation with the same range of outputs. Consider Figure 2.

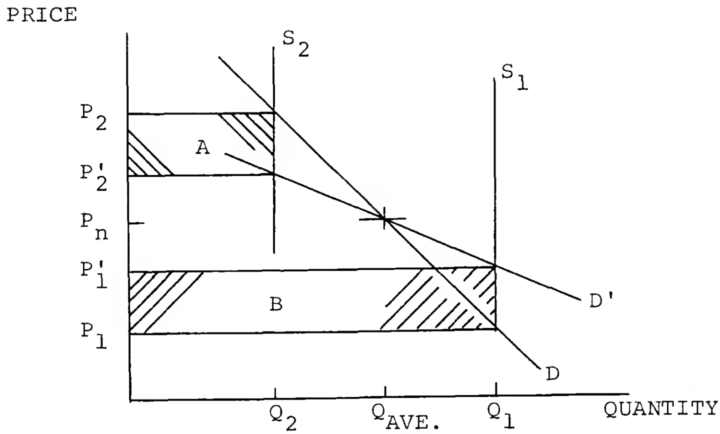

Figure 2. Producers surplus with a change in demand

Again the assumption can be made that output is an exogenous variable and varies to Q_1 and Q_2 with 0.5 probabilities. With the demand curve changing from D to D' it can easily be seen that the producers do in fact benefit from such a price-

---

[1]Yeoh (37) in a recent study showed that if all supply functions in the FCOJ markets were perfectly stabilized, all market participants on the supply side would obtain an increase in welfare. 81% of the increase in welfare would go to growers, 13% would go to retailers and the remaining 6% would go to processors.

stabilizing influence and the benefit is calculable. The losses from the stabilizing influence are Q_2 $(P_2 - P_2')$ and the gains are $Q_1(P_1' - P_1)$. Letting ΔP represent the price differential, the long-run gain to the industry is 1/2 $(\Delta P\ Q_1 - \Delta P\ Q_2)$ or $\Delta P \cdot Q_{ave}$. Thus it seems that any measurable influence that affects the price flexibility affects price stability and this can be translated into a change in revenue to the benefit of the industry.

Massell (18) argues the case in a more general sense. He assumes that the supply and demand curves each have an intercept term that is a continuously distributed random variable. They have the form:

(3.2) $S = \alpha p + x$ where $\alpha \geq 0$

(3.3) $D = -\beta p + y$ where $\beta \geq 0$

S represents the quantity supplied, D the quantity demanded, p represents the price, and x and y are jointly distributed random variables with means μx and μy, and variances σ_{xx} and σ_{yy} and covariance $\sigma_{xy} = 0$. The latter assumption means that the forces causing demand and supply to vary are independent.

The price prevailing in this competitive market would be determined by equating (3.2) and (3.3) yielding:

(3.4) $p^e = \dfrac{y - x}{\alpha + \beta}$

The quantity moved in this market is determined by substitution of (3.4) into either (3.2)or (3.3) above, yielding:

(3.5) $q^e = \dfrac{\alpha y + \beta x}{\alpha + \beta}$

Massell then evaluated the producers' surplus under conditions of supply and demand variations compared to a condition of price stability. Consider Figure 3.

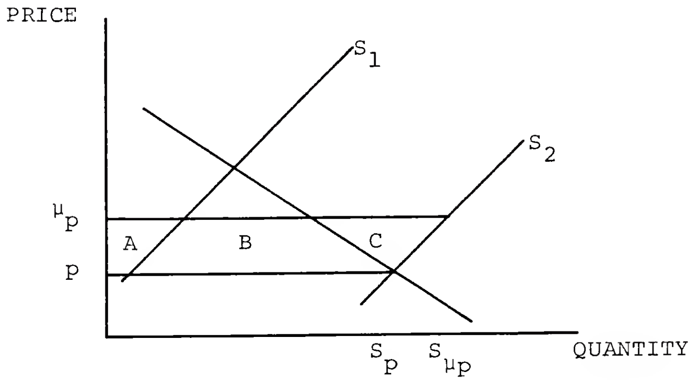

Figure 3. Geometric analysis of producers surplus with price stabilization

He suggests that the producers' gain from a price stabilization program can be represented by areas A + B + C in the illustration above. The areas can be represented by a rectangle plus a triangle. By appropriate geometric representation the gain can be mathematically stated as

$$G_{(p)} = \frac{1}{2} (\mu_p - p)[S_{(\mu p)} + S_{(p)}] \tag{3.6}$$

From (3.3) one can derive that

$$\mu_p = \frac{\mu_y - \mu_x}{\alpha + \beta} \tag{3.7}$$

By substituting equations (3.2), (3.4) and (3.7) into (3.6) and collecting terms one can derive that

$$G_{(p)} = \frac{1}{2}\left[\frac{\mu_y - \mu_x - y + x}{\alpha + \beta}\right]\left[2x + \frac{\alpha(\mu_y - \mu_x - y + x)}{\alpha + \beta}\right] \tag{3.8}$$

The expected value of the gains to producers can be derived from (3.8) above by properly integrating over x and y.

Subsequent to some mathematical operations the results can be shown to be:

$$(3.9) \quad E(G_p) = \frac{(\alpha + 2\beta)\ \sigma_{xx} - \alpha\ \sigma_{yy}}{2(\alpha+\beta)^2}$$

Equation (3.9) represents the gain to producers by a price stabilization program when they face variations in both supply represented by σ_{xx} and variations in demand represented by σ_{yy}. This general relationship can be applied to the Florida orange industry with one assumption. That assumption is that the supply of oranges is not sensitive to price but rather is a perfectly inelastic function whose level is determined by a number of exogenous influences. The assumption means that α is zero. Therefore (3.9) may be rewritten as

$$(3.10) \quad E(G_p) = \frac{\sigma_{xx}}{\beta}$$

Equation (3.10) may be used to draw some conclusions about the benefits of a price-stable situation for this industry. The gains to producers by price stability is greater the greater is the variation in supply.

Differentiating (3.10) with respect to yields

$$(3.11) \quad \frac{d\ E(G_p)}{d\beta} = - \frac{\sigma_{xx}}{\beta^2}$$

This can be interpreted as meaning that the gains to producers from a price stabilization program will be reduced by an increase in the elasticity of demand for oranges.

The purpose of this discussion has now been fulfilled.

First by a simple diagramatical and mathematical exercise it was deduced that price stability was desirable to producers. Second, a more rigorous exercise led to substantially the same conclusion, which is that producers can expect to gain by price stabilization. Since the first objective of this study will determine the contribution that the futures market has made to price stability and since it has been determined that price stability is desirable, should the futures market be shown to be price stabilizing in nature, then it will be judged as being beneficial to this industry.

On the Theory of Hedging

A repeat of the definition of hedging is in order. A hedger is one who has exposure to risk in one market and offsets all or part of that risk by taking offsetting positions in another market. This compares to a speculator who can be defined as one who assumes risk where no risk existed before.

The concept of hedging may be motivated with a Venn diagram as in Figure 4.

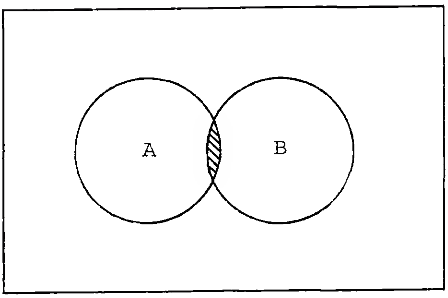

Figure 4. Risk in two markets with low price correlation

Let A represent the revenue risk represented by holding inventory of the real commodity. Let B represent the revenue risk by taking an opposite position in the futures market, that is, selling for future delivery an equal position. In this case the relation of the price series in the two markets is so weak, that is non-correlated, that the risk after hedging represented by the non-shaded portion of A and B is clearly larger than if no hedge was taken.

Suppose however, that the correlation of prices in the two markets was fairly close as depicted in Figure 5.

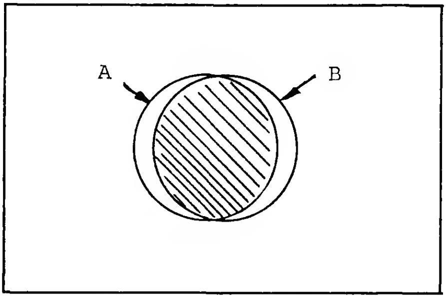

Figure 5. Risk in two markets with high price correlation

In this case also, A represents the revenue risk in the cash market while B represents the revenue risk in the futures market. The non-shaded portions of A and B are smaller than A alone so in this case hedging has reduced the risks compared to the non-hedged condition. This is rather simplistic; however, it serves to visually stimulate the idea that should there be relationships of prices for a commodity in different markets, and if this relation is strong enough, then there may be ways of taking appropriate positions in the two markets that can reduce the price risk that the inventory owner must face.

The concept of Figures 4 and 5 can be expressed mathematically. Let μ_A and σ_A^2 represent the expected level of profits and variation of profits in market A respectively. Likewise, let μ_B and σ_B^2 represent the expected level of profits and variation of profits in market B respectively. The series are assumed to be related and the covariance between the series is represented by σ_{AB}. The variance of the difference between the price series is represented by:

(3.12) $\mathrm{Var}\ (A - B) = \mathrm{Var}(A) + \mathrm{Var}(B) - 2\mathrm{Cov}(AB)$

where $\mathrm{Cov}(AB) = \rho_{AB}\ \sigma_A\ \sigma_B$.

Substituting these notations in (3.12) yields:

(3.13) $\mathrm{Var}(A-B) = \sigma_A^2 + \sigma_B^2 - 2\rho_{AB}\ \sigma_A\ \sigma_B$

To explore the necessary closeness of the price series, assume that it is desired that $\mathrm{Var}\ A \geq \mathrm{Var}(A-B)$. The profit risk after hedging, must be smaller than or equal to the original non-hedged position. From (3.13) it follows that:

(3.14) $\sigma_A^2 \geq \sigma_A^2 + \sigma_B^2 - 2\rho_{AB}\ \sigma_A\ \sigma_B$

or:

(3.15) $2\rho_{AB}\ \sigma_A\ \sigma_B \geq \sigma_B^2$

Since both σ_A and σ_B are positive roots of σ_A^2 and σ_B^2, (3.15) may be expressed as:

(3.16) $\rho_{AB} \geq \dfrac{\sigma_B}{2\sigma_A}$

Therefore, depending upon the relative size of the variances in the two markets, the necessary coefficient of correlation can be determined that would facilitate a successful hedging program. Should there be reasonable equality of variances in the two markets the necessary correlation coefficient can be as low as 0.5.

The above mathematical representations serve to give some feel for the necessary relationship between the two series, assuming equality of holdings of identical commodities in the two markets.

To generate some relationships allowing the holdings in each market to vary, equation (3.13) will be rewritten and put in more general terminology. Let the return from storage be represented by $\Delta P_i X_i$ where ΔP_i is the change in price and X_i represents the amount of holding of the cash commodity. Let $\Delta P_j X_j$ represent the return from the futures markets. In each case let μ_i and μ_j represent the expected returns, σ_i^2 and σ_j^2 represent the price variation in the two markets and let the variance in the returns be represented by $X_i^2 \sigma_i^2$ and $X_j^2 \sigma_j^2$ with covariance $X_i X_j \mathrm{Cov}_{ij}$. Then a formula for variance of total return is:

$$(3.17) \quad V(R) = X_i^2 \sigma_i^2 + X_j^2 \sigma_j^2 - 2X_i X_j \mathrm{Cov}_{ij}$$

Assume that it is desired to determine the position in the futures market that will minimize this variation. That value can be determined by differentiating (3.17) with respect to X_j and setting that expression equal to zero.

$$(3.18)\quad \frac{\partial V(R)}{\partial X_j} = 2X_j\,\sigma_j^{\,2} - 2X_i\,\text{Cov}_{ij} = 0$$

From this the optimum level of holdings in the futures market can be determined as:

$$(3.19)\quad X_j{}^* = \frac{X_i\ \text{Cov}_{ij}}{\sigma_j^{\,2}}$$

Remembering that $\text{Cov}_{ij} = \rho_{ij}\sigma_i\ \sigma_j$, (3.19) can be restated as

$$(3.20)\quad X_j{}^* = \rho_{ij} X_i\ \frac{\sigma_i}{\sigma_j}$$

or

$$(3.21)\quad \frac{X_j{}^*}{X_i} = \rho_{ij}\ \frac{\sigma_i}{\sigma_j}$$

These equations mean that the optimum hedge, $X_j{}^*$, can be determined by a simple mathematical manipulation of observable parameters. Equation (3.21) is restated by graphical methods in Figure 6 below.

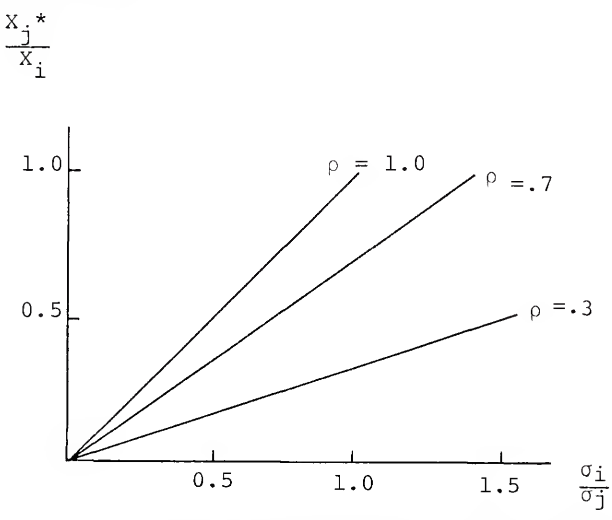

Figure 6. Optimum hedging ratios with varying price deviation ratios and correlation coefficients

Consider a situation where the price variation ratio is 1.5 and the correlation coefficient to be 0.7. Figure 6 would indicate that the hedge ratio should be 1.05. This suggests that positions should be taken in the futures markets which are larger than one's ownership of the real commodity. This would be classed as speculation plus hedging which is a position that would be difficult to defend. Facing such market parameters, full hedging would be the next best alternative.[2]

At optimum hedge levels, the optimum of variance in return is determined by substituting (3.19) in (3.17) above yielding:

$$(3.22) \quad V(R)^* = X_i^2 \sigma_i^2 + \sigma_j^2 \left[\frac{X_i \ Cov_{ij}}{\sigma_j^2}\right]^2 - 2X_i \left[\frac{X_i \ Cov_{ij}}{\sigma_j^2}\right] Cov_{ij}$$

which combines to

$$(3.23) \quad V(R)^* = X_i^2 \sigma_i^2 - \frac{X_i^2 \ Cov_{ij}^2}{\sigma_j^2}$$

remembering that $Cov_{ij} = \rho_{ij} \ \sigma_i \ \sigma_j$ and substituting in (3.23) yields:

$$(3.24) \quad V(R)^* = X_i^2 \sigma_i^2 (1 - \rho_{ij}^2)$$

It can be deduced from (3.24) above that the larger the absolute value of the coefficient of correlation, the more re-

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[2]Ward and Fletcher (33) showed that producers and other marketing agencies may take positions in the futures market which represent less than complete hedging, 100% hedging, or hedging plus speculation. Should there be extensive industry policy that hedging must be limited to 100% of stocks, then an inqeuality constraint must be introduced into the objective function and optimal hedging positions established by programming techniques.

duction in return variance that can be expected. As ρ becomes 1, that is when there is perfect correlation between prices in market i and j, the risk can be reduced to zero. The analysis indicates that the variance in return is dependent upon the return variation of the real commodity and the coefficient of correlation of prices in the two markets.

This analysis would be sufficient for a holder of a known amount of a commodity to determine the optimum level of hedging to minimize risk if that is a goal for which he is indeed striving. Given that he has observed enough data to estimate σ_i, σ_j and ρ then his hedging operation may become a matter of counting his inventory and acting accordingly.

McKinnon (19) suggested that in a more real world situation a producer would not really know what amount of commodity that he would have available for sale until the harvest period. Earlier in the growing season his output would have to be considered a random variable. McKinnon also assumed that prices were a random variable but that there is a correlation between prices and output. In some commodities this correlation might be small but such an assumption for the Florida orange industry would be most valid. Due to the relatively close geographic concentration of producers, if one grower is blessed with good growing conditions or cursed with poor conditions the likelihood is great that a substantial number of other growers in his locality are likewise affected and thus will affect the aggregate output of the industry. Given that industry output changes measurably, prices will likely change also.

In this model let the following represent the return to an individual producer.

(3.25) $Y = PX + (P_f - P)X_f$

Here Y is a measure of total return from production of a commodity represented by P (the price at harvest time) plus the return from hedging in a futures market. X represents the amount of planned production while P_f represents the futures price at the time of the hedge and X_f represents the amount actually hedged. X_f represents the only decision or controlled variable in the model.

The assumptions in this model are:

(A) P and X are bivariate normal distributions with $E(P) = P_f$, $E(X) = \mu_X$, $V(P) = \sigma_P{}^2$ and $V(X) = \sigma_X{}^2$ and they are known to the producer along with a correlation coefficient $\rho_{XP} < 0$ between them.

(B) That $E(P) = P_f$ means that the prices at harvest time are expected to be the futures price when the hedge was taken.

(C) That there is no appreciable cost of hedging (an assumption made to keep things manageable).

(D) That the producer is a risk minimizer.

Using these assumptions the expected return is presented by:

(3.26) $E(Y) = E[P\ X + X_f\ (P_f - P)]$ which yields

(3.27) $E(Y) = E(P\ X)$ since $E(P_f - P) = 0$

The variance of the return with this model is

(3.28) $\text{Var}(Y) = E\ [Y - E(Y)]^2 = E(Y)^2 - [E(Y)]^2$

Substituting (3.26) and (3.27) into (3.28) and expanding yields

$$(3.29) \quad Var(Y) = E\,[P^2\,X^2 - 2X_f\,PX(P - P_f) + X_f^{\,2}\,(P - P_f)^2] - [E(P \cdot X)]^2$$

carrying the expectation operator inside the first bracket yields

$$(3.30) \quad Var(Y) = E(P^2\,X^2) - 2X_f\,E\,[PX(P - P_f)] + X_f^{\,2}\,E(P - P_f)^2 - E(PX)^2$$

This expression now is in the form that is differentiable with respect to the amount of goods to hedge, X_f.

$$(3.31) \quad \frac{\partial Var(Y)}{\partial X_f} = -\,2E\,[PX(P - P_f)] + 2X_f^*\,E(P - P_f)^2 = 0$$

There exists now an expression about the optimum hedge position to take X_f^* that will minimize the return risk. It is minimum since the second order condition, the second partial of Var(Y) with respect to X_f, is positive. These terms need some manipulation to state them in more meaningful terms.

The second term is $2X_f^*\,\sigma_p^{\,2}$ by definition. Expanding the first term yields:

$$(3.32) \quad -E\,[P \cdot X(P - P_f)] = -E[P - P_f + P_f)(X - \mu_X + \mu_X)(P - P_f)]$$

$$= -E\,[(P - P_f)^2(X - \mu_X) + \{(P - P_f)^2\,\mu_X\} + P_f(P - P_f)(X - \mu_X) + \mu_X\,P_f(P - P_f)]$$

Carrying the expectation operator inside the brackets yields:

$$(3.33) = -E(P - P_f)^2(X - \mu_X) - \mu_X E(P - P_f)^2 - P_f\left[E(P - P_f)(X - \mu_X)\right] - \mu_X\,P_f\,E(P - P_f)$$

The first term is the third moment about the mean and with the assumption of bivariate normal distribution becomes zero. The last term is likewise zero since $E(P - P_f) = 0$. Thus, the remainder can be expressed as

$$(3.34) \quad = -\mu_X \sigma_p^2 - P_f \, Cov(PX)$$

or

$$(3.35) \quad = - \mu_X \sigma_p^2 - P_f \, \rho_{Xp} \, \sigma_p \, \sigma_X$$

Substituting (3.35) into (3.31) yields

$$(3.36) \quad 2X_f^* \sigma_p^2 + 2 \left[-\mu_X \sigma_p^2 - \rho_{Xp} P_f \sigma_p \sigma_X \right] = 0$$

or finally

$$(3.37) \quad X_f^* = \mu_X + \rho_{Xp} P_f \frac{\sigma_X}{\sigma_p}$$

This can be rearranged into a more usable, understandable form in the following fashion

$$(3.38) \quad \frac{X_f^*}{\mu_X} = 1 + \rho_{Xp} \frac{\frac{\sigma_X}{\mu_X}}{\frac{\sigma_p}{P_f}}$$

These terms can be interpreted in the following fashion. X_f^*/μ_X represents the optimum ratio of hedging to expected output. σ_X/μ_X represents the coefficient of variation of output and σ_p/P_f represents the coefficient of variation of prices. Since $\rho_{Xp} < 0$, $X_f^*/\mu_X < 1$, therefore the hedge is always less than the expected output. Only when output variability goes to zero can the hedge be as large as expected output. Generally speaking then, the larger the output variability the lower the optimal hedge. Also, if ρ_{Xp} is zero, that is, if one producer's output and market prices are uncorrelated, this says that he should hedge his expected output. Thus, even though he has a short crop and needs to go into the market to complete his commitment he will pay average prices over time and thus will not increase his income variance.

Should the coefficient of prices be zero, i.e., prices are completely stable, equation (3.38) is valued at zero. That is, under completely stable price conditions one would not need to hedge.

Tools for the determination of optimum hedges have now been presented. For the grower seeking to hedge his output, McKinnon's model described above would prove to be a useful guide. For those who can see for certain the level of inventory or stocks, the model described by equation (3.20) or (3.21) would prove to be the better guide.

Summary

The purpose of this chapter was to explore two theoretical areas. One area dealt with price stability and the benefits that may be derived from such a price situation. The other area dealt with hedging and its potential benefit to producers or holders of inventory. That purpose has been accomplished.

Price stability was shown to be a state toward which producers of a commodity should strive. From a rather simple graphical analysis as well as a more rigorous mathematical analysis it was shown that producers would gain additional revenue from a program of price stabilization. Thus any influence that contributes to price stability should be considered a desirable influence.

The first specific objective of this study will deal with the contribution that the futures market in FCOJ may have made to price stability within the orange industry. If it can be shown that the futures market has contributed to price stability for orange solids, then the futures market will be judged as being beneficial to the industry.

The last portion of the chapter probed the theoretical benefits that could be expected from hedging. Two models were developed for hedging depending upon the certainty of one's inventory. It was shown that if an economic link be established for prices of a commodity in two different markets, then a hedging program can be established which will reduce revenue risks for a business enterprise. It will therefore be the purpose of the second specific objective of this study to determine a relationship between prices for oranges in the cash market and FCOJ in the futures market. Given that a relationship can be shown, then hedging programs can be designed for industry participants which will reduce price and revenue risks that have at times plagued this industry.

CHAPTER IV
PRICE VARIATION ANALYSIS

This chapter deals with the first specific objective of this study. The appropriate theoretical formulation for the analysis will be presented followed by the empirical efforts necessary to describe an econometric model. The last portion of the chapter will deal with the results of the model and the implications for the Florida orange industry.

Theoretical Discussions

Price Variation Model

There have been attempts to measure the influences of futures markets upon price fluctuations in various markets. The first published empirical investigation occurred in 1957 when Gray (8) forwarded evidence which indicated that the seasonal price range in onion prices had been reduced subsequent to active trading in the onion futures market. Public law 85-839 passed in 1959, legislated the onion futures market out of existence. Gray (9) re-investigated the onion market in 1963 and found that the onion price variation had gone back to its original, higher seasonal price variation pattern.

Powers (24) studied the variation of live choice grade cattle and pork bellies for a period before and after the introduction of futures trading in these commodities. He attempted to partition the variance into a systematic component and a stochastic component. He used Tintner's variate difference method to isolate the stochastic component of price variation and test the hypothesis that there was no change in price variation. He concluded that the random elements of the price series had been reduced and that the differences in variances were significant at the 5 percent level.

The price variation analysis that is proposed for this study will follow a different methodology than that cited above. It is the purpose of this analysis to assess the contribution that futures trading has made to the variation in prices for orange solids paid to growers.

A model will be developed to assess the various factors that influence the variation in prices paid to producers during the course of a harvesting season. The analysis will focus upon the weekly average price paid to producers for orange solids destined for use as FCOJ. Florida Canners Association publishes price and other citrus data which are distributed throughout the industry. These data are widely used and watched as indications of the strength or weakness existing in the FCOJ market.

These prices react to fundamental changes that occur within the industry. Based upon recent data only about 20 percent of the oranges are priced at or near the time of delivery; thus the reported cash prices would represent more nearly the worth of an added pound of orange solids during the week they were delivered to the processors. If these data are indeed marginal measures of worth, the variation would likely be rapid and would be of significant levels enabling the identification and measurement of influences. The dependent variable will be developed from the intraseasonal variations in prices and will be normalized to mean yearly prices to facilitate comparisons.

Figure 7 can be used to aid in selecting the likely contributors to seasonal price variation. The supply, demand and inventory need to be examined to determine factors that potentially affect a stable price. The demand and changes in demand for FCOJ develop slowly and take considerable time to become recognized. Thus the demand side of equilibrium will offer little explanation for the level of variation in price levels. The major perturbation upon the equilibrium pricing is the expected supply and it will be from the supply and inventory conditions that explanatory variables will be chosen.

Crop size and its relation to previous production levels and consumption are major contributors to price level and interseasonal changes in that level. The crop size is estimated with reasonable accuracy, barring freezes, about two months prior to the beginning of the early variety orange harvest. The price formation activities therefore have had considerable time to establish a price level for a season prior to the commencement of harvesting. Thus one explanatory variable that needs not be included in an intraseasonal price variation model is the estimated crop size or its relation to previous seasons.

The principal modifier to the supply and consequently to the seasonal price variation is cold weather. A freeze can modify

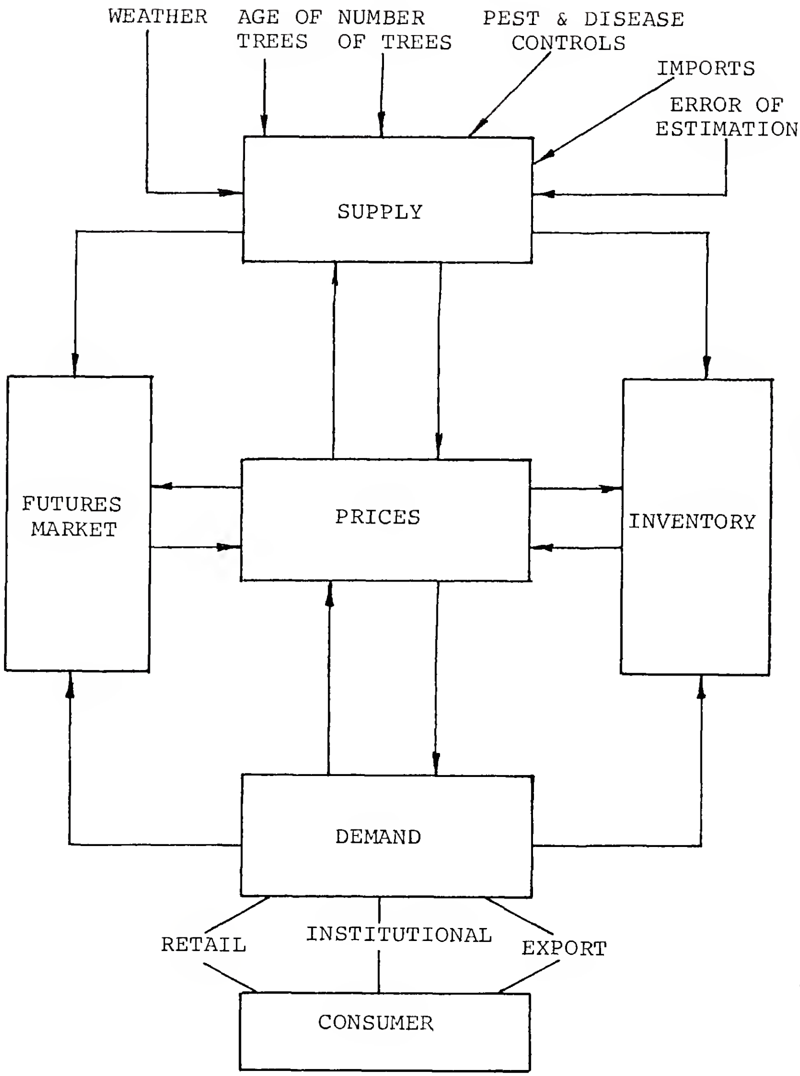

Figure 7: Simplified flow diagram of influences in pricing Florida oranges.

the crop size substantially, and depending upon the timing may alter the seasonal price variation in a similar fashion. An index of weather effect will be generated for each season which will represent the contribution of a freeze to the seasonal price variation. The index will be comprised of the severity as well as the timing within the season.

An additional variable to be considered is the change in expected supply. The total crop can not be estimated with certainty until harvesting is completed. However, pricing decisions continually need to be made as the harvest season progresses. The source of the estimated crop size is the USDA estimate which is released beginning in October for the upcoming season and then monthly (except November) throughout the harvest season. In general the more variation which is observed in the crop forecasts the more one would expect to see prices change as the season progresses. Thus a variable which reflects the changes in the crop forecasts will be developed to assess this influence. In developing this variable, the influence of freezes will be netted out to allow the other changes in forecasts to be properly reflected.

Futures trading may influence the intraseasonal price variation in two ways. The first influence is that of price information transfer. By the mere fact that a futures market exists and trading does take place, the dissemination of the trading prices can be a means of transferring pricing information more completely. A futures price may act as a datum upon which the parties in a selling situation focus and negotiate.

People can use the futures prices, particularly the nearby price, to judge if offering prices are reasonable. Thus it will be hypothesized that a qualitative variable representing the informational effect for futures trading will be necessary in the price variation model. It is further hypothesized that the effect should be stabilizing in nature.

The second effect of futures trading is felt through an inventory variable. Theoretically inventory holding is facilitated by hedging in the futures market. If an inventory variable is beneficial in decreasing price variability, then through the inventory influence hedging is also influential in reducing price variation. This argument will be discussed in more detail later in an inventory submodel.

In this, as in other commodity markets, pricing strategies generally include price adjustments, holding inventories stable, inventory adjustments, holding prices stable, or adjustments in both. The FCOJ industry exhibits a seasonal pattern of holding inventory which is normal and desired. Inventories may be allowed to build somewhat above the historical pattern if the industry feels collectively that adjustments in marketing policies other than price adjustments can contribute to revenue gains. Should that be the case, the marginal worth of extra inputs would not be expected to change as much as if a rigid inventory policy was maintained. Therefore, the development of an explanatory variable which measures inventory in relation to historic norms would be useful in helping to explain seasonal price variation.

Over time many pervasive influences are present which facilitate the orderly development of an industry. Better technical production methods, better marketing activities, more knowledge, better financing, easier, cheaper and more available storage represent improvements that contribute to a more orderly market. These influences are difficult to observe and quantify; however, many are likely to be highly colinear and be increasing over time. One way to represent these aggregate influences would be to introduce time as an explanatory variable. While this may not lead to a completely specified model the interest in this model is not principally directed towards having discrete knowledge of these effects, but only to fairly represent them.

Incorporating the variables discussed above, an implicit form of the price variation model follows as:

Annual measure of price variation = f(weather variable, forecast deviation variable, inventory variable, technological variable, futures trading variable)

Inventory Sub-models

Before addressing the empirical analysis for the price variation model, a digression into the theoretical impact of futures markets on inventory and inventory management will be given.

As was discussed earlier, hedging can be useful in protecting inventory from adverse price swings. Hedging, therefore, represents the other method that futures markets may yield a measurable influence.

Placing a hedge is a behavioral decision that can be measured, using hedgeable goods as an explanatory variable. Prior to or at the beginning of a season, inventories are usually at the lowest levels of the season and these inventories are visible and certain. An estimate of the potential inventory is evident from the reported expected crop size. Beginning plus estimated inventories represent the hedgeable goods which can be used to measure the behavior of the hedgers in the industry. If the futures market is being used by the industry, one could hypothesize a rather simple model for this behavioral response where:

Observed hedging = f(goods available to hedge)

It can be further hypothesized that if the behavior is normal there will be a positive relation between potential inventory and hedging.

The economic impact of hedging comes about after the hedging has taken place. The seasonal pattern of inventory suggests strongly that inventory management is carefully planned and effected. Should inventories be below normal the marketing policies would be towards raising prices of the finished product thereby reducing the amount demanded with the counsequent raising of inventory levels. In such a condition there would be no pressing reason to hedge for downward price protection since the likelihood of prices dropping with a short crop and inventory would be low.

Suppose that a condition of plenty exists. This may come about due to a large crop forecast with nominal inventories or a nominal crop and large beginning season inventories. These suppositions mean that potential inventory[1] levels could rise to a level above normal patterns. Should such a condition occur, the industry could actively hedge, expecting to cover carrying costs, thereby holding that inventory for a period with considerably reduced risks. The industry could engage in marketing activities designed to stimulate demand. These marketing actions could result in an actual inventory pattern different from and below potential levels. Figures 8 and 9 depict the two conditions.

The deviations of I_{actual} below $I_{potential}$ could be a result of marketing policies. Thus the size of the shaded area in Figure 8, $(I_{potential} - I_{actual})$, could be represented as a dependent variable upon which the countervailing forces of hedging and marketing activities could be regressed. The more active and aggressive is the hedging program, the smaller would be the area between the curves. The more aggressive the marketing activities the larger would be the area. Thus the model could be depicted in general form as

$$(I_{potential} - I_{actual}) = f(\text{hedging, marketing policies})$$

with the hedging carrying a positive relationship and marketing activities a negative relationship.

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[1]Potential inventory is a level of inventory that may occur in a specific season. This can be derived by summing to carryover inventory the assumed difference between the cumulative harvest and the cumulative movement into consuming channels.

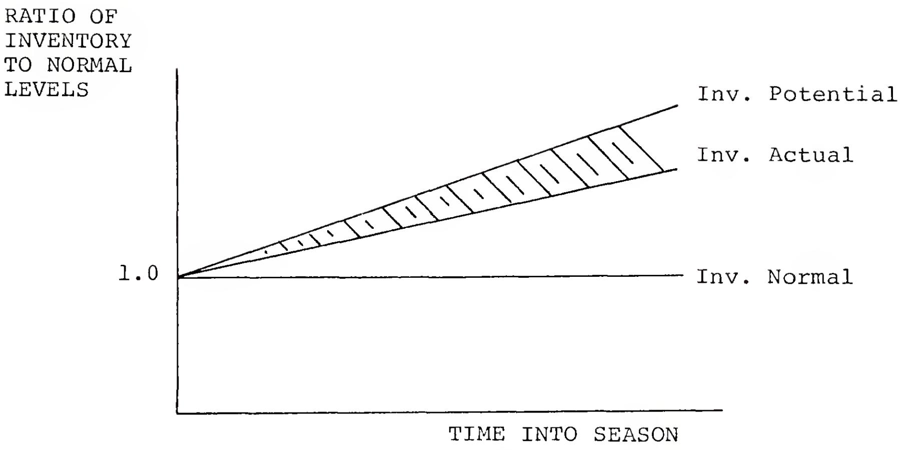

Figure 8. Possible Inventory levels with a large crop and normal beginning inventories

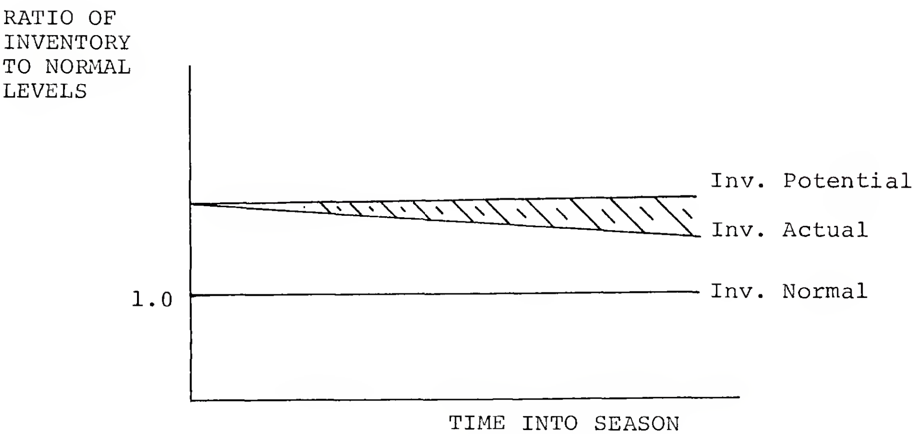

Figure 9. Possible inventory levels with a nominal crop and a large beginning inventory

Prior to moving into the empirical development of these models a review with specific attention to the futures trading aspects will be made. The price variation model will assess the contributions made by a number of influences toward intra-seasonal price variation. Of specific interest in this model is the coefficient associated with the futures trading variable, FT_j. The second model developed will measure the behavior of hedgers towards apparent changes in their potential stock. Finally the inventory model will assess the contribution that hedging has made to carrying inventory.

The signs on each of these coefficients will cause reactions that may best be presented in tabular form. These reactions will apply when the coefficient has been judged significantly different from zero.

	Futures trading variable	Hedgeable goods variable	Observed hedging variable
> 0	Cause for concern/ action	Expected and normal industry behavior	Hedging is not helping inventory management
< 0	Benefit to industry	Industry is wasting a tool	Hedging is aiding

There is a temptation to draw conclusions when the coefficient is not significantly different from zero. Both the researcher and the reader must realize that the chances of being wrong are greater than the limits which were initially found acceptable.

Empirical Efforts

Price Variation Model

The specific form of the price variation model in linear additive form is postulated to be:

$$(4.1)\quad PVI_j = \alpha_0 + \alpha_1 W_j + \alpha_2 FT_j + \alpha_3 \bar{I}_{\cdot j} + \alpha_4 FD_j + \alpha_5 T + u_j$$

where PVI_j = jth year's relative variance of prices,

W_j = yearly weather (freeze) index,

FT_j = futures trading qualitative variable,

$\bar{I}_{\cdot j}$ = yearly mean deviation from historical inventory patterns,

FD_j = seasonal deviation in forecasted crop,

T = a time variable which is included to account for the effects of unspecified technological changes which are assumed to occur uniformly over time

u_j = a stochastic error term

α_i = the coefficients to be estimated

In order to compare price series from year to year in the orange industry, the weekly price data need to be divided by the mean price for the season to facilitate comparison between seasons.

By reducing all weekly prices to a ratio of the mean seasonal price, the data can be used directly with no concern for deflating the price series as is often necessary and with little concern for the heteroscedasticity between the mean and the variance of prices in the different seasons.

Let P_i represent the price in week i and $\overline{P}$ the mean price for the season. The mean of Z_i letting $Z_i = P_i/\overline{P}$ is:

$$(4.2) \quad E(Z_i) = \frac{1}{n} \sum_{i=1}^{n} \frac{P_i}{\overline{P}} = \frac{n}{n \, \Sigma P_i} \quad \Sigma P_i = 1$$

The variation of Z_i is by definition

$$(4.3) \quad V(Z) = E\ (Z - E(Z))^2$$

or

$$V(Z) = \frac{1}{n} \sum_{i=1}^{n} (Z_i - 1)^2$$

This is an expression for relative variance of the seasonal price series. The PVI_j then will represent the level of V(Z) observed for each season. The data used to calculate PVI_j are the weighted weekly average prices of spot plus contract fruit[2] delivered-in reported by the Florida Canners Association.

In developing the seasonal weather index W_j, consider Figure 10 on the following page:

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[2]Spot fruit are brought to market with no prior price negotiation whereas contract fruit comes to market with a price prearranged up to four weeks in advance of delivery, depending upon the specific terms of the contract.

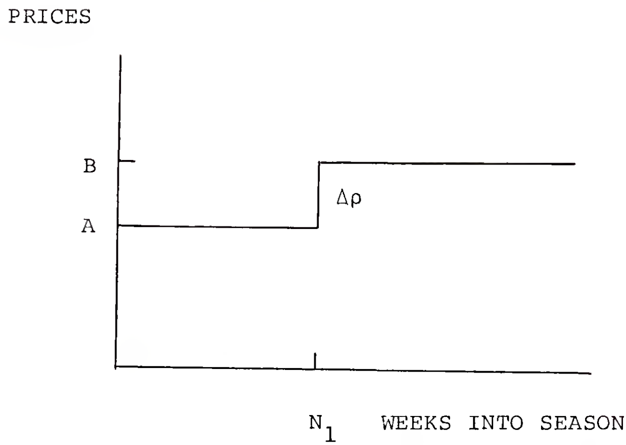

Figure 10. Weather effect upon seasonal price variation

Suppose A represents the price before a freeze which occurs N_1 weeks into the season. Let B represent the price after the freeze which will exist for the remaining $(N - N_1)$ weeks of the season. The price differences (B - A) will be represented by a percentage of the crop being destroyed. This relationship between crop reduction and price increase is assumed to be linear.

Seasonal variation then is represented by

$$(4.4)\qquad \mathrm{Var}(p) = \frac{N_1(A - \bar{p})^2 + (N - N_1)(B - \bar{p})^2}{N}$$

where

$$(4.5)\qquad \bar{p} = \frac{AN_1 + (N - N_1)B}{N}$$

Substituting for $\bar{p}$ in (4.4) gives:

$$(4.6)\qquad \mathrm{Var}(p) = \left(\frac{A - B}{N}\right)^2 N_1(N - N_1)$$

which may be restated as

$$(4.7)\qquad \mathrm{Var}(p) = \Delta p^2 \left[\frac{N_1}{N}\right]\left[\frac{N - N_1}{N}\right]$$

Thus by a combination of freeze severity represented by percent of crop destroyed and by time into the harvest season, the weather index vector, W_j, will be constructed. Other weather influences are ignored as being small compared to the freeze effect.

It will be assumed that the slope of the demand curve stays constant throughout the season. Therefore there will be a linear relationship between the change in the supply of oranges and the change in the prices received for them. A proxy for Δp will be the percentage change in the USDA estimates of crop size from a prefreeze estimate to the next "meaningful" post freeze estimate. A meaningful estimate is one where the full impact of a freeze has been included.

Consider the data in Table 1 below which presents the estimates for the 1970-71 season. In this example there was a freeze on January 20-21. The estimate for February was held relatively stable because the extent could not be properly assessed. The March estimate, down 11 million boxes or 6.6 percent of the total crop estimated the previous month, was the first estimate to reflect the freeze damage. To continue with this example, the (N_1/N) $(N - N_1)/N)$ can be developed. The length of the typical season N can be set at 210 days. In this case, the freeze occurred on the 51st day of the season so the value of (N_1/N) $(N - N_1)/N)$ is equal to (51/210) (159/210) = .1839. The weather index, W_j for the 1970-71 season then would be 1.2137 which is the product of 6.6 (.1839).

Table 1

USDA crop estimates for Florida oranges, 1970-71 season

Month	Early and Midseason	Valencia	Total
	- - - - - - - - - - -1,000 boxes	- - - - - - - - -	
October	100,500	74,000	174,500
November	100,500	74,000	174,500
December	98,500	71,000	169,500
January	95,500	71,000	166,500
February	94,000	71,000	165,500
March	87,000	67,000	154,000
April	87,200	67,000	154,200
May	87,200	63,000	150,200
June	87,200	63,000	150,200
July	87,200	60,600	147,800
FINAL	87,100	60,200	147,300

Source: Florida Crop and Livestock Reporting Service.

The futures trading variable in the model, FT, is proposed to be a qualitative variable set equal to 1 for all years in which trading has taken place. In the first season of trading, the 1966-67 season, the value is scaled to be $0 < FT < 1$. This scaling reflects the developing awareness of futures pricing information during this first season. This futures trading variable will pick up the informational aspect of futures trading and will be the principal focus of this model.

Attention will now be focused upon the inventory variable for this model. As stated earlier in the chapter the industry has two decision actions available when considering what to do with the crop and the potential of moving it. With potentially burdensome crops a useful method to help movements would be to store the excess of production over consumption with the anticipation that prices will become more favorable in the future. The inventory would be stored if the holder expected with reasonable certainty to recoup the storage costs.

Inventory maintenance, however, is an economic necessity for processors. Typically, inventory must be built up for two reasons. One is the usual agricultural problem of short production seasons and the necessity to maintain inventory so that the year-long demand can be met without major variations in the product prices. The second reason stems from the industry desire to produce a homogeneous product via the blending of juices. Early and midseason juice is usually kept and blended with the late season Valencia juice and some Valencia juice is maintained over the summer to blend with the early varieties harvested in the fall months of the next season. There is a seasonal pattern clearly established for inventory levels which often serves as a guide for many within the industry to help determine pricing policies. For the purposes of the price variation model a typical inventory pattern needs to be established such that these data and deviations from the historical pattern may be used as potential explanatory variables.

To develop this pattern, a value was established for all weeks of every season beginning with the recognized first week for each season, usually the first week of December. With a desire to normalize these data, the recognized goods on hand for any specific week of a given season was divided by the mean weekly movement for the past 52 weeks thereby creating a datum that was free of absolute size problems.

Thus for week i in year j the datum would be represented by:[3]

$$(4.8) \quad I_{ij} = \left[\frac{GOH_{ij}}{YM_{ij}}\right](52)$$

---

[3]An example of a calculation for I_{ij} will be made using the data for the first week of the 1973 - 74 season. The goods on hand of FCOJ in all forms on 12/8/73, which represents the end of the first week of the season, was 49,839,278 gallons of 45° Brix. The actual inventory may have been stored at a higher concentration level; however, the data were converted into gallon equivalents of 45° Brix. It was reported that 160,173,956 gallons of 45° Brix concentrate were moved in the 52 weeks preceding 12/8/73, thus

$$I_{1,74} = \frac{49,839,278}{160,173,956} \times 52 = 16.180 \text{ weeks}$$

represents an entry for the first week of the 1973 - 74 season.

where

I_{ij} represents the level of inventory in weeks at the end of the ith week of the jth season,

GOH_{ij} represents the goods on hand at the end of the ith week of the jth season,

YM_{ij} represents the total movement of FCOJ for the 52 weeks preceding and including the ith week in the jth season.

Summing these inventory levels across the k years and dividing by k would represent a typical historical level for the first week of a season. Represented mathematically

$$(4.9) \quad \bar{I}_{i.} = \frac{1}{k} \sum_{j=1}^{k} I_{ij}$$

where

$\bar{I}_{i.}$ represents the historic mean or average level of inventory in the ith week of any given season,

k represents the number of years in the study.

In this manner the data from the 1958-59 season through the 1973-74 season were used to construct Table 2 and Figure 11, a graph of the typical inventories for the industry.

It is proposed that an inventory variable be developed which shows the mean weekly deviation from historic norms for the specific season, i.e.,

$$(4.10) \quad \bar{I}_{.j} = \frac{1}{n_j} \sum_{i=1}^{n_j} (I_{ij} - \bar{I}_{i.})$$

Table 2

Typical inventory of industry during the season
(averages of 1958-59 season through 1973-74 season)

Weeks into Season	Average Goods on Hand	Weeks into Season	Average Goods on Hand
	(Weeks)		(Weeks)
1	10.424	21	23.718
2	10.374	22	24.881
3	10.919	23	26.212
4	11.463	24	27.565
5	12.397	25	28.881
6	13.378	26	29.982
7	14.509	27	30.949
8	15.796	28	31.669
9	17.241	29	31.976
10	18.567	30	31.848
11	20.025	31	31.649
12	21.222	32	31.024
13	22.089	33	30.236
14	22.567	34	29.280
15	22.686	35	28.343
16	22.429		
17	22.087		
18	21.943		
19	22.166		
20	22.735		

Source: Developed from Florida Canners Association data.

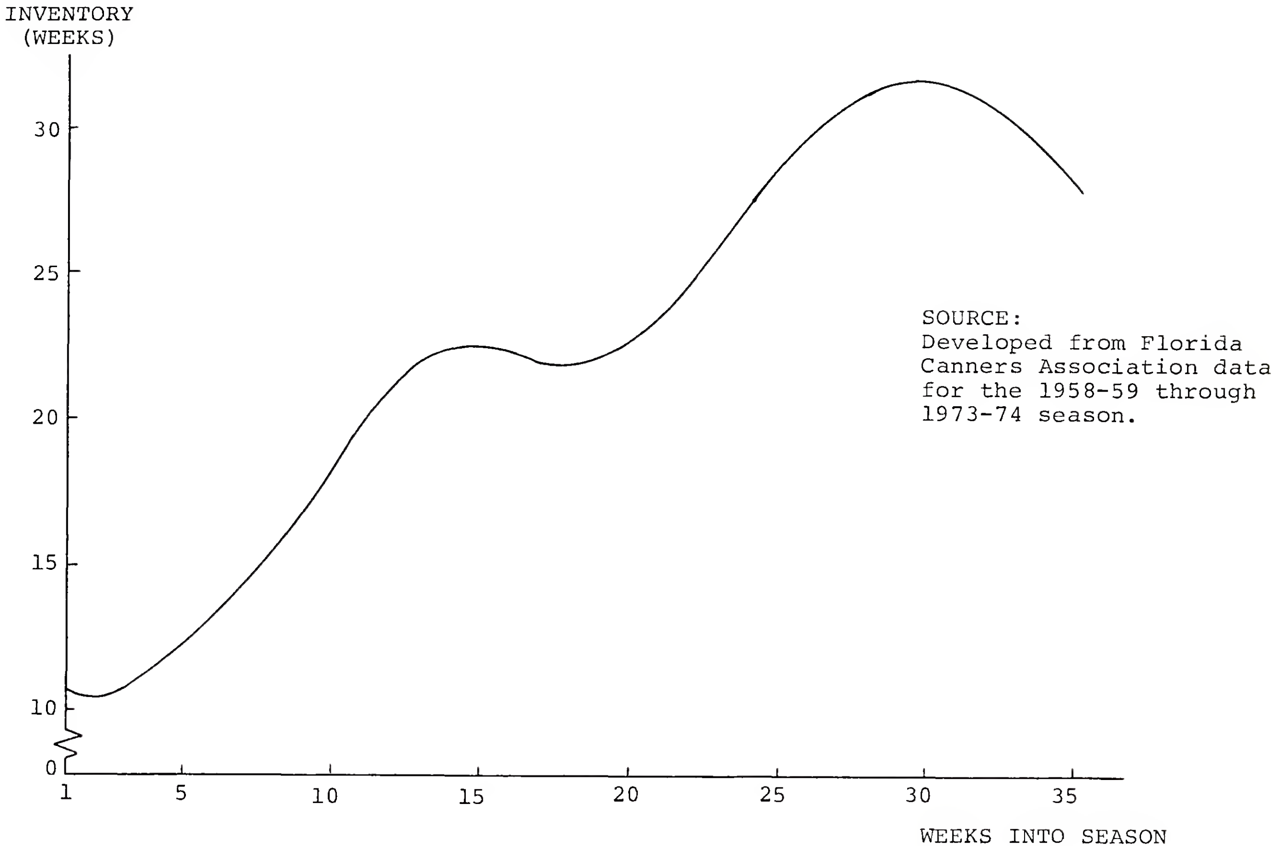

Figure 11. Plot of typical inventory vs. weeks into season

where

$\bar{I}_{\cdot j}$ represents the mean weekly deviation from historic norms for the jth season,

n_j represents the number of weeks in the jth season,

I_{ij} and $\bar{I}_i$ are as before.

$\bar{I}_{\cdot j}$, as developed, is assumed to be a measure of the industry's willingness to follow a strategy of holding prices constant and allowing inventories to build. This willingness to carry inventories higher than normal would likely translate into less price variation within the industry.

The seasonal variation of crop forecasts, FD_j, will be developed on an annual basis from the USDA forecasts. These crop forecasts will be adjusted to allow for the estimated loss should a freeze occur. The data from Table 1 would be useful as an example. There was an 11 million box decline in the crop forecast for March 1971 due to the freeze which occurred on January 20-21. The March estimate and all subsequent estimates would then be corrected for a freeze by adding the 11 million boxes. This correction would separate the influence of a freeze measured by another variable in the model from the influence of changes for other reasons. To compensate for the varying crop size the deviation will be normalized by the mean forecast for the season to develop a meaningful and comparable statistic. FD_j, the index of crop forecast deviation, then would be represented as:

$$(4.11)\quad FD_{.j} = \frac{1}{n\,\overline{CF}_{.j}} \sum_{i=1}^{n} (CF_{ij} - \overline{CF}_{.j})^2$$

where CF_{ij} represents the crop forecast in the ith month of the jth season compensated for a freeze loss as necessary,

$\overline{CF}_{.j}$ represents the mean crop forecast for season j corrected for freeze losses,

n represents the number of forecasts in season j.

Lastly, the time variable will be represented either as time in linear form or as a log function to represent the technological variables that could contribute to the price variation.

The observations have been made over a period of 16 years through the 1973-74 season. The number was chosen to insure enough degrees of freedom to generate a reasonable estimate of the covariance matrix. The number was also selected to give an equal period of time before and after the introduction of the futures market in FCOJ.

Making the assumptions of the classical linear model, that is $E(u) = 0$, $Var(u) = \sigma^2$ and $E(u_t, u_{t-1}) = 0$, the price variation model was subjected to an ordinary least squares (OLS) fit using the RAPE[4] program with the following estimates of

[4] RAPE is an acronym for Regression Analysis Program for Economists. Version 2.7 dated February 22, 1972, was the program being used at the University of Florida's Northeastern Regional Data Center during this investigation.

the structural form of the model. The figures in parentheses are the standard errors developed by the program for each coefficient.

$$(4.12) \quad PVI_j = \underset{(-7.262)}{-6.601} + \underset{(6.796)}{65.282} W_j + \underset{(1.422)}{2.485} FD_j - \underset{(-.940)}{0.689} \bar{I}_{\cdot j}$$

$$\underset{(-15.856)}{-33.029} FT_j + \underset{(1.612)}{2.353} T + u_j$$

with $R^2 = .9366$, DW = 2.04

or

$$(4.13) \quad PVI_j = \underset{(-9.990)}{-4.827} + \underset{(7.033)}{66.290} W_j + \underset{(1.539)}{1.867} FD_j - \underset{(-\ \ .921)}{0.401} \bar{I}_{\cdot j}$$

$$- \underset{(10.975)}{21.490} FT_j + \underset{(7.079)}{7.808} LT + u_j$$

with $R^2 = .9315$, DW = 2.05

The only difference in substance between the two equations is in the presentation of time. Equation (4.12) has time in a linear increase while equation (4.13) presents time in a natural log form. From a technical sense both equations are reasonable. The coefficient of determination is slightly higher in equation (4.12) and both are absent of any autocorrelation. The signs of the coefficients are identical so there is little to suggest that one is better than the other. Equation (4.12) will be used to discuss the coefficients and their implications in the next section of this chapter.

During the early stages of this investigation another variable had been contemplated for use in this model. That variable was the ratio of priced fruit that entered the FCOJ channel. The feeling was that possibly the size of this priced fruit ratio might help explain the observed seasonal price variation. It was dropped in the rudimentary stages of the model development because its coefficient value and the t ratio were both low. The extra degree of freedom gained by discarding this variable was considered a desirable trade-off.

If the reader will refer to Figure 7 it will be noted that the major influences upon prices have been included in the price variation model. The omitted influences upon supply are not considered useful in determining intraseasonal price variation.

Inventory Sub-models

During the development of the inventory variable for the price variation model, a second influence of futures trading was discussed. Theroretically a futures market offers a hedging medium which facilitates the carrying of inventory. It will be the purpose of this section to probe that second influence. It was discussed earlier in this chapter that hedging in FCOJ must involve two distinct activities. One is the act of placing the hedge which is accomplished by selling contracts on the futures market. The second act is removing the hedge which is accomplished by either delivering the commodity or by buying back the contracts in the futures market. The act of placing the hedge is hypothesized to take place when the size of the season's potential is known.

It is postulated that this behavioral response can be represented by

$$(4.14) \quad OH_j^A = \beta_0 + \beta_1 \, GH_j^A + v_j$$

where OH_j^A = the observed hedging at time point A in season j,

GH_j^A = goods available to hedge at or near time point A in season j.

The observed hedging will be represented by the level of short hedges held by large traders whose accounts are classified as hedge accounts.[5] The level of open interest in these accounts reported by the Commodity Exchange Authority for October 31 of each season (29).

At that time the hedging programs have had time to be formulated and enacted, based upon goods readily visible in freezers and the USDA October crop estimate for the upcoming season. The observed hedging will be expressed in 1000 gallons of 45° Brix by using the following conversion:

$$(4.15) \quad OH_j^A = \frac{OI_j^A \left(15{,}000\right)}{4.5122}$$

where OI_j^A = the level of open interest in hedge accounts held by large traders,

15,000 = the pounds of solids in each contract,

4.5122 = the pounds of solids in a gallon of 45° Brix concentrate.

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[5] A large trader is one who has more than 25 contracts open at any one time. This would represent about 70,000 gallons of 52° Brix concentrate. There may be some hedging done in lesser amounts, however it is felt that the bulk of the hedging would be represented by the large traders.

The large traders were not required to report their positions until January 20, 1969. For those periods not covered by reporting an estimate of the hedging was generated by assuming that 30 percent of the open interest would represent the hedge accounts. This level was chosen because it reflected the conditions for a number of months subsequent to the start of reporting. This behavior was assumed to have been constant up to the beginning of reporting.

To develop the variable, GH_j, the stocks existing in inventory as of October 15 were summed to the estimated gallonage available for concentrate from the new crop. Expressed mathematically

$$(4.16) \quad GH_j^O = GOH_j^O + (CF_j^O\, U_{j-1} Y_j)$$

where GOH_j^O represents the goods on hand as of October 15 in season j,

CF_j^O represents the October crop forecast for the coming season in boxes,

U_{j-1} represents the percentage of the total crop utilized for FCOJ in the previous season and assumed to remain constant for the upcoming season,

Y_j represents the estimated yield in gallons of concentrate per box from the USDA crop forecast or the previous season's yield for years prior to the USDA yield estimates.

The data from the 1966-67 season were not used since the market had just been formed and the industry reaction was virtually non-existent for a period of months thereafter. Thus there are eight observations from which the following estimates of October hedging behavior were derived.

$$(4.17)\quad OH_j^O = \underset{(-2544)}{-1608} + \underset{(.0137)}{.0415}\ GH_j^O + v_j^O$$

$$R^2 = .6065,\ DW = 1.90.$$

Also the same model was used to observe the behavior for July 31 of each season. At that time the harvest is complete and GH_j can be represented completely by GOH_j. The OH_j^J were developed in precisely the same manner using July 31 data. The estimate of the structure of the July hedge model was

$$(4.18)\quad OH_j^J = \underset{(-5455)}{-6803} + \underset{(.0617)}{.1435}\ GH_j^J + v_j^J$$

$$R^2 = .4739 \text{ and } DW = 2.45.$$

The effect of hedging upon the industry is that inventory above traditional levels may be safely carried. The economic effect of hedging can possibly be measured by a careful examination of possible and actual inventories. At the beginning of each season an $I_{potential}$ (maximum possible inventory) curve may be generated. The beginning level of stocks can be augmented by expected harvest activity. Estimates of change in stock level can be determined by estimating the movement, assuming a constant demand. Should that stock level prove to be burdensome, marketing actions can be taken to move the product thus reducing sotcks nearer to the desired or normal levels. Stocks may be successfully hedged and completely maintained above normal levels (I_{normal}). Thus there exists a measurable influence on which explanatory variables can be regressed.

The dependent variable is a measure of ($I_{potential}$ - I_{actual}) as initially discussed on page 40. The area between these values (see Figures 8 and 9) can be calculated by summing the deviations observed weekly over the season. Thus the area between these curves would represent the success of the hedging or marketing activities or a combination of these influences. Since hedging inventories is most useful when stocks are above levels that offer convenience yields, the data will not be useful in developing a dependent variable when inventory levels are at or below normal levels. An examination of the inventory level in existence since the introduction of futures trading shows only two seasons (1973-74 and 1969-70) when inventories were substantially above the normal levels. Even though only two explanatory variables are envisioned for the model, there clearly are not enough data to facilitate estimation of the structure of the model. A number of years of data with inventory surpluses will be necessary to allow judgment on this aspect of the economic benefits of hedging.

Interpretation and Industry Application

Price Variation Model

Recall that the fitted price variation model was

$$\widehat{PVI}_j = -6.601 + 65.282\ W_j + 2.485\ FD_j - 0.689\ \bar{I}_{\cdot j} - 33.029\ FT_j + 2.352\ T \tag{4.19}$$

The dependent variable is a dimensionless measure of the square of the deviation of cash prices expressed as a percent of the yearly mean price. The coefficient on each explanatory variable then shows the contribution to this yearly index. A positive sign indicates that the variable has contributed to price variation while a negative sign indicates a lessening of price variation or said differently, a contribution towards price stability.

The weather variable coefficient had a t ratio of 9.606 which is an indicator of its statistical significance as an explanatory variable. The weather phenomenon is well recognized with the industry. There is little that can be done to soften the effects of freezes, given the industrial structure and technology as it exists today. Development of better warning and better protection methods could possibly, over time, mean that fewer oranges would be lost to a freeze of a given severity. Development of mechanical harvesting means could aid in salvage operations subsequent to a freeze. Presently the salvage method is by hand picking as quickly as possible and that must be limited by the size of the labor force and the processing capacity. Should the industry decide to develop a buffer stock program, the wide price swings that are sometimes evident subsequent to a freeze could be softened by the sale of this buffer stock. Thus, while there are possible means to mitigate the effects of freezes, they are not now available and therefore the industry will continue to experience the problem of price variation as a result of a freeze.

The positive sign on the time coefficient indicates that there is a time related destabilizing influence. This may have occurred due to the introduction of new technology or may have occurred due to the problems attendant with moving ever larger orange crops into consuming channels.

The crop forecast deviation variable had a positive sign and a relatively high t ratio. This indicates that changes in the forecasts do contribute to price variation. The implication for the industry is that there should be attention paid to the problems of errors of estimation. It might prove beneficial to the industry if there were developed better estimation methodology.

The second best coefficient in terms of the t ratio was the futures trading variable. With the t ratio of -2.083 one can test the hypothesis that the coefficient is equal to zero against the hypothesis that it is less than zero. The null hypothesis can be rejected in favor of the alternative that it is less than zero at the 5 percent level. This means that the futures trading <u>has contributed to price stability</u> for the industry.

The inventory variable had a negative coefficient which means that as the industry holds more inventory prices tend to become more stable. Since hedging theoretically aids in holding inventory, the futures market appears to have made another contribution to price stability.

The purpose of the price variation model was to isolate the major contributors to variability of prices for orange solids. Once accomplishing that the interest would be focused upon the contribution that the futures trading may have made. Those purposes have been fulfilled. The futures market in FCOJ can be judged as being a beneficial influence for the industry. It was demonstrated in Chapter III that a tendency toward price stability meant additional revenue to producers. With the recognition of a number of influences that contribute to price variability, the industry can consider itself fortunate and financially stronger since and because of the introduction of a futures market in FCOJ.

Inventory sub-model (Hedge Model)

The regression of large trader open interest of each season upon the goods available to be hedged yielded this relationship:

(4.20) $\widehat{OH}_j^O$ (in 1000 gallons) = $-1608 + .0415\ GH_j^O$ (in 1000 gallons)

(4.21) $\widehat{OH}_j^J$ (in 1000 gallons) = $-6803 + .1435\ GH_j^J$ (in 1000 gallons)

These results will be presented in Figure 12 below.

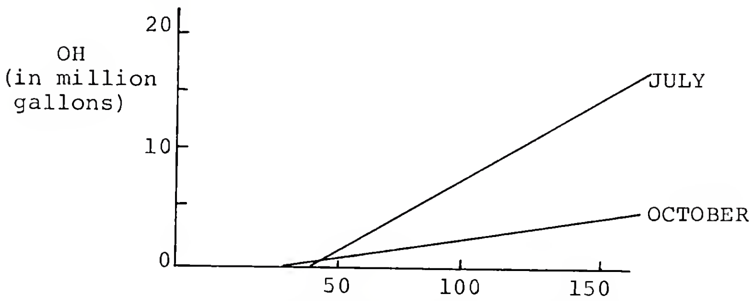

Figure 12. Observed hedging at specific points in the season

It can be deduced that there apparently has been a level of inventories below which hedging is unnecessary. That point is determined by dividing the constant term by the slope coefficient of GH_j. This industry seems to consider that in the vicinity of 40 million gallons, hedging is unnecessary. This could be entirely reasonable if hedging is an activity which is entered into to lower the risk of a price decline. When goods available to hedge are low, the risk of price declines is low and thus participants may accept that low risk, leave their goods unhedged and wait for the more likely probability that prices will rise.

The second deduction is that only a small percentage of the goods available to be hedged are indeed hedged. The coefficient for the October model indicates that the typical response of the industry to a rise in goods to hedge will be the placement of hedges on only 4.2 percent of the increase. With increases in hedgeable goods in the offing, there is an attendant risk of price declines. When facing such prospects, reasonable behavior would suggest the placement of substantial hedges; thus it appears that this industry is not availing itself of the opportunities to pass risk through the medium of hedging.

The same deductions may be made when observing the July hedging except that the response to extra inventory is higher at 14.3 percent. Perhaps the lack of uncertainty in the level of inventory which exists at the end of the harvesting season would account for the more positive response of hedging to stock levels. A conclusion that can be drawn from both results is that there is considerable inventory that does not carry a protective hedge during a marketing season.

If inventories decline towards the 40 million gallon level, present behavior would suggest that industry usage will decline towards zero. This observation leads to two possible implications. First, should the reduction of hedging actually decline towards zero, one of the beneficial effects of the futures market on price variation would be considerably lessened. The implication for the industry is that cash price variation would be expected to increase. Second, should industry hedging actually drop to very low levels, there may be implications for the health and continued vigor of the futures market for FCOJ.

Summary

The futures market has contributed to price stability within the Florida orange industry. Should price stability be accepted as a desirable goal, then the futures markets have clearly contributed to achieving that goal. The behavior of industry participants towards hedging potential inventory has the proper relationship; however, the reaction seems to be relatively minimal.

One policy implication that can be suggested from the analysis above is that as a minimum a policy of no intervention would be in order. A more positive policy of endorsing an educational program for industry participants would be suggested. Included in this educational program would be the attempt to create a more positive image of the futures market in the minds and actions of the industry members, as well as informing the participants to the intricacies of the act of hedging.

CHAPTER V
PRICE DIFFERENTIAL ANALYSIS

Oranges may enter the marketing channel and become valued or priced at the time title to the fruit is passed to the buyer. These oranges are classified as cash fruit. Also, oranges may enter the marketing channel without a value being established at the time possession and title change hands. These oranges may be referred to as pool fruit. The ultimate prices for pool fruit and the prices for cash fruit may be and usually are different. These marketing methods (described in Appendix A) have developed and have existed for many years. It will be the purpose of this chapter to determine if the futures market in FCOJ has become an influence which has changed the relative returns for these two marketing methods.

Theoretical Model

To facilitate the discussions for this analysis, a slightly different flow diagram from that presented earlier would be necessary. Figure 13 below schematically highlights the price differential potential. One can deduce from Figure 13 that pool fruit flows from producers to processor without any direct influence from the futures market. Cash fruit pricing, however, may be influenced by the futures market. Since the price formation activities take place at or near the time of delivery both the buyer (processor) and seller may use the data from the futures market as indicators from which to make pricing decisions.

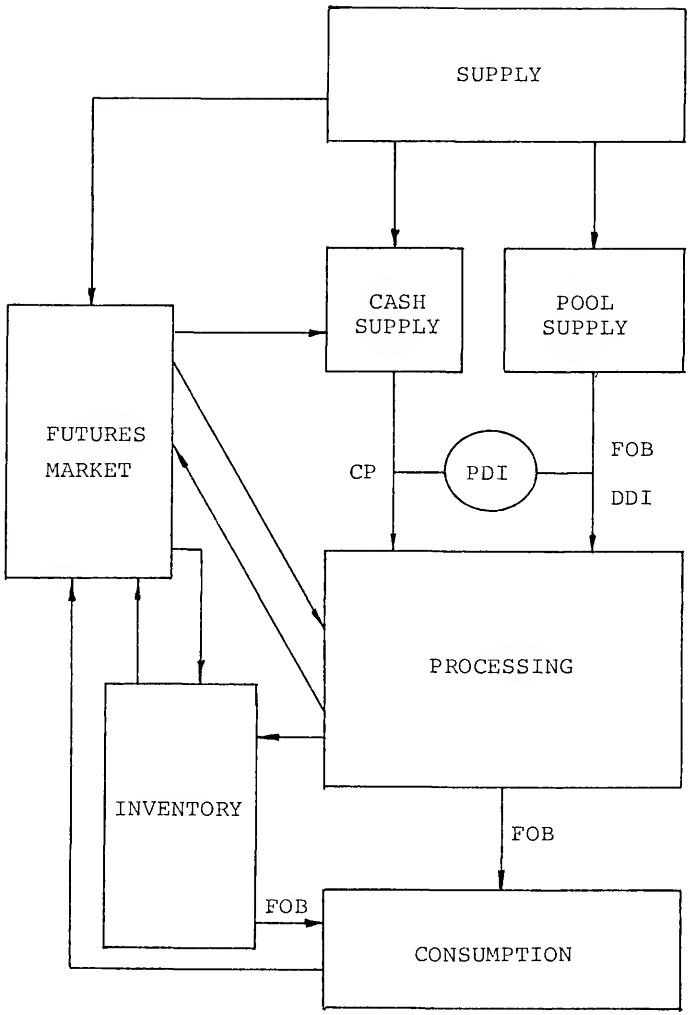

Figure 13. Orange flow highlighting price differential possibilities

The price differential between pool and cash fruit which existed before the development of the frozen orange concentrate product may have been affected by the advent of trading in a FCOJ futures market. It can be hypothesized that with the reporting of futures price information, the pricing of cash fruit may well have been aided relative to pool fruit. This occurs because there is an alternative market for the fruit, that of custom processing and delivery through the futures market. A model will be developed which will analyze the price differential for a number of years with the intent of assessing the contribution that the futures market may have made.

For this model one price series (cash fruit) is widely published and easily available. The other price series, that for pool fruit, is not available and must therefore be derived. For the non-published price series, it is proposed that a delivered-in price be derived from published FOB prices. The FOB derived delivered-in price will be established by netting from the current FOB prices the total costs of producing and marketing concentrate. This is a practice normally used by cooperatives and participation pools and is expected to serve as a measure of what the "typical" grower might receive for his product. The data which will be used to determine the production and marketing costs are presented in the Spurlock reports (27). The selected production costs will be those for producing and selling a case of 48 six-ounce cans of frozen orange concentrage, a typical retail size.

The largest influence contributing to the price differential is the new season's FCOJ availability.[1] Participation plans and cooperative membership once established tend to be relatively stable over a number of seasons. Therefore, most processors have known number of acres from which they receive fruit. Also, most processors have usual sales outlets or an assumed sales commitment. Cash fruit, in contrast, represents an additional supply having a different marginal value to processors. Suppose the processors' sales commitments can be made from committed pool fruit. In that case, additional supplies from cash fruit are not particularly desirable and therefore it would command a price considerably less than the derived price for pool fruit. Suppose, on the other hand, that committed fruit will not fulfill expected needs. Then the marginal value of the cash fruit may exceed that of the non-priced, pool fruit.

An explanatory variable which presents the relative change in potential product availability would be a useful explanatory variable for this price differential model. Ward (32) reported a secular growth in processed orange products that would amount to an estimated increase in expenditures of about 6 percent annually. Given that the secular trend has been established, one might expect that the availability influence upon

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[1]Availability is defined as FCOJ on hand in storage plus estimated FCOJ production from new fruit.

relative prices for oranges could be represented as in Figure 14 below.

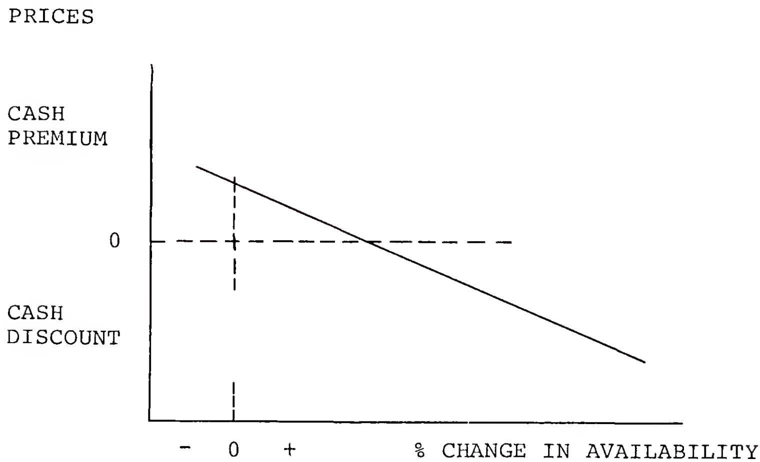

Figure 14. Availability influence upon relative prices

Figure 14 implies that a growth in availability may be observed, but if the growth in availability just matches the secular increase in demand for FCOJ then there will not be an influence upon price differential. An increase in availability less than the increase in demand would cause prices to move in favor of cash fruit. There is an implicit assumption that as availability increases, there will be a change in price differential in favor of pool fruit.

As in the previous model a principal modifier to the availability is the effect of a freeze. The occurrence of a freeze reduces the pool crop size. Given the crop commitments by processors a reduction in members' supply increases the marginal value of cash fruit. Hence the cash fruit may sell at a premium to the derived delivered-in prices. Since this model is dealing with a price differential some function of time during season and severity of a freeze will need to be included in the price differential model.

Referring again to Figure 13 it can be deduced that there are influences which in and of themselves should not contribute to the differential price but which are multiplicative or interactive terms with the supply parameters discussed above. These influences are hypothesized to be the cash fruit ratio[2] and the effect of futures trading.

Earlier it was discussed that because of supply and sales commitments, processor would value an extra box of oranges below the derived pool fruit price if it appears that the inflow of fruit was ample compared to the demand. Conversely an extra box of fruit may be valued well above pool fruit if sales commitments could not be met from members' fruit. The amplitude of the price variations would vary inversely with the size of the cash fruit ratio. Thus the cash fruit ratio is hypothesized to be an interaction term for both of the supply parameters discussed above.

The second interactive influence and the one of principal interest for this model is the influence of futures trading. The futures market would be of considerable interest to those

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[2]The cash fruit used for FCOJ is represented by spot fruit and contract fruit. The size of this cash fruit in relation to the total used for concentrating will be referred to as the cash fruit ratio.

who are in the market to sell cash fruit. Given adequate knowledge of processing costs, the cash seller can use the futures market prices, particularly the near contracts, as data to aid in the determination of fair and equitable prices for his fruit. Thus because futures price data are widely published and easily available to anyone interested, it is hypothesized that the futures market has become an influence which has dampened the amplitude of supply-induced price differential variations.

Referring once again to Figure 13, it will be noted that the influences discussed above are the principal contributors to the difference in prices between cash and pool fruit. The price differential model in very general terms can be stated as:

Price Differential = f(availability, freezes, cash fruit ratio, futures trading)

A priori, any increase in the availability term would be expected to affect the price differential with pool fruit benefitting. The weather influence should affect the price differential to the benefit of cash fruit. Each of the cross-product terms should tend to soften the influences of these two supply parameters, that is, have opposite signs.

Empirical Model

The linear form of the price differential model is postulated to be:

$$(5.1)\quad \overline{PDI}_{\cdot j} = \gamma_0 + \gamma_1\, \Delta A_j + \gamma_2\, F_j + \gamma_3\, \Delta A_j\, (PI_{\cdot j}) + \gamma_4 \left[F_j\, (PI_{\cdot j})\right] + \gamma_5 \Delta A_j\, (FT_{\cdot j}) + \gamma_6\, F_j\, (FT_{\cdot j}) + u_j$$

where $\overline{PDI}_{\cdot j}$ = mean seasonal differential between cash prices and FOB derived delivered-in prices,

ΔA_j = percentage change in availability from season j-1 to j,

F_j = a freeze index to be developed below,

PI_j = ratio of cash fruit to total fruit used for concentrate in season j,

FT_j = a qualitative variable representing the informational effects of futures trading.

The dependent variable for this price differential model, $\overline{PDI}_{\cdot j}$, will be developed comparing what a cooperative or participation plan member might expect to receive for his fruit to the cash price actually paid to those who did not market their fruit in this manner. What a participation plan member might receive for his fruit can be approximated by the FOBDDI--the FOB derived delivered-in price.[3]

It is calculated by subtracting processing and marketing costs from the reported FOB price. The FOB price is usually quoted on the basis of 12 six-ounce cans, thus some conversion is necessary to derive an FOB price per pound solid. The processing and marketing costs used are those costs for producing a case of 48 six-ounce cans as reported in the Spurlock reports. Again some conversions are necessary to determine a cost per pound solid. The difference between the revenue and costs as stated will be the FOBDDI. It will represent what a "typical"

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[3]Fairchild (4) outlined methods for deriving delivered in prices from FOB quotations. The method used in this model is similar to his "shortcut" method.

participation plan or pool member would receive for his orange solids.

A seasonal mean price differential, $\overline{PDI}_{\cdot j}$, may now be established as:

$$(5.2) \quad \overline{PDI}_{\cdot j} = \frac{1}{n} \sum_{i=1}^{n} (CP_{ij} - FOBDDI_{ij})$$

where CP_{ij} = cash prices during the ith week,

$FOBDDI_{ij}$ = derived delivered-in prices for week i,

n = number of weeks in the season.

The calculations for $\overline{PDI}_{\cdot j}$ are plotted below in Figure 15.

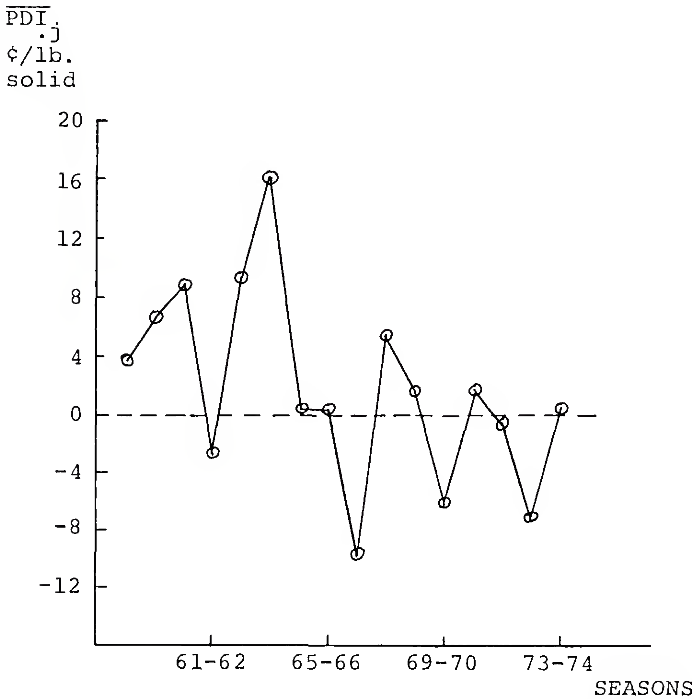

Figure 15. Observed mean seasonal price differential (1957-58 season through 1973-74 season).

A positive level of $\overline{PDI}_{\cdot j}$ indicates that over the season the cash prices netted out higher than the value that was likely received by pool fruit sellers. A specific grower, whether he be a pool fruit or a cash seller, might expect to have enjoyed prices in excess of those used or fared worse than indicated. However, this measure of differential prices is an indicator of what likely happened in a specific season.

To develop an estimate of availability, fruit in concentrate form must be aggregated with on-tree fruit. The inventory, in concentrate form, can be expressed in equivalent boxes by dividing the gallons of 45° Brix concentrate by the previous season's reported average yield. This can then be summed with the new crop forecast to yield an expected availability. This method was chosen because early forecasts were only in terms of boxes and only recently have yield estimates been reported. The change in availability, ΔA_j, can be expressed in percentage terms as:

$$(5.3) \qquad \Delta A_j = \frac{A_j - A_{j-1}}{A_{j-1}}$$

The freeze effect, F_j, will be calculated in a manner similar to that used in developing the weather index for the price variation model. Consider Figure 16.

It is assumed in Figure 16 that a freeze occurs N_1 weeks into the season or with N_2 weeks left. The mean price differential for this model might be expressed as

$$(5.4) \qquad \overline{PD}_{\cdot j} = \frac{(D - A)N_1 + (D - B)N_2}{N}$$

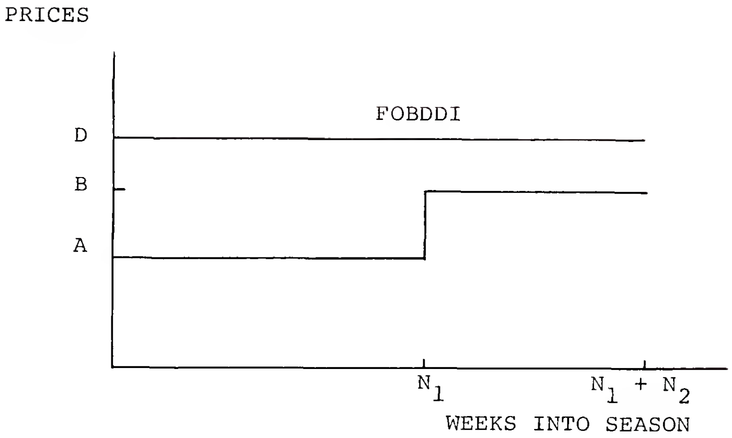

Figure 16. Freeze effect upon seasonal price differential

which after necessary multiplications and rearrangements yields

$$(5.5) \quad \overline{PD}_{\cdot j} = (D - A) - (B - A) \frac{N_2}{N}$$

The availability term discussed above, ΔA_j, will help describe the initial levels of (D - A). The second term on the right-hand side of (5.5) will be the freeze effect, F_j, postulated for use in the price differential model (5.1). Assuming there is a linear relationship between changes in supply and prices, (B - A) will be represented by the percentage of the crop destroyed. N_2/N is simply the ratio of time remaining to total time in the harvest season. Suppose a freeze destroyed 10 percent of a crop 70 days into a 210 day season. The freeze effect, F_j, for that season would be represented by 10(140/210) = 6.666.

As mentioned earlier, there are influences which in and of themselves should not cause the price differential to widen or narrow; however, because they are present at different levels they may have a multiplicative or dampening effect upon the price differential. These influences in the differential model are the cash fruit ratio and the futures trading influence. These influences will be introduced as cross-product terms. PI_j will represent the ratio of cash fruit to total crop used for concentrate during a specific season. The futures market influence, FT_j, will be a qualitative variable set at a level of one for all seasons since the introduction of futures trading except for the 1966-67 season where the value was set at .25 and .50 for two fits presented below.

As was discussed in the price variation model, 16 years of observations were used to generate estimates of the structure of the model. This number was chosen so that sufficient degrees of freedom were available to estimate the covariance matrix but not large enough to encompass significant structural changes in the industry.

The model was fitted by OLS using the assumptions of the classical linear model. The numbers in parentheses are the standard errors. The estimates were:

$$(5.6)\quad \widehat{PDI}_{.j} = \underset{(1.501)}{2.385} - \underset{(-.436)}{.467}\,\Delta A_j + \underset{(7.214)}{2.637}\,F_j + \underset{(.924)}{.728}\left[\Delta A_j\, PI_j\right] - \underset{(25.884)}{7.496}\,F_j(PI_j) + \underset{(.184)}{.088}\,\Delta A_j\,FT_j - \underset{(-.093)}{.426}\,F_j\,FT_j$$

with $R^2 = .6936$ and DW = 1.27

or

$$\text{(5.7)} \quad \widehat{PDI}_{\cdot j} = \underset{(1.493)}{2.462} - \underset{(-.372)}{.569}\ \Delta A_j + \underset{(7.150)}{2.451}\ F_j + \underset{(1.125)}{1.012} \left[\Delta A_j\ PI_j\right] - \underset{(-25.666)}{6.745}\ F_j\ PI_j + \underset{(.224)}{.144}\ \Delta A_j\ FT'_j - \underset{(-2.063)}{.465}\ F_j\ FT'_j$$

with an $R^2 = .6997$ and $DW = 1.24$.

From a technical sense (5.7) which has the futures variable, FT'_j scaled to a level of 0.5 for the 1966-67 season would offer slightly more in terms of R^2. The Durbin-Watson statistic deteriorates some; however, because of the low number of observations and the relatively high number of parameters, the inconclusive region is quite large in the test for autocorrelation and the small amount of change is inconsequential. Equation (5.7) will be used as a basis in the following discussion.

Interpretation and Industry Application

It will be noted from an examination of the t ratios of (5.7) that the coefficients of the variables used in the price differential model have low statistical significance. Therefore the following discussions must be interpreted with reasonable caution.

A positive sign on a coefficient in the model will indicate that a positive change in the associated variable will cause a price differential change in favor of cash fruit prices. A negative sign indicates that a positive change in a variable will cause prices to move in favor of pool fruit sellers.

The coefficient with the highest t ratio was ΔA_j, the availability term. The theoretical discussions earlier hypothesized that the influence would be negative and this was realized. For every percent increase in seasonal availability there is a change of approximately one-half cent per pound solid in favor of pool fruit. It was also discussed in the presentation of Figure 13 that there would be some positive level of availability change that would not influence the price differential. This would account for a secular increase in the demand for processed orange products. By dividing the intercept in (5.7) by the slope coefficient on ΔA it can be determined that a 4.33 percent yearly increase in availability did not affect the price differential prior to futures trading. Subsequent to the introduction of futures trading the coefficient of ΔA_j must be modified by the coefficient of $\Delta A_j \; FT'_j$ yielding a combined coefficient of -.425. The implication is that the availability may now increase nearly 5.8 percent before there is an influence which will be to the detriment of the cash fruit seller.

Cash fruit sellers do benefit from a freeze. A freeze in early February destroying say 3 percent of the crop holding all other terms constant can be evaluated by means of:

$$(5.8) \quad \widehat{\Delta PDI}_{\cdot j} = \left[2.451 - .4652 \; FT'_j - 6.745 \; PI'_j\right] \Delta F_j$$

Assume PI_j equals 0.200. FT'_j is a qualitative variable equal to one. F_j can be evaluated by the $(B - A)N_2/N$ developed in (5.5). $(B - A)$ will be represented by the 3 percent crop loss. N_2/N will equal about 140/210 or 2/3. Thus $F_j = 3(2/3) = 2$

therefore ΔPDI for this example is 2(2.451 - .465 -1.349) or about 1.3 cents per pound solid and the change will be in favor of the cash seller.

The negative sign on the coefficient of $F_j\ FT'_j$ indicates that a given freeze severity will not produce as much positive benefit to cash sellers due to the influence of futures. That is the nature of an information variable. If information were to aid in keeping prices from dropping too much it will also aid in keeping prices from increasing too much. It can be deduced that the futures trading information effect has aided in the reduction of the variability of differential prices, which in the past were due to changes in supply.

Summary

While the futures market in FCOJ appears to have been beneficial to price differentials for fruit, that position can not be defended very rigorously. What can be stated empirically is that there is no evidence to indicate that the futures market in FCOJ has been detrimental to the price structure existing within the Florida orange industry.

The only policy implication that can be derived from the preceding price differential analysis is that since there has been no detrimental effect from the futures market upon the industry, a policy of no action is clearly indicated.

CHAPTER VI
BASIS MODEL

The last specific objective of this study was to develop an understanding of the relationship between prices in the futures market for FCOJ and the cash market for orange solids. Should an economic relationship be established, then, as reviewed in Chapter III, a means has been established to successfully hedge some of the price risks of the industry.

This chapter will analyze the relationship existing between prices on the FCOJ futures market and the cash price for oranges. The difference between the two market prices is known as "the basis." A "Basis Model" will be developed to facilitate the study of the relationship.

It is expected that the knowledge gained in developing the model will be useful in the generation of rules and insights into hedging on the FCOJ market.

Theoretical FCOJ Basis Model

Existing Theory

Commodity basis refers to the difference between a commodity futures price and a spot or cash price for that commodity in a certain location. There has been considerable literature generated on basis and a number of articles will be cited as the FCOJ basis model is developed.

Perhaps the first major contribution to the theory of basis was developed by Keynes (16). He argued that "if supply and demand are balanced, the spot price must exceed the forward price by the amount which the producer is ready to sacrifice in order to 'hedge' himself, i.e., to avoid the risk of price fluctuations during the production periods."(16,Pg.143) In a normal market, hedgers would be willing to sell forward contracts at a discount to the cash price in order to reduce their price risk. That discount would represent an insurance premium for the hedger. Keynes denoted this pricing phenomenon as normal backwardation on the market.

Kaldor (15) later added to the basis theory the concept of a convenience yield for holding goods. Generally, distant futures will exceed the spot or nearby futures by the cost of storage. Yet, if nearby reflects a shortage there is some convenient yield for having at least a minimal stock. This yield offsets at least part of the carrying cost. At times, then the distant contract price may exceed the nearby by less than the full storage cost.

Kaldor also theorized that interest cost must be summed to carrying costs. He observed that by selling forward, holders of stocks free themselves of any uncertainty (apart from the risk, which we may treat as negligible, of contracts not being fulfilled); hence the difference between forward price and current price must be equal to the sum of interest cost, carrying cost and convenience yield. The forward price must always fall short of the expected price by the amount of the marginal risk premium.

These statements can be expressed algebraically as

$$(6.1) \quad EP - CP = r + C + R - Q$$

and

(6.2) $FP - CP = r + C - Q.$

Therefore

(6.3) $FP = ER - R$

where EP = expected price,

CP = cash price,

FP = forward price,

r = interest cost,

C = carrying costs,

R = risk premium,

and Q = convenience yield.

Working (34, 35) attempted to synthesize a satisfactory explanation for inverse carrying charges, that is when the cash price is higher than futures prices, and to mold the explanation into a theoretical supply curve for storage, which looks like:

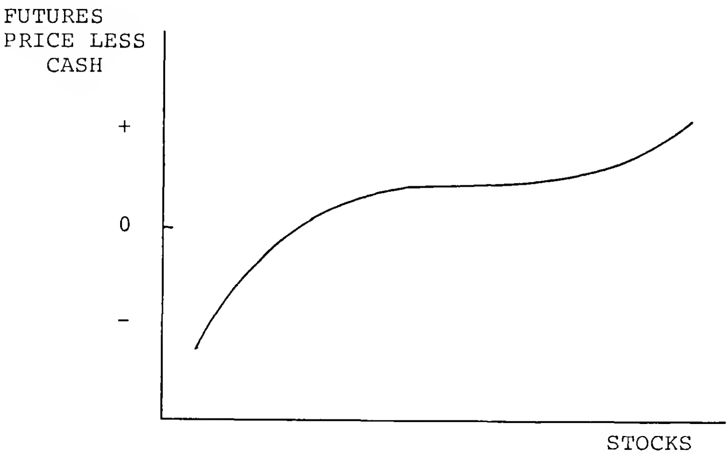

Figure 17. Supply curve of storage

He draws upon Kaldor's concept of convenience yield to rationalize why a great deal of storage does exist with a negative storage yield. He concludes the negative prices occur when supplies are relatively scarce. They then impose pressure on hedging merchandisers and processors to avoid holding unnecessarily large quantities out of consumption in the form of stocks which they can do without. Thus a negative price of storage reduces storage and increases availability of product for consumption in a year of shortage. Supplies would otherwise remain in storage.

Brennan (1) developed an equilibrium model for storage that used fundamentally the supply curves developed by Kaldor and Working. He assumed the supply curve was stable. He hypothesized that the observed stocks could then be the equilibrium solutions of the varying demand for storage curves and the fixed supply of storage curve. By calculating expected prices and carrying costs, Brennan was able to empirically measure a marginal risk premium and convenience yield related to the level of stocks for a number of commodities.

Ward (31), applying theories of Gray (10) and Working (36), developed a speculative index and attempted to explain price distortions of the basis in the FCOJ futures market using this index. He suggested that price distortion had a higher range with too little speculative activity in the market than too much. His data suggest that optimum speculative activity is somewhere between three and five times the net hedging activity in this FCOJ market. This is optimum because price distortion is less than one cent, which typically is about 2½ percent of spot prices.

Additions to Basis Theory for FCOJ

The above influences can all be applied to the FCOJ basis. In developing an empirical model for the basis, a synthesis of the above theories together with some additional considerations is necessary.

In almost all other agricultural commodities where there exist futures markets, very little, if any, product transformation is necessary for the grower to maintain the capability for delivering product. Sugar would be a notable exception where the producers of cane or beets cannot deliver on contract except by subjecting their product to a processing or extracting operation.

In FCOJ an orange grower needs to have the juice extracted from his oranges and then processed into a concentrate level that is typically used within the industry such as 58° Brix. This concentrate is packaged in plastic liners, placed into 55-gallon drums and then frozen. Then and only then does the grower have the potential to deliver against his futures contract. Thus it can be expected that there will be a differential between cash solids and concentrate which will reflect the transformation costs. The typical rule of thumb has been a processing cost of 11 cents per pound solid. These data are available in the Spurlock reports cited earlier. Processing costs have risen slightly in the last few seasons. These costs include selling expenses as well as certain fixed expenses which a user of the futures market may not require. The typical manufacturing costs or variable expenses in producing concentrate have been slightly less than 50 percent of the total cost based upon the data from the 1966-67 season through the 1972-73 season. Further, these costs do not recognize the economic value in the residual material. Cattle feed, molasses, and essence oil are examples of the products which are derived out of the residual from the concentrating operations. This may have the effect of lowering the required differential price between the cash and futures market to a level considerably below full published transformation costs.

It can be hypothesized that the basis will reflect what the industry considers a reasonable transformation cost. Futures prices lower than that which would cover such costs would cause the supply of contracts from the industry sources to dry up. Futures prices higher than reasonable costs would cause an active supply of contracts from industry sources causing prices to adjust back to a reasonable difference.

The futures markets react to expected prices according to the theory discussed earlier. The cash price will react to the same conditions after the expectations become fact. It is anticipated that there exists a different response rate for the two markets. Should this differential response exist, then the basis, a differential price, will exhibit that behavior. An expectation variable built upon crop estimates and reported freeze conditions will be incorporated as an aid in explaining the basis.

Lastly, the FCOJ basis appears to react to a "freeze syndrome." The potential of a freeze which can destroy a significant percentage of the crop exists until mid-February. This has become ingrained in the behavior of participants of the industry to the extent that prices of dealings in the future usually include some expectation of a rise in value due to a freeze-reduced crop. As the freeze season passes the expectation dissipates and the supply situation has very few "surprises" left. By "surprises" is meant that unpredicted, exogenous influences are largely dissipated and that the variance between actual and predicted crop size drops considerably.

Speculators, knowing that the freeze potential exists, may be willing to assume the risk of freezes by paying something each year for the privilege of buying the occasional windfall gain when a substantial freeze actually occurs. This action would be in consonance with the desires of the producers in that they would sell their rights to a windfall gain for a smaller, more certain sum each season. This would be particularly true for risk-averse individuals.

The influences have now been discussed. In general form the basis model in FCOJ can be hypothesized as follows:

Basis = f(interest rate, carrying costs, convenience yield, risk, transformation costs, futures trading distortions, weather premium, expectation)

The model will be derived explicitly below. There will be basis models generated for the six contract months. In that fashion participants with different and varying needs may make use of the results.

Basis Model Development

As stated earlier the purpose of the "basis model" is to develop an understanding of the relationship between the futures prices in FCOJ and the cash prices paid for fruit (pound solids). An understanding of the basis is useful for determining if and to what extent this market will pay a risk premium and to what extent price distortions resulting from trading activities in the FCOJ futures market occur. Does the market require a weather premium prior to and during the freeze season and does the market reflect a convenience yield. Finally, does the basis model demonstrate the expectations influence prices in the two markets differently.

Explanatory Variable Development

Theroetically for a trader to hold inventory the market will have to pay either the interest cost in carrying the inventory or an opportunity cost of the inventory which is held with capital generated in the business. Thus it seems reasonable that futures prices should be high enough to pay interest on the investment in inventory. Thus

(6.4) $FP = (CP + TC)e^{rt}$

where FP = Futures prices,

CP = cash prices,

TC = transformation costs,

r = market interest rates,

and t = time that inventory will be held.

Substituting (6.4) into the original basis definition where $B = FP - CP$ yields

(6.5) $B = (CP + TC)e^{rt} - CP$

or

(6.6) $B = CP(e^{rt} - 1) + TC\ e^{rt}$

A series for e^{rt} using only the first two terms yields[1]

(6.7) $B = CP(1 + rt - 1) + TC(1 + rt)$

$B = TC + (CP + TC)rt$

Thus a time/interest value analysis suggests that as a minimum the basis should reflect transformation costs plus an interest yield on the investment represented in inventory holdings.

It can be hypothesized that inventory holders will receive payment for bearing risk. Risk is associated with the length of time that the inventory is held and also is proportional to the cost of acquiring the inventory. For the purposes of the basis model risk is assumed to be a linear function of time emanating from the origin. It is further hypothesized that price risk is also a linearly increasing function of the cash price of the fruit. Low prices usually imply that there is an abundant crop. Considerable impetus would be required to change the price significantly--prices will stay relatively stable. Whereas when prices are high it is implied that the crop is small. New demand or supply information of a given size will have a higher percentage effect on short supplies

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[1]the expansion is

$$e^x = 1 + x + \frac{x^2}{2!} + \ldots \frac{x^n}{n!}$$

For the purposes of this model the terms $x^2/2!$ and beyond could be ignored because errors would be less than 1 percent.

when compared to the effect that same information will have on ample supplies. If it can be accepted that this risk parameter is indeed zero when and if there were such a thing as a zero price the risk would emanate from the origin for this influence also. A combined effect of time and cash price would therefore be necessary to adequately pick up the total risk contribution. The form would be $\omega(CP)(t)$ where ω represents the combined risk effect.

An inventory holder would not want to hold inventory above necessary levels when he felt that carrying costs could not be covered. Thus a portion of the basis could be expressed as Ct where C represents carrying cost per a unit of time.

Kaldor hypothesized and Brennan confirmed empirically the existence of a "convenience yield." The argument is that when supplies are short, lack of adequate inventory of goods will result in lost sales and inefficiency in operation. Thus for a firm to draw down inventory, the market must offer to pay for these costs. The market will do so by bidding up prices in the near term in relation to distant prices. Characteristically this variable has been represented by a reciprocal term involving stock levels which attains a zero value at the desired or normal level of stocks. From (4.8) and (4.9) an observed stock ratio will be developed which relates stocks on hand (4.8) to historic stock levels (4.9). The term will be developed as

$$(6.8) \quad S_{ij} = \frac{I_{ij}}{\overline{I_{i.}}}$$

where S_{ij} represents the stock ratio existing in week i of season j. A variable having the form ($1/S_{ij}$ - 1) would represent the typical form of the explanatory variable. The variable would be constrained to zero with stock levels higher than normal reflecting zero convenience yield, since excess stocks do not create a yield but only a cost. When there is little time left before maturation of a specific contract,it can be expected that there will be little convenience yield being offered to release stocks just a few days early. Conversely should time before maturation be long, a convenience yield can be expected to be relatively high. Thus a cross product term involving stocks and time would be necessary to allow for this time-related influence upon convenience yield.

In this industry weather is more of a potential influence than in many other agricultural industries. The geographic concentration of orange producers is such that weather can and often does influence a major portion of the industry. Secondly, the length of potential exposure to cold weather is rather long. The freeze season typically begins about December 15 and extends to February 15, a duration of 62 days. Prior to the freeze season and well into it the individuals within the industry attach an extra value to the future prices when compared to the cash prices to compensate for the possibility of a crop-reducing freeze. That attitude rapidly dissipates as the end of the freeze season nears. If that behavior is extensive one can hypothesize that there will be a basis bias that should be evident and measurable in all contracts maturing in March or later. That same bias may exist in the January contract; however, the influence may be represented as a risk premium rather than be reflected as a freeze bias.

Figure 18 graphically presents the above discussion.

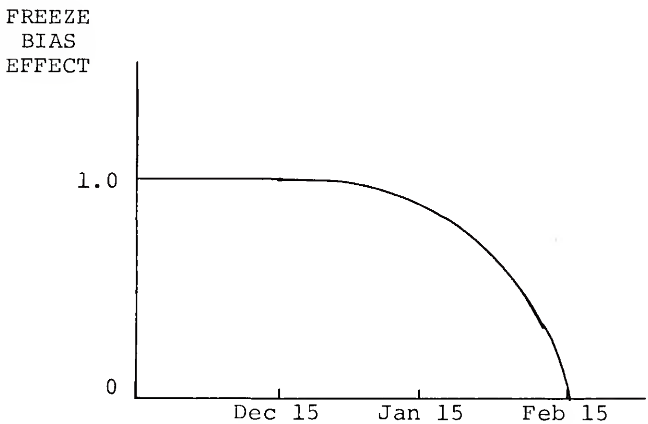

Figure 18. Theorized freeze bias influence in FCOJ futures

A variable that would stay at a high value until the end of the freeze period and then decay rapidly to a zero value would represent such an influence. Let EFT represent the elapsed time since the beginning of the theorized freeze period. The $(1 - EFT/62)^{\frac{1}{2}}$ would be an explanatory variable having a decaying influence as proposed in Figure 18. The variable would be held at a level of 1 before December 15 and zero after February 15. The decay would represent the declining potential of a freeze as well as representing that the harvesting activities are removing a portion of the crop from the danger of a freeze.

It was discussed earlier that there may exist a reaction time to information which is different in the futures market when compared to the cash market. Should this be true, there will be basis changes which will need explanation. Therefore a variable must be developed which recognizes both expectations and time lags. Let the expected crop forecast in week i be

(6.9) $ECF_i = CF_{i-4}\ (1 - \phi)$

where CF_{i-4} = the crop forecast actually observed four weeks previous,

and ϕ = the effects of a crop-reducing freeze which may have occurred during the four-week period.

Oranges start showing internal damage when temperatures reach 28° F. for a period of two hours. It is proposed that ϕ be represented by a cross product term which includes the temperature difference between that achieved and the critical temperature, and the size of the crop estimated with the previous report. Therefore let

$$\phi = \psi(DT)$$

where DT = difference between achieved temperature and 28° at representative locations.[2]

Therefore (6.9) may be represented as

(6.10) $ECF_i = CF_{i-4} - \psi(DT)\ (CF_{i-4})$

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[2]Four locations, Orlando, Clermont, Avon Park and Lakeland were locations selected because they had weather reporting stations and were located in or between the largest orange-producing counties in Florida.

The first term of (6.10) will represent the expectation for crop size and the second term will represent the expectation of a loss due to a freeze.

When ECF $\neq CF_i$, that is where the new crop forecast does not equal expectations then an element of surprise exists which will be reflected in the futures prices. $(CF_i - CF_{i-4})$ will represent one portion of the expectation influence while $\psi(DT)$ (CF_{i-4}) would represent the other. The terms need to be normalized to beginning season's availability to facilitate comparisons. GH_j^D as represented in (4.16) will be used to normalize each term.

Lag structures other than that used in (6.9) were considered but discarded because in using these more extensive models the generation of parameters which are highly correlated would be required. A one-period lag is a reasonable representation of the real world since there is no reason except for a freeze that this period's crop forecast report should be any different than last period's reported forecast except for a stochastic element accounting for errors in estimation.

Ward attempted to measure a basis distortion for FCOJ using market liquidity as an explanatory variable. He concluded that there was an inverse relationship between basis distortion and liquidity. Low levels of liquidity yielded positive levels of price differential in favor of futures prices while high levels of liquidity yielded low negative price differentials--favoring cash prices. He also noted that the pressure from long and short speculative positions yielded roughly equivalent effects.

It is desired that a futures liquidity variable, similar in nature to that developed by Ward, be generated for use in this model. The problem is that the USDA CEA reports on the commitments of traders do not break out the holdings by contract but rather report an aggregate open interest and do so only on a monthly basis. Thus some measure of liquidity will be developed that will have the desired characteristics. When a market is liquid it is implied that a participant can enter or leave a market with reasonable positions and not cause major perturbations in the pricing in that market. If a new trader wants to enter the market, a new contract or contracts may be traded and the open interest may or may not change. If the market lacks liquidity, potential traders may find difficulty in executing a transaction and significant price concessions may have to be made to effect a trade. In such a case the volume of trading and the change in open interest are very likely equal. Conversely when a market is active the number of trades in relation to the changes in open interest is likely to be quite high.

To fulfill the need to develop a liquidity variable a statistic L_{ij}^{m} which will represent a measure of liquidity during the ith week of the jth season for the mth contract month will be generated using the following formula:

$$(6.11) \quad L_{ij}^{m} = \frac{V_{ij}^{m}}{DOI_{ij}^{m}}$$

where V_{ij}^{m} = the trading volume of the mth contract month in the ith week of the jth season.

DOI^m_{ij} = the summation of changes in open interest of the mth contract month in the ith week of the jth season.

There may be occasions where particularly in distant months there may be no change in open interest over the entire week. When such a condition exists the variable will be arbitrarily set to 1 which will represent the least possible liquidity state.

Empirical Model Specification

The above discussions may now be postulated in additive form as a basis model. There are deterministic as well as functional variables and they will be presented in the order of discussion.

$$(6.12)\quad B^m_{ij} = \lambda_0 + TC_j + (CP_{ij} + TC_j)\ (r_{ij})(t^m_{ij}) + \lambda_1$$

$$\omega(CP_{ij}\ t^m_{ij}) + C_j(t^m_{ij}) + \lambda_2\left[\frac{1}{S_{ij}} - 1\right] \ln t^m_{ij}$$

$$+ \lambda_3\left[1 - \frac{EFT_i}{62}\right]^{\frac{1}{2}} + \lambda_4\left[\frac{CF_i - CF_{i-4}}{GH^D_j}\right]$$

$$+ \lambda_5\ \frac{DT_i\,(CF_{i-4})}{GH^D_j} + \lambda_6\ L^m_{ij} + u_{ij}$$

The subscript ij represents the observation for a variable in the ith week in the jth season. The superscript m represents one of the specific contract months. All the variables were discussed in the textual material earlier.

The deterministic variables may be moved to the left-hand side of (6.12) which will then yield a modified basis comprised of deterministic elements. The rearrangements will yield:

$$(6.13)\quad B^{m}_{ij} - TC_{j}\ (1 + r_{ij}t_{ij}{}^{m}) - C_{j}\,(t^{m}_{ij}) = \lambda_{O} - \left[\frac{\lambda 1\ \omega}{r_{ij}} + 1\right]$$

$$(CP_{ij})\ (r_{ij})\,(t^{m}_{ij}) + \lambda_{2}\left[\frac{1}{S_{ij}} - 1\right]\ \ln t^{m}_{ij}$$

$$+ \lambda_{3}\left[1 - \frac{EFT_{i}}{62}\right]^{\frac{1}{2}} + \lambda_{4}\left[\frac{CF_{i} - CF_{i-4}}{GH^{D}_{j}}\right]$$

$$+ \lambda_{5}\left[\frac{DT_{i}\,(CF_{i-4})}{GH^{D}_{j}}\right] + \lambda_{6}\ L^{m}_{ij} + u_{ij}$$

The left-hand side of (6.13) will be referred to as the modified basis, MB^{m}_{ij}. It represents the "normal" basis, futures price minus cash price, less the future value of the transformation costs and less the carrying costs to maintain the product until contract maturation.

The modified basis model will be presented in a form to be estimated.

$$(6.14)\quad MB^{m}_{ij} = \lambda_{O} + \lambda_{1}'\left[CP_{ij}\quad r_{ij}\quad t^{m}_{ij}\right] + \lambda_{2}\left[\frac{1}{S_{ij}} - 1\right]$$

$$\ln t^{m}_{ij} + \lambda_{3}\left[1 - \frac{EFT_{i}}{62}\right]^{\frac{1}{2}} + \lambda_{4}\left[\frac{CF_{i} - CF_{i-4}}{GH^{D}_{j}}\right]$$

$$+ \lambda_{5}\left[\frac{DT_{i}\ \ (CF_{i-4})}{GH^{D}_{j}}\right] + \lambda_{6}\ L^{m}_{ij} + u_{ij}$$

λ_1' in (6.14) is a proxy for $(\lambda_1\omega/r_{ij} + 1)$ in (6.13). It measures the premium that the market will pay for risk plus opportunity or interest cost.

A symbolic language of sorts will be established for the explanatory variables in (6.14) and these symbols will be used for the rest of the study.

Let: VCP^m_{ij} represent $CP_{ij}\ r_{ij}\ t^m_{ij}$. The coefficient will measure the risk plus interest rate payment.

CY^m_{ij} represent $(1/S_{ij} - 1)\ \ln t^m_{ij}$. The coefficient will indicate the convenience yield existing in the FCOJ market.

FB^m_{ij} represent $(1 - EFT_i/62)^{\frac{1}{2}}$. The coefficient will indicate the freeze bias that may exist in the market.

CX^m_{ij} represent $[(CF_i - CF_{i-4})/GH^D_j]$. The coefficient will measure the market reaction to crop expectations.

FX^m_{ij} represent $[DT_i\ (CF_{i-4})/GH^D_j]$. The coefficient will measure the market reaction to reported freezes.

In this new symbology (6.14) may be stated as

$$(6.15)\quad MB^m_{ij} = \lambda_0 + \lambda_1'\ VCP^m_{ij} + \lambda_2\ CY^m_{ij} + \lambda_3\ FB^m_{ij} + \lambda_4\ CX^m_{ij} + \lambda_5\ FX^m_{ij} + \lambda_6\ L^m_{ij} + u^m_{ij}$$

A typical observation of the basis model will be examined to provide insights into the calculation of MB^m_{ij}. Assume the specific observation of interest is the first full week of February of the 1970-71 season. Assume further that the contract month is the July contract. The dependent variable for the first week of February is calculated by subtracting the price paid for spot fruit from the weekly average July futures price. This would represent a normal basis. However, for the modified basis model, the transformation cost is netted out. The transformation costs used are the season's average processing costs for 58° concentrate packed in 55-gallon drums. Included in this term is a market interest rate term designed to cover opportunity costs for transformation investment during the time remaining on contract. The interest rate used is the prime interest rate as reported by the Federal Reserve.[3] The carrying costs that are to be netted out will be represented by the quoted rates for certified storage.[4] The time remaining on contract is the time from Wednesday of the week in question until the last day of trading for the contract of interest. All of these variables will be represented in terms of cents per pound solids.

The first term on the right-hand side of (6.15), VCP_{ij}^{m},

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[3]An investigation revealed that there was no appreciable difference between typical prime interest rates and the short term or revolving credit interest rates for the southeastern region represented by the Atlanta Federal Reserve Bank.

[4]A number of certified public storage firms were contacted during this investigation and asked for their historical rates. From these quotations the average carrying costs for a given season were determined. Private storage costs are recognized to be considerably lower.

will determine the extent to which the market does pay opportunity cost plus a risk premium. The coefficient will be dimensionless since the dimension of the explanatory variable and the dependent variable is identical. Suppose in an a priori sense the market does pay for an opportunity cost plus some risk premium. Should this be the case, the coefficient would have to be larger than one by the ratio of risk premium to interest rate.

The rest of the terms have been explained adequately in the preceding discussions. Each coefficient of these terms will be in terms of cents per pound solid per unit of the explanatory variable.

The model was fitted using the data from the 1966-67 season through the 1973-74 season. It was noted that the September contract estimates had the signs of the coefficients which were expected from the theoretical discussions, had an R^2 and Durbin-Watson statistic which were higher than the other contract months. The September contract did not come into existence until the 1967-68 season. The pattern and characteristics of the data for the first season indicated that, due to lack of knowledge, lack of participation, hestancy or similar reasons, the basic patterns were clearly atypical of the remaining seasons. For that reason the 1966-67 data were dropped from the analysis.

Empirical Results

The initial estimates for the basis of each contract are listed in Table 3. Table 4 is included to show the relation-

Table 3
Results of initial least squares fit of basis model

	Variable			
Contract Month	Interest & Risk Payment (VCP)	Convenience Yield (CY)	Freeze Bias (FB)	Distortion Index (L)
JAN	8.157 (7.429)	-2.295 (-1.249)	10.910 (7.866)	-.116 (-.149)
MAR	3.904 (2.550)	.048 (.522)	4.461 (1.637)	-.094 (-.142)
MAY	1.360 (1.108)	.065 (.353)	6.238 (1.027)	-.105 (-.116)
JUL	1.380 (.538)	-.240 (-.353)	5.958 (.837)	-.038 (-.053)
SEP	1.012 (.485)	-.704 (-.282)	6.183 (.816)	-.054 (-.071)
NOV	.914 (.495)	-1.908 (-.326)	7.811 (.929)	.015 (.101)

The numbers in parenthesis below the estimate of the coefficients are the standard errors.

Table 3 - Extended

Crop Expectation (CX)	Freeze Expectation (FX)	Constant	R^2	D.W.	N
-27.610 (-23.398)	3.142 (.377)	-5.626 (-6.104)	.6760	.83	50
-52.790 (-17.388)	1.798 (.324)	-.875 (.794)	.5681	.63	110
-56.890 (-12.839)	1.778 (.247)	-1.079 (-.487)	.6142	.54	170
-66.130 (-11.547)	1.883 (.240)	-2.066 (-.479)	.6420	.58	232
-74.520 (-12.857)	2.073 (.261)	-2.038 (-.800)	.6241	.58	235
-74.140 (-15.277)	2.193 (.317)	-2.151 (-.994)	.6092	.43	235

Correlation between various price series (data from 1967-68 through 1973-74 seasons) and price level observations

Price Series	JAN FUT	MAR FUT	MAY FUT	JUL FUT	SEP FUT	NOV FUT	Spot Prices	Contract Prices	Cash (Spot & Contract) Prices
JAN FUT	1.0000	.9964	.9914	.9891	.9879	.9761	.8905	.8206	.8348
MAR FUT		1.0000	.9931	.9868	.9831	.9476	.8363	.7929	.7796
MAY FUT			1.0000	.9954	.9888	.9454	.7849	.7247	.7337
JUL FUT				1.0000	.9909	.9414	.7555	.7027	.7068
SEP FUT					1.0000	.9697	.7110	.6569	.6605
NOV FUT						1.0000	.7593	.7150	.7200
Mean Prices	51.291	51.310	50.923	50.769	51.141	50.179	43.152	44.141	43.814
Standard Deviation	9.322	8.683	7.868	7.658	7.304	6.958	7.976	7.745	7.754

SOURCE: Derived from Florida Canners Association and Citrus Association of the New York Cotton Exchange data.

ships between price series in the futures market contract months and prices existing in the real commodity. Included also are the observed average (mean) prices and the deviation in the same price series observed during the period. These data will be of interest in developing hedging strategies later in the study.

The results of the initial runs indicated a rather serious problem with autocorrelated error terms. Autocorrelated error terms create concern over the estimated coefficients since although they are mathematically unbiased, they result in a covariance matrix with nonzero off-diagonal elements. The assumptions of the classical linear model include the assumption of $E(u_t, u_{t-s}) = 0$, for $s \neq 0$ which means the residual terms are not related. Should they be related the covariance matrix contains off-diagonal elements which will result in biased estimates of standard errors of the coefficients. Testing of levels of significance and the use of standard error in developing confidence intervals on estimations involving the model would be in error.

Serial correlation may come about because of mis-specification, either through the omission of relevant explanatory variables or through improper specification of the form of the included variables. There is a tendency for a properly specified model to show serial correlation as the observational time period represents a shorter time interval.

This serial correlation caused some reflection upon the model and as a result of this reflection an additional variable was considered as a valuable addition to those already included. That variable was a cross product term involving the freeze bias and the availability of FCOJ for the season. The rationale was that as availability increases for a season either by a much larger crop and/or a large carryover the market would not anticipate quite as large a potential price impact from a freeze than if the season's availability were low.

The season's availability was adjusted to the mean season's availability over the period of the study to yield a ratio to facilitate the study of this effect. This ratio may be expressed as

$$(6.16) \quad MSA_j = \frac{GH_j^D}{\overline{GH}^D}$$

where MSA_j = the mean seasonal availability ratio,

$\overline{GH}^D$ = the mean beginning seasonal availability from 1967-68 through 1973-74.

The new explanatory variable will be represented as

$$(6.17) \quad FBA_{ij}^m = FB_{ij}^m (MSA_j).$$

where FBA_{ij}^m = the availability adjusted freeze bias.

The review of basis theory indicated that the important elements seemed to be included in the model and that further efforts along this line would end up as rather crude empiricism. The coefficients as derived from the initial fit were in consonance with theory. The only problem was to reduce the serial correlation to a point where some valid hypothesis testing could be accomplished and where the model could be used for predictive purposes.

An initial correction for serial correlation was implemented assuming that the error terms followed a first order autoregressive scheme, i.e., $u_t = \rho\, u_{t-1} + \varepsilon_t$. However, correction for a first order scheme gave results which were questionable in that there were major changes in the signs and the values of the coefficients. Higher order autoregressive schemes were then explored.

The transformations for a higher order autoregressive scheme follow the same technique applied to the first order scheme above except that lags of higher order are necessary. Estimates of the ρ's were generated by subjecting the observed residuals to an ordinary least squares estimation using the following model.

$$(6.18) \quad u_t = \rho_1\, u_{t-1} + \rho_2\, u_{t-2} + \rho_3\, u_{t-3} + \rho_4\, u_{t-4} + \varepsilon_t$$

Estimates for ρ_1 through ρ_4 were obtained for each contract month. Three-period lags or third order autoregressive schemes were used only when their contributions appeared to be significant. Table 5 lists the transformations used.

Subsequent to fitting the March contract a second iteration was used to check yet another estimate of the ρ's, and it was found that the estimates to be used for a second iteration would have been -.035, -.005, and +.024 respectively. This was not enough to change the estimates appreciably.[5]

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[5]This technique is the Cochran-Orcutt iterative method for correcting for autocorrelated error terms (3).

Table 5

Transformations used for
serial correlation corrections

Contract Month	Lags		
	ρ_1	ρ_2	ρ_3
January	-.245	+.206	----
March	-.036	+.005	+.026
May	-.068	+.040	----
July	-.099	+.065	----
September	-.778	+.111	----
November	-.866	+.105	----

The estimate for the structure for the monthly basis models corrected for serial correlation are listed in Table 6.

Coefficient Interpretation

From Table 6 it can be deduced that the FCOJ futures market pays a freeze bias in all contracts. The total freeze bias is $(\lambda_3\ FB_{ij}^{m} + \lambda_7\ FBA_{ij}^{m})$ in any contract. Assume for expository purposes that a season with normal availability is being examined. Therefore the net freeze bias effect will be equal to $(\lambda_3 + \lambda_7)$. Figure 19 represents the freeze bias by contract months for the assumed conditions.

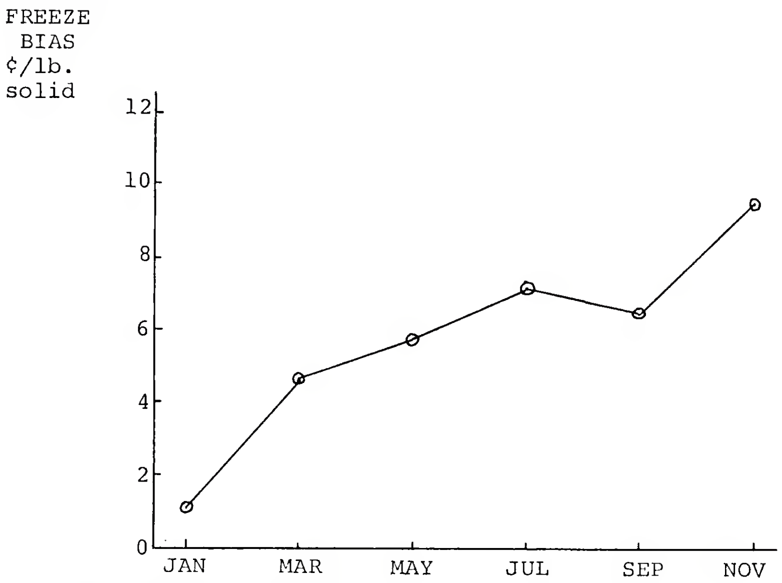

Figure 19. Freeze bias by contract month

An implication which can be drawn from Figure 19 and Table 6 is that either the speculator is willing to pay more for the privilege of having a longer time to collect the re-

Table 6

Results fitting basis model with data
Corrected for serial correlations

Contract Month	Variables				
	Interest & Risk Payment (VCP)	Convenience Yield (CY)	Freeze Bias (FB)	Distortion Index (L)	Crop Expectation (CX)
JAN	23.233 (4.806)	-3.405 (-1.415)	10.543 (7.579)	.002 (.002)	-41.375 (-25.106)
MAR	3.464 (2.376)	-.699 (-.512)	16.826 (3.339)	-.098 (-.129)	-58.179 (-16.081)
MAY	1.463 (.973)	-.303 (-.353)	18.367 (2.873)	-.069 (-.074)	-58.642 (-12.297)
JUL	1.103 (.553)	-.455 (-.300)	17.861 (2.722)	-.027 (-.047)	-63.963 (-11.436)
SEP	1.301 (.702)	-1.109 (-.440)	2.541 (1.843)	.007 (.043)	-24.545 (-14.287)
NOV	-1.260 (.806)	.344 (.623)	-7.728 (-1.149)	.017 (.044)	-16.914 (-14.432)

The numbers in parenthesis are the standard errors.

Table 6 Extended

Freeze Expectation (FX)	Availability Adjusted Freeze Bias (FBA)	Constant	R^2	N
3.164 (.413)	-9.408 (-2.927)	-.305 (-4.919)	.7735	50
1.746 (.248)	-12.190 (-2.855)	-.465 (-.724)	.6180	110
1.702 (.235)	-12.677 (-2.674)	-.678 (-.538)	.6523	170
1.699 (.234)	-10.835 (-2.557)	-1.556 (-.402)	.6568	232
1.680 (.267)	3.921 (1.298)	-.807 (-.348)	.3723	235
1.652 (.270)	17.190 (2.050)	.007 (.333)	.4579	235

wards of a potential freeze or the hedger wants more to yield his claim to a windfall gain should a freeze occur. Whatever the reason there is apparently 6 cents per pound solid added to the modified basis on the more distant contracts prior to December 15 of a typical season.

The low level of the freeze bias for January may be compensated for by the interest and risk payment, VCP. A bias of any magnitude can not exist when the January contract goes off the boards. The threat of massive deliveries or acceptances of deliveries will force the basis to adjust the bias out at the time of contract maturation. However, since VCP is time related it appears that the market may still be paying a freeze bias under the guise of a risk premium. Recall from (6.14) that $VCP^m_{ij} = CP_{ij}\ r_{ij}\ t^m_{ij}$. Assume r is fixed at 8 percent per annum and cash prices are steady at 45 cents per pound solid. Inserting those values in the risk premium term will yield a value of VCP in cents per pound solid which may be plotted against time as in Figure 20 below.

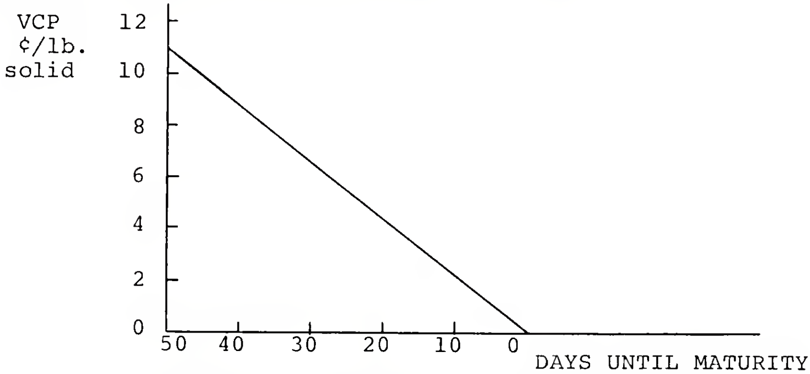

Figure 20. Typical risk payment for January contract

The implication in Figure 20 is that in effect the market is paying a handsome bonus for risk in the January contract as a substitute for a freeze bias. As this variable was developed, time was entered in a linear fashion. It may be that this risk bonus may react more like the freeze bias and stay reasonably level throughout December and start decaying at a faster rate during January.

The FCOJ market does react to low stock levels by extracting a convenience yield from the basis except for the November contract. Recall from (6.14) that $CY^m_{ij} = (1/S_{ij} - 1) \ln t^m_{ij}$. The contribution to the basis may be assessed by allowing both the stock ratio, S_{ij}, and time, t^m_{ij}, to vary over reasonable limits. Let the influence that the convenience yield exerts upon the September contract be examined. Table 7 below was constructed by calculating $\lambda_2 \; CY^S_{ij}$ at intervals during the contract and at different stock ratios. The entries in each cell show the contribution of convenience yield to a September contract in cents per pound solid.

The net effect is that the basis will be reduced and some or all of the storage costs will not be covered. This may act as an inducement not to store but to reduce maintained inventory. Depending upon the level of stocks there may be times that the market is inverted,that is cash prices may actually be at a premium to distant futures prices.

The crop expectation coefficient has a large t ratio indicating that the market reaction to crop estimate changes is rather strong. The variable was constructed so that a one unit

Table 7

Convenience yield influence on September basis

S_{ij}	Date				
	JAN 1	MAR 1	MAY 1	JUL 1	SEP 1
1.0	0	0	0	0	0
.9	-.67	-.64	-.58	-.48	-.37
.8	-1.51	-1.43	-1.31	-1.09	-.83
.7	-2.59	-2.45	-2.24	-1.87	-1.42
.6	-4.03	-3.81	-3.49	-2.91	-2.21

change in CX means a 100 percent change in crop estimate. Therefore to make the coefficient more useful it should be divided by 100 thereby allowing CX to be expressed in terms of a single percentage point. The July contract basis reacts downward 0.64 cents per pound solid for every percent increase in crop estimate. The November contract may not react as strongly as the other months because it is a seasonal transition contract. This means that needs which occur in late November may possibly be fulfilled from new crop fruit or could be delayed for a matter of days until harvest in the new season begins.

There is a strong reaction in all the bases due to the reports of freezing temperatures as evidenced by the coefficients and t ratios on the FX variable in Table 6. It may be recalled that $FX = DT(CF_{i-4})/GH_j^D$. Assume that the CF_{i-4}/GH_j^D has a value of 0.85 when a freeze occurs. Differentiating (6.15) with respect to DT would yield $\partial MB_{ij}^m/\partial DT = \lambda_5(.85)$. This result means that each degree achieved below 28° F. would cause a 0.85 λ_5 change in the basis of interest. If one were interested in the March contract and the average temperature achieved was 26°, then the expected increase in the March basis would be 1.746 (.85)(2) = 2.97 cents per pound solid.

The low coefficients and t ratios achieved on L_{ij}^m, the distortion measure, indicate that there is very little if any measurable influence of market liquidity upon basis patterns. That is an important implication in that there is no evident price distortion when the volume of trading is light. Since the volume of trading does not cause any basis distortions and since the viability of the futures market depends upon active support by both the hedger and speculator, a policy by all parties associated with the futures market and the citrus industry should be to encourage more active participation.

Aggregate Model

It became apparent when examining the results of Table 6 that a method of testing statistical significance of coefficients between contract months would be desirable. The above methods fitted separate matrices of explanatory variables upon different dependent variable vectors. To facilitate testing of coefficient differences, aggregation of all observations of all variables would be necessary to form a single population of observations. Dummy variables would be generated for five of the contract months to isolate either slope changes on the coefficient terms or intercept changes on the constant terms.

The whole population of data was fitted with the model to determine in an aggregate sense if all basis observations would describe a structural form consistent with theory. The estimates of the structural form for the aggregate modified basis was:

$$(6.19) \quad MB_i = -.7391 + \underset{(.013)}{.023}\ VCP + \underset{(1.305)}{18.536}\ FB - \underset{(-.167)}{1.123}\ CY$$

$$- \underset{(-.010)}{.003}\ L - \underset{(-5.731)}{65.905}\ CX + \underset{(.112)}{1.931}\ FX$$

$$- \underset{(-1.240)}{11.958}\ FBA - u$$

$$R^2 = .60532$$

These results were very much in consonance with theory and in an aggregate sense represented what might be expected from an examination of Table 6 where the individual contract month estimates are listed.

(6.19) also indicates that a typical basis would react strongly to a crop estimate change as is evidenced by the large negative coefficient on CX. For every 1 percent change in crop estimate from the previous estimate the typical basis would change 0.659 cents per pound solid. Referring to Table 1 in Chapter IV the December crop estimate dropped 2.86 percent. This model would suggest that the basis would have increased 1.89 cents per pound solid.

A typical contract will react to the report of a freeze. Recall that $FX = DT(CF_{i-4})/GH_j^D$. Should the average temperature at the four locations reach 25° F., then DT would equal a value of 3. Assume the CF_{i-4}/GH_j^D ratio is 0.85. Then the typical contract basis would increase 1.931(3)(0.85) or 4.92 cents per pound solids.

The basis distortion from futures market trading appears to be virtually nonexistent as evidenced by the low coefficient on L and its correspondingly low t ratio. This implies that the typical contract basis is not affected by trading upon the exchange.

Further interpretation of (6.19) indicates in a general, aggregate sense that the market pays a freeze bias amounting to (18.536 - 11.958 MSA) FB cents per pound solids for a typical contract. Assume that MSA is equal to one, i.e., an average season. The freeze bias represents 6.578 cents per pound solid under these conditions. This bias amounts to a payment beyond transformation costs plus carrying costs and is available to a seller before or early in the typical freeze period.

The market does react to short inventory by lowering the basis. That is evident from the -1.123 coefficient on the convenience yield term of (6.19). Assume a contract is considered maturing 200 days away with the inventory ratio S_{ij} being 0.8. The reduction in basis then would be equal to $-1.123(1/0.8 - 1) \ln 200$ or -1.5 cents per pound solid. Therefore under these conditions full storage costs will not be paid which will cause the release of stocks into immediate consumption.

In a theoretical sense, each variable of an aggregate model should have dummy variable cross product terms to determine if slope and intercept changes of any significance existed between contract months. These dummy variables would recognize the psychological and real value differences that participants in a futures market may perceive. However, the empirical results suggested that only two variables, the freeze bias and crop expectations, appeared to exhibit differences between contracts which could be significant.

D_1 was defined to equal 1 when the March contract information was being observed and to be zero otherwise. Similarly, D_2 equals 1 for May; D_3, for July; D_4 for September and D_5 equals 1 for November. The January data were used directly with no dummy variable. The value representing the coefficient of a variable for a month with a dummy would be the January coefficient plus the coefficient on the cross product term using the dummy.

The results of fitting the model with dummy variables on the freeze bias and crop expectation was:

$$\begin{aligned}
(6.20)\quad MB = {} & -.678 + \underset{(.015)}{.033}\ VCP + \underset{(1.384)}{18.583}\ FB - \underset{(-.083)}{.005}\ FB\ D1 \\
& + \underset{(.793)}{.328}\ FB\ D2 + \underset{(.809)}{.056}\ FB\ D3 - \underset{(-.845)}{.137}\ FB\ D4 \\
& - \underset{(-.888}{1.789}\ FB\ D5 - \underset{(-.167)}{1.155}\ CY - \underset{(-.032)}{.012}\ L \\
& - \underset{(-20.506)}{33.178}\ CX - \underset{(-26.018)}{17.640}\ CX\ D1 - \underset{(-24.268)}{22.649}\ CX\ D2 \\
& - \underset{(-23.796)}{31.387}\ CX\ D3 - \underset{(-23.238)}{41.328}\ CX\ D4 - \underset{(-23.736)}{52.314}\ CX\ D5 \\
& + \underset{(.112)}{1.923}\ FX - \underset{(-1.238)}{11.865}\ FBA + u
\end{aligned}$$

with an $R^2 = .61094$

The results of (6.20) indicate that the freeze bias difference for the November contract may be the only value significantly different from the January level. This suggests that the apparent differences listed in Table 6 for freeze bias may not be statistically different from each other and from the January contract except for the November value.

Equation (6.20) also suggests that the September and November contract responses to crop expectations are significantly different from the January contract at the 10 percent level. The other contract months can not be judged different from the January contract.

Apart from these noted differences the values of all contracts on all variables, though they appear to be different may not be so in a statistical sense. The implication is that the aggregate model (6.19) may prove just as useful as the model used to generate the data in Table 6.

Implications for Industry

The second objective of this study was to develop an understanding of the relationship between the FCOJ futures market prices and the cash prices paid for fruit, and to develop possible strategies for futures market usage by participants of the industry.

The first part of the objective has been met successfully. The basis model and results achieved by fitting the model to the data available indicate that this futures market is acting as theory indicates that it should. Further the models isolate specific influences that may be of use in determining more successful hedging programs.

Additional observations though discussed earlier are summarized below.

(1) The futures market does appear to pay an opportunity cost equal to interest rates plus a risk premium as evidenced by the positive coefficients on VCP in Table 6.

(2) The futures market appears to pay for the privilege of assuming the windfall gains that might come about if a freeze occurs. That influence is the freeze bias and the results are significant as indicated by the high t ratios in both Table 6 and (6.19).

(3) There does not appear to be any consequential distortion in the basis due to the activities of trading on

the exchange as these models structured the explanatory variable.

(4) There is a strong reaction to changes in crop forecasts as indicated by the coefficients on the crop expectation variable and as is indicated by the t ratios. This variable serves to highlight the fact that the futures market is quick to react to reported conditions in the supply of oranges while the cash market reacts more slowly. With enough time the reported supply should of course have the same effect upon both futures prices and prices in the cash market.

(5) There is a strong reaction to reports of freezes as indicated by the high t ratios on the freeze expectation variable. Again this highlights the speed of reaction of the futures market compared to the cash market.

(6) There appears to be a reaction to the size of the availability on the freeze bias that the market is willing to pay. As the availability goes up, the size of the freeze bias goes down, which appears to be a reasonable reaction.

(7) This market extracts a convenience yield when industry inventories are low in consonance with theory.

(8) There are relatively high positive correlations between prices in the futures markets and prices for the real commodity. This indicates that influences

affecting prices in one market have a tendency to affect prices in the other market in similar manner.

(9) Though there appears to be some difference between the levels of the freeze bias variable when separate fits were attempted for each contract month, the aggregate model suggests there is a statistical difference (at the 5 percent level) only between the January contract and the November contract.

(10) There does appear to be some significance between the coefficient of the crop expectation variable for the different months as observed in the aggregate model. The September contract is significantly different from the January contract at the 10 percent level while the November contract is significantly different at the 5 percent level.

(11) This market appears most amenable to hedging and in fact seems to pay some bonuses for early commitments because of the size of the freeze bias that exists in all contracts.

Summarizing the above points would lead to the conclusion that the relationship between the futures market and the cash market is understandable and in fact makes reasonable economic sense. Armed with these beliefs, hedging plans may be established which can benefit a substantial number of participants in the orange industry. These plans will be probed depending upon one's position in the industry.

Hedging Strategies

The owner of cash fruit can develop a hedging plan using McKinnon's model (3.38) with the potential of having a bonus represented by a positive basis as an added incentive to hedge. Recall that the optimum hedge ratio was

$$\frac{X_f^*}{\mu_{x.}} = 1 + \rho \frac{\text{coefficient of variation of output}}{\text{coefficient of variation of prices}}$$

The coeffficient of variation of output for Florida orange production was calculated to be 0.1524.[6] The grower may have data indicating a different value, however, this term does take into account reductions in output due to freezes. From Table 4 the coefficient of variation of spot prices over the last eight years has been .1849. Assume the grower knows there is a relation of -.5 between his output and what he typically has received for fruit in the past. Thus his hedge ratio could be

$$\frac{X_f^*}{\mu_x} = 1 - .5\ \frac{.1524}{.1849} = .5878$$

or about 60 percent of his expected output.

Cooperatives may hedge their collective expected output in precisely the same manner. The modified basis in this model was generated by subtracting from the price differential between

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[6]The output variation was calculated using the familiar formula

$$\text{Var(Yield)} = \frac{1}{n} \sum_{i=1}^{n} (Y_i - \overline{Y})^2$$

where Y_i represents the yield in boxes of fruit per acre for bearing acreage as reported by the Florida Crop and Livestock Reporting Service. The data included observations from the 1956-57 season through the 1972-73 season. The coefficient of variation is simply Var(Yield)/mean Yield.

a futures price and the existing spot price the commercial storage rates plus the typical maufacturing costs per pound solid. Should the cooperative have good knowledge and control of their costs, the basis pattern could be much enhanced in their favor. Then the typical freeze bias bonus could be supplemented by the efficiency savings creating a very desirable situation for the cooperative members. The usual caveat should be repeated; a hedging program will protect against undeisrable downward price movements as well as desirable upward price movements. The benefits of a freeze will not be realized by hedging. The market is paying for the privilege of assuming these risks as represented by the freeze bias. The hedger must be willing to forgo an occasional windfall gain for a smaller, more certain return each season.

Processors can recognize two potential benefits from the futures market. When there is a positive basis the processor by selling on the futures market and buying on the cash market can enhance his processing margin by the size of the basis. Again since this model already recognized manufacturing costs and commercial storage rates, the freeze bias in the contracts represents additions to the processing margins normally enjoyed. Thus when large positive bases exist, the processors can and should pursue commitments in the two markets.

The second method that processors may benefit from use of the futures markets is by the use of protecting inventory by hedges. The model to use is (3.21) or its counterpart, Figure 6. Since the citrus futures market pays for storage, the processor can expect to considerably reduce his risk of carrying inventory by hedging. Should the inventory conditions be below normal and the market is recognizing a convenience yield, the benefits would not be as large and in some cases may be negative. This would indicate that carrying large inventories is not profitable and stocks should be released.

The individual that does not have an easy access to the benefits of the futures market is the grower who is a member of a pool administered by a private processor. He is committed to deliver his fruit to the processor. By selling short in the futures market, which is the method of hedging, he is committing a portion of his fruit a second time. Should a freeze occur and his crop be affected in a serious manner he would have little fruit to commit to a pool thereby reducing his revenue. Further he would lose in the futures market because the prices would have likely gone up against his position reducing further his revenue. Thus instead of reducing the variation in his revenue he is amplifying it. The trader faces two alternatives. The first alternative is to drop out of the plan to become a cash seller. The second alternative is to negotiate individually or collectively with the processor to develop a hedging plan for the pool fruit with some portion of the benefits accruing to the pool participants.

Reviewing the results of the basis model indicates that the Florida orange industry did indeed gain an additional marketing tool when the FCOJ futures market was established. The behavior of the market is understandable in an economic sense. There is an established, close relation between the futures market for FCOJ and the cash market for fruit. It remains for the individual and collective members of this industry to aggressively exploit the benefits which this market offers.

CHAPTER VII
SUMMARY AND CONCLUSIONS

General Conclusions

There has been considerable concern expressed by members of the Florida orange industry that the futures market in FCOJ is and has been a detrimental influence to the cash market for oranges and/or orange solids. This feeling has generated a sub-committee within the Florida Citrus Commission whose responsibility is to assess the influence that the futures market may have had or is having and to recommend remedial action as appropriate.

With such an apparent concern within the industry this study was undertaken with the intent of developing a broader understanding of the citrus futures market. Having broadened the understanding of citrus futures various policy recommendations relating the usefulness of the market can be made. Futures markets may or may not influence prices of the cash commodity as discussed in Chapters III, IV and V. Further, the futures markets can facilitate hedging cash price risk. Therefore the specific objectives of this study were to (1) analyze the variation of prices paid to growers of oranges before and after the introduction of FCOJ futures trading and (2) develop an explanatory model of the FCOJ "basis" for use in understanding the relationship and developing strategies for futures market usage by a larger segment of the industry.

It was necessary to develop a rationale for determining what would be a desirable influence upon the cash market, whether price stability or price instability would be beneficial to the producers. As a result of the graphical and mathematical treatment of price variability it was determined that a movement toward price stability would be beneficial to producing members of the industry.

It was necessary to develop a rationale also for the potential benefits of hedging. It was shown that if there were a relationship between price series in a futures market and the spot market for a specific commodity, then a program of hedging could indeed reduce the normal price risk that an enterprise faces. Two models were suggested depending upon the certainty of the size of the enterprise's holdings. For a holder of inventory that was certain, the optimum hedging could be determined by knowing the correlation between prices in the two markets and the ratios of the standard deviations of the prices in the two markets. For a grower who must recognize some uncertainty in the potential production of the commodity a model was developed to determine an optimum hedging program with these terms.

The first area of interest to be explored was an analysis of the price variation for cash orange solids that has existed for the past 16 years. This analysis was conducted with the purpose of being able to determine if the futures market has had any effect and if the effect was desirable. It was determined that the futures markets had indeed contributed towards price stability for the industry. Therefore the futures market has been a beneficial influence at least when measured by the criterion of price stability.

As an adjunct to the price variation analysis the contribution of the futures market towards inventory management was explored. The behavior of hedgers was hypothesized and analyzed with a hedge model. It was determined that hedging behavior was proper although at a seemingly low level. That was true at two periods during a season, one prior to the beginning of the season and one at the end of the harvest period. Theory was discussed about how inventory maintenance might be explained by observed hedging. Although the model was developed in general form there were not enough data to do any estimation.

The next area of interest was to determine if any inequities had developed between sellers of cash fruit and pool members since the introduction of futures trading. The results of this analysis indicated that the major causes of price differences that may exist between the two types of fruit are the size of the crop plus inventory carryover and the freeze effect. The first influence tends to widen the price difference in favor of the pool member. The freeze influence tends to favor the cash seller. It was determined that these influences were softened by the effects of futures trading. The influence, however, was not significant from a statistical sense, and therefore any discussion about the beneficial effect of futures trading can not be defended with any vigor. A statement that can be made in much stronger terms is that there is no evidence to indicate that the futures market has contributed to inequities in the price structure of this industry.

The second objective of this study was to develop an understanding of the relationship between futures prices and cash prices for orange solids. A "basis" model was developed which synthesized theory developed by others with some unique features of the orange industry.

The desire was to explore with this model if and to what extent this futures market paid an interest and risk premium and recognized a convenience yield. Would the futures market pay a freeze bias or bonus, and did it have price distortions due to trading in the futures markets. Would it react to expectations of crop forecasts and freezes, and finally was there any adjustment in the freeze bias due to changes in availability.

It was determined that the market does recognize and pay for the variable costs of transformation from oranges to bulk concentrate and the costs of storage.

In addition to the above:

(A) The market pays for opportunity costs (interest) and a risk premium.

(B) The market does react to short supplies and extract a convenience yield.

(C) There is a freeze bias paid by this market which represents what speculators are willing to pay for the privilege of buying a windfall gain in the event of a freeze.

(D) There is an adjustment to the size of the freeze bias depending upon the size of the availability.

(E) There does not appear to be any measurable distortion in the basis due to trading activities on the exchange.

(F) The basis is affected by changes in estimated crop size as recognized by the coefficient of the expectation variable.

(G) The basis is affected by reported cold weather as indicated by the freeze expectation coefficient.

The general point to be made from the above observations is that the relationship between the cash and the futures market is as one could expect from the theoretical development. This futures market is behaving rationally and holds the promise of offering eminently successful hedging programs for those members of the industry wishing to use it.

Policy Implications

From the summary presented above three observations might be offered as policy.

(1) Since the market has beneficially affected the Florida orange industry or at least not detrimentally affected it, and since the futures market seems to be functioning as theory indicates that it should, a policy of no intervention, legal or otherwise, would be suggested at this time.

(2) The character of markets may and does change over time, therefore a policy of rethinking and redoing the analysis at intervals in the future would be suggested.

(3) That a program of education be urged and supported for members of the industry to acquaint them with the potential benefits of prudent hedging programs. This education may extend to the financial community as well.

Suggestions for Further Research

The futures market is a relatively new institution for the orange industry. More time and observations of behavioral patterns would possibly allow more definitive conclusions about the impact of futures trading upon the industry.

The price differential model may offer more statistically significant conclusions with a few more years of observations and theoretical restructuring.

The inventory management model can be developed with additional seasons of surplus inventories. The general arguments presented here would be just starting points to the development of a model which can distinguish the inventory carrying capability offered by a futures market.

A very important person in the study of the basis has been overlooked and that is the speculator. Possibly some of the serial correlation problems encountered in the basis model could have been eliminated if the speculative behavior could have been adequately and appropriately included. It could possibly be very fruitful and instructive if the psychological motivations of speculators could be isolated and tested. With that addition the model may be just that much more capable of explanation and prediction.

APPENDIX A
INTRODUCTION TO THE FLORIDA ORANGE INDUSTRY

INTRODUCTION TO THE FLORIDA ORANGE INDUSTRY

For those who may not be acquainted with the Florida orange industry, the following discussions will help develop a reasonable understanding of its structure. Hume (14), McPhee (20), and Sinclair (26) are suggested as references for those interested in more detail than will be presented here.

Agricultural Aspects

The oranges of commerce in the world are made up of three species in the order of their commercial interest: The sweet orange, Citrus sinensis; the mandarin or tangerine orange, Citrus reticulata; and the sour or bitter orange, Citrus aurantium.

The sweet oranges are by a large margin the most important of the species. There are three groupings within the species that should be recognized. These groups are: (A) those with normal fruit and which include varieties such as the Valencia, Parson Brown, Hamlin, Pineapple; (B) those with abnormal fruit such as the Navel; and (C) those with red or red-streaked pulp normally referred to as "blood" oranges.

Hume (14) states that the different species of Citrus had their native home in Cochin China and adjacent sections of China is well established. He further states that sour oranges reached Europe in the 11th century and the sweet oranges in the 15th century. Columbus was credited with the introduction of oranges into the Americas November 22, 1493. He had brought from

Spain numerous varieties of seeds, including orange seeds. A garden was established in what is now known as Santa Domingo on the isle of Haiti.

Just when they were introduced into Florida is not recorded. However, a resident of St. Augustine, Pedro Menendez, wrote to his superior officer in Santa Domingo on April 2, 1579, "There are beginning to be many of the fruits of Spain, such as figs, pomegranates, oranges, grapes in great quantity." (26, Pg. 3)

From this a fairly safe assumption can be made that oranges were introduced into Florida when St. Augustine was settled in 1565. Animals and Indians can likely be credited with the spread of citrus throughout Florida since in the 1700's wild orange groves could be discovered as settlement spread across Florida.

Citrus production began and developed to the point where over five million boxes were produced in the 1893-94 season. There was a disastrous freeze in the 1894-95 season that almost wiped out the Florida citrus industry. It took 15 years, until the 1909-10 season, when production finally surpassed that mark.

The acreage planted grew in Florida and during the 1932-33 season Florida became the state with the largest acreage planted in citrus fruits. It took over production leadership in the mid-40's and has not relinquished its lead since. Table A-1 is included to show Florida's position vis-a-vis the world in production of oranges and tangerines. The Florida orange

Table A-1

World citrus production, oranges and tangerines, seasons 1970-71 through 1973-74 (production in thousands of 90 lb. boxes)

	1970-71	1971-72	1973-73	1973-74[a]
United States	192,938	193,281	229,390	222,400
% of U.S. to World Production	32.7	32.0	33.9	33.2
Spain	49,123	53,386	64,729	59,633
Brazil	52,234	67,620	62,720	78,596
Italy	39,176	43,120	43,120	41,283
Japan	73,353	70,952	99,372	92,267
Argentina	30,748	23,912	25,284	21,168
Mexico	34,447	27,293	31,115	27,979
Algeria	11,050	10,903	11,050	10,976
Morocco	18,449	20,115	24,206	24,108
So. Africa (Rep.)	11,785	12,593	13,206	14,186
Israel	26,289	28,053	26,362	28,420
Australia	7,718	9,016	7,816	8,796
Greece	10,315	9,555	10,584	10,584
Turkey	12,569	12,459	13,794	12,422
Florida[b]	147,000	140,200	177,800	174,200
% of Florida to World Total	24.9	23.3	26.2	26.0
World Total[c]	589,911	601,818	677,597	669,806

[a]Preliminary.

[b]Includes Temples.

[c]Smaller citrus-producing counties included in total.

NOTE: United States and Florida production, Florida Crop & Livestock Reporting Service.

SOURCE: Foreign Agricultural Service, U.S. Department of Agriculture, Washington, D.C.

industry appears to produce one out of every four oranges in the world.

Table A-2 is included to show the recent production and value performance of the orange industry in Florida including estimates for the current season.

Table A-3 is included to show the ten largest producing counties in Florida for the 1973-74 season.

It can be seen that Polk and Lake counties alone produce as many oranges as any country with the exception of Japan. The economy of virtually all counties south of Marion county in the north central region of Florida is affected by the orange industry.

Most oranges grown in Florida are budded or grafted on a rootstock chosen because of its ability to forage well in the specific soil in which it is planted or because of pest and disease resistance. Most oranges in the "Ridge"[1] or interior regions of Florida are grown on rough Lemon rootstock while those in the Indian River region are usually grown upon bitter or sour orange rootstock. Only 0.5 percent of recent plantings are seedlings, that is non-budded trees.

Recent inventory data indicate that recent plantings average about 115 trees per acre which are planted on the the

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[1]The "Ridge" is the section of Florida stretching from around Leesburg in the Northwest portion of Lake county to Frostproof in southern Polk county. This is an area of sandy hills and acts as a watershed for the state--a continental divide.

Table A-2

Florida orange production in thousand boxes

Crop Season	Early and Midseason	Valencia	Oranges	"On-Tree"Value Oranges (1,000 dollars)
1955-56	48,700	39,500	88,200	162,745
1956-57	51,600	38,700	90,300	124,631
1957-58	51,200	29,800	81,000	172,284
1958-59	43,900	38,900	82,800	236,269
1959-60	45,100	42,500	87,600	168,799
1960-61	47,000	37,700	82,700	242,446
1961-62	52,300	56,500	103,800	201,847
1962-63	43,500	29,000	72,500	194,081
1963-64	24,400	30,500	54,900	241,286
1964-65	42,600	39,800	82,400	198,435
1965-66	47,000	48,900	95,900	154,363
1966-67	73,200	66,300	139,500	129,944
1967-68	51,400	49,100	100,500	205,475
1968-69	69,700	60,000	129,700	217,155
1969-70	72,900	64,800	137,700	155,929
1970-71	82,100	60,200	142,300	208,200
1971-72	68,800	68,200	137,000	280,317
1972-73	90,000	79,700	169,700	275,300
1973-74	92,100	73,700	165,800	265,636**
1974-75(est.)*	97,000	79,000	176,000	

*At March 10, 1975

**Preliminary.

SOURCE: Florida Crop & Livestock Reporting Service, Orlando, Florida.

Table A-3

Florida round orange production by counties in 1,000 boxes, 1973-74 season

County	Oranges	% of Florida Production
Polk	32,570	19.6
Lake	24,766	14.9
Orange	12,857	7.8
Hardee	11,449	6.9
St. Lucie	8,763	5.3
Highlands	8,465	5.1
Hillsborough	8,471	5.1
Pasco	7,818	4.7
De Soto	5,397	3.3
Martin	5,283	3.2
TOTAL (10 Counties)	125,839	75.9
TOTAL (State)	165,800	100.0

SOURCE: Florida Citrus Mutual's "Annual Statistical Report, 1973-74 Season."

corner of a 25 x 15 foot rectangle.[2] This compares to an average of about 80 trees per acre in the 60-61 era and an average of about 70 trees per acre in the late 40's.

The citrus season is defined to be from November 1 to October 31 of the following year. There are two major harvest periods, the early midseason and the late, with a "break" usually during the month of March.

The early varieties are comprised of the Hamlin, Parson Brown and the Navel oranges with the Hamlin predominating (74.3 percent of all early varieties). The mid-season variety is largely the Pineapple accounting for 89.2 percent of the mid-season types. The late season orange is the Valencia and the two terms are synonomous.

The oranges are budded or grafted in nurseries from certified budstock usually and are ready to plant in their second year. Subsequent to planting in groves it usually takes three years for the trees to become sizable enough to be classified as bearing acreage. The oranges continue to increase production until they are about 20 to 25 years old depending upon variety. The typical early or mid-season variety will produce about 6.5 boxes of fruit per tree after reaching maturity, which in Valencias will produce about 5.5 boxes per tree.[3]

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[2]These were calculated from the "Commercial Citrus Inventory as of December, 1973," a publication of the Florida Crop and Livestock Reporting Service in Orlando.

[3]More completely detailed estimates can be found in Chern (2) and Savage (25).

Each of these boxes will yield around 5.4 gallons of chilled orange juice based upon averages for the past six seasons or if the oranges are used for concentrate a box will typically yield 1.3 gallons of 45° Brix.[4]

A discussion of temperature and the effects upon the Florida orange industry will be given and it is a summary of a presentation by Ziegler (38, pp. 85-92). Injurious low temperatures can occur under two sets of conditions--frost and freeze. In both cases the temperature of the air and/or the plant tissue goes below 32° F. but for different reasons.

Frosts are local occurrences and are due to radiation of heat from the soil and plants out into space. Rapid loss of heat by radiation occurs on cloudless nights for clouds will reflect the heat backward in great measure. Frosts can occur anywhere on the mainland and with a given geographic latitude muck soils are more prone to radiate heat than sandy soils. Elevated areas are less susceptible since cooler air is more dense and thus gravity will cause cold air drainage down into pockets.

Freezes are general in nature. They are a result of large frigid air masses flowing southeastward from polar regions. The air in a moving air mass tends to be at a constant temperature thus low and high ground locations will experience relatively equal temperatures at least during the frost day. A

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[4]A Brix° usually refers to the percent sugar by weight contained in a solution. The orange industry uses the term to describe the percent of orange solids by weight contained in a solution. Thus, for instance, 20 pound solids contained in 100 pounds of juice would be 20° Brix.

cold air mass freeze usually has a three-day period. The first night is cold and windy but usually causes no serious damage. The second night usually has light wind or calm conditions and the temperatures may reach dangerously low levels, particularly in low locations in the first few hours of the night. The third day usually finds the temperature moderating but the nighttime conditions will be cold and calm. Thus the most disastrous conditions occur during the second and/or third nights after a cold air mass has moved into the state.

The most dangerous condition for freezes exists when an early freeze occurs and is followed by warm, growth-inducing weather. The trees' conditions then are very tender and highly susceptible to subsequent freezes. The "big freeze" of 1894-95 cited earlier in the appendix had just that pattern. The trees had recovered from a December freeze with excellent new growth. A February freeze killed them to the ground.

The fruit starts to show damage when its tissues reach the freezing point which may be between 30° F. and 26° F. depending upon variety and maturity of the fruit. It is felt generally that fruit will start to show some damage when it is exposed to 27° F. for two hours, although individual fruits vary greatly in this respect. Cultivation plays a great part in protection since well-cultivated soil will radiate its heat to the trees at a more rapid rate than grass or mulch-covered soil does. The vigor and health of the tree, its state of dormancy, minimum air temperatures and duration of low temperatures are all major factors in determining the effects of a given exposure to cold weather.

Parvin (22) offers a detailed discussion of weather effects upon the supply of oranges and demonstrates the complexities of predicting the results of climatological phenomena upon orange supplies.

Marketing Schemes

A Florida orange goes to the consumer in many forms and through many possible marketing channels. A flow chart, Figure A-1, depicts the process and sets the stage for further discussions.

There are over 18,000 growers, it has been estimated, of citrus in Florida. A large percentage of these are absentee growers; that is, they live in large urban areas within the state or in some other state. The caretaking duties have been contracted to firms specializing in that field. The fruit from those groves usually enters the market through cooperatives or participation plans, which will be explained below. There are in addition, substantial acreages owned by corporations, such as Coca Cola, who are vertically integrated owning processing, storage and distribution facilities.

An owner has two options in getting his fruit started down the marketing channel. He can attempt to sell it for cash, that is, receive payment for the fruit when title changes hands, or he can become a member of a cooperative or a participation plan. Should he choose the cash route he can either sell direct to a processor and receive what is referred to as spot prices for his fruit as he delivers it or he can forward contract with a processor receiving at the time of delivery a

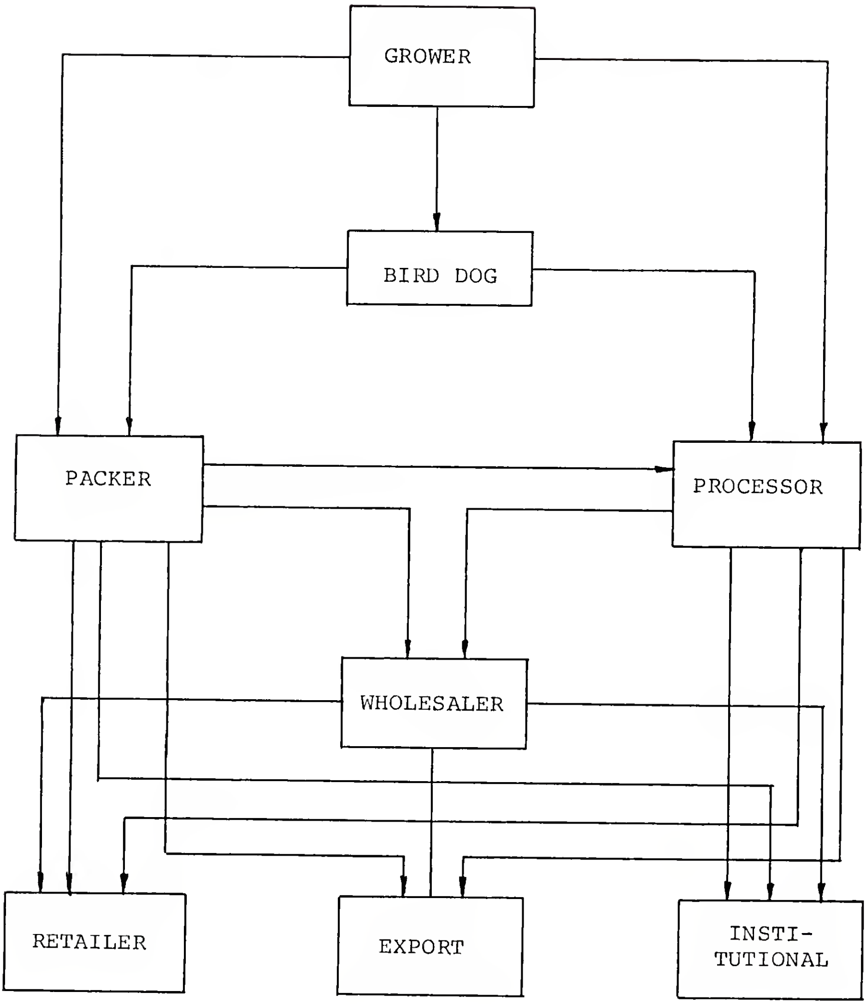

Figure A-1 Flow of oranges from grower to consumption outlets predetermined or contract price for his fruit or finally he can sell to a "bird dog" who will pay him a sum and speculate on his ability to in turn resell the fruit to a processor with a profit. In this manner the grower assumes the responsibility to participate in the price formation process actively.

Table A-4 is presented to show the recent breakdown in the relationship of "priced" fruit to the total used in the production of FCOJ. It can be seen that the spot box percentage has remained at a quite stable level of 5 percent of the total used for concentrating. The contract boxes average slightly more than 11 percent but the level is a little more variable compared to the spot boxes.

The alternative method, the non-priced method, is the more predominant method of marketing oranges as is evident from Table A-4. This occurs when a grower becomes a member of a cooperative or a participation plan established by a processor. Under these plans the fruit is picked and delivered to a processing plant. The oranges are analyzed and weighed in order to establish the number of pounds of solids contained in the delivery. The grower is credited then with the delivery and title is transferred to the processor who then processes the oranges and ultimately sells the processed fruit. The grower may at this time receive a payment designed to cover picking and hauling costs if this is not provided by the pool. When the pool has been sold a value is established for each pound solid in the pool. This is determined by netting from the total revenue the marketing and processing costs.

Table A-4

Analysis of "priced fruit" used for concentrate (in boxes)

Season	Spot Boxes	% of Total	Contract Boxes	% of Total	Total Boxes	% of Total "Priced"
1973-74	7,609,815	5.74	7,702,085	5.81	132,468,892	11.55
1972-73	6,264,255	4.74	12,420,526	9.40	132,210,060	14.64
1971-72	5,929,495	5.68	14,661,785	14.04	104,399,222	19.72
1970-71	4,195,490	4.05	12,021,895	11.61	103,521,172	15.66
1969-70	3,955,809	3.93	11,893,623	11.81	100,738,932	15.74
1968-69	4,047,636	4.39	14,858,500	16.13	92,125,322	20.52
1967-68	3,056,343	4.93	7,918,636	12.78	61,965,500	17.71
1966-67	6,491,004	6.93	8,033,791	8.58	93,686,282	15.51
8 Season Averages		5.05		11.27		16.38
Standard Deviation		1.015		3.263		2.881
S.D. as % of Mean		20.10		28.95		17.59

SOURCE: Florida Canners Association.

The sum is then paid to the grower.

There are some benefits and drawbacks for the grower in this type of arrangement. The benefits come about particularly during freezes. When such conditions occur, member fruit would likely be the only fruit that a processor could accept during the post-freeze frenzied attempt to salvage as much fruit as possible. Therefore, nonmembers could lose out entirely. Under pool conditions the available labor force is used to pick fruit in as efficient a manner as possible, often starting with those groves that are nearby and radiating outward as long as the fruit and weather allows. All members in such an arrangement would share from the revenue of what was salvaged even though some members' fruit may not have been salvaged. This, as well as not having to get involved in the price formation activities seems to be the biggest attractions to the pool or cooperative marketing type arrangements. The drawback is that the processors do not necessarily have the growers' interests at heart in marketing of the orange products. The processor is interested in keeping the plant running efficiently and keeping the movement high in order to maximize his profits. To assure this, FOB prices may be kept at a level which is lower than necessary to move the product. The processor has no financial risk because of the pricing arrangements. The price risk therefore is shifted backward to the grower. The attractions appear to outweigh the drawbacks since nonpriced fruit accounts for around 80 percent of all oranges used in making FCOJ.

As depicted in Figure A-2 the oranges go to market either through a packing house or a processor. A packing house will sort, grade, wash, polish, sometimes color, and ship fruit in whole fresh form. These fresh shipments amounted to 7.6 percent of the 1973-74 Florida round orange crop.[5] This is a continuation of the decline in importance of fresh fruit shipments to the Florida orange industry. This compares with over 90 percent utilization in fresh fruit form as late as 1939. Should the oranges go to a processor then the resultant product may be oranges in canned form, either canned single strength orange juice, blends, or sections and salad pieces; in chilled form as single strength juice or sections; or finally as frozen concentrate. Recent utilization data are displayed in Figure A-2.[6] It is evident that FCOJ is the dominant usage for Florida oranges and the trend is getting stronger.

It has now been established that FCOJ is the major marketing form for Florida oranges. This concentrate is put up in three major types of packs--retail, institutional, or bulk. The retail sizes are typically the 6, 12 and 16-ounce size. The institutional pack, aimed toward the vendor, restaurant, fast-food operations, school, hospital and prison markets, is packaged in 32, 46, and 96-ounce sizes, although institutions may still purchase considerable amounts of concentrate

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[5]Data from Florida Citrus Mutual's "Annual Statistical Report 1973-74 Season."

[6]Data taken from various Florida Citrus Mutual's "Annual Statistical Reports."

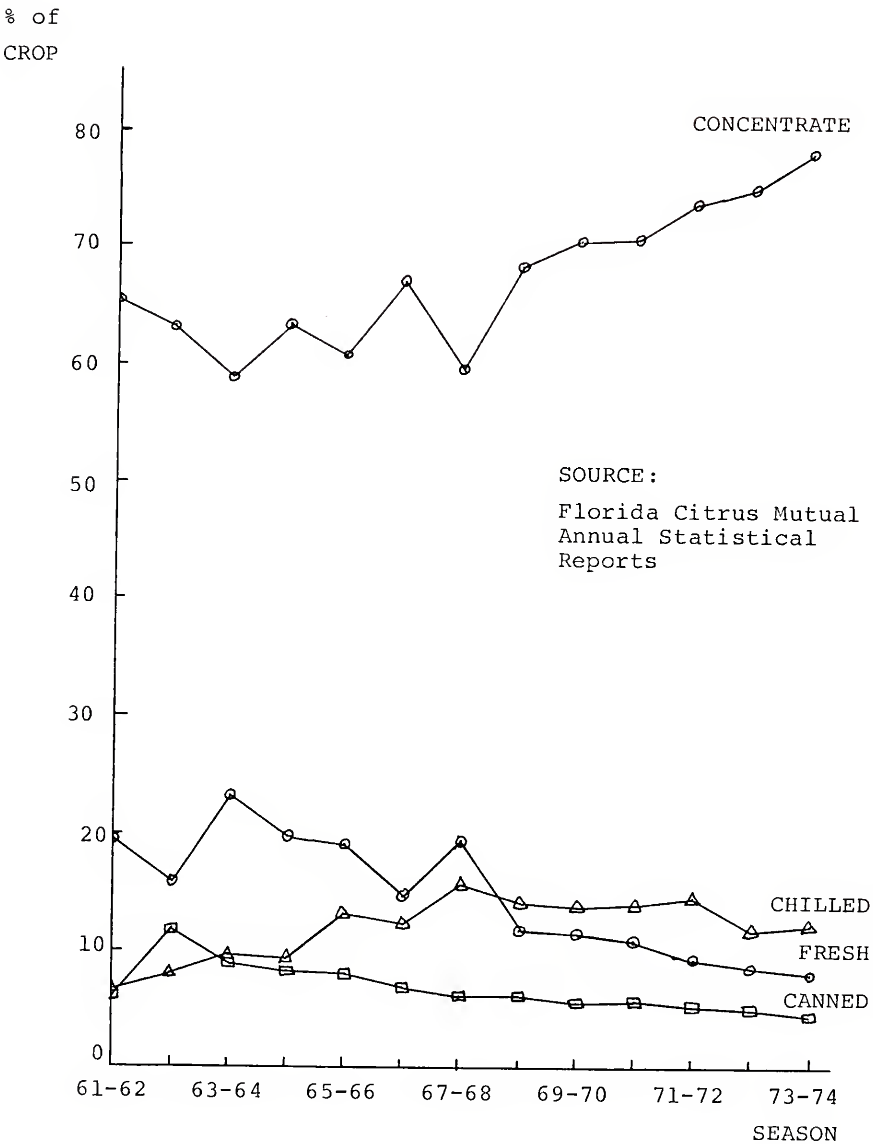

Figure A-2 Utilization by outlets of Florida oranges through supermarkets. The last pack mentioned was the bulk pack which is typically a 55-gallon drum. This size facilitates longer storage and also facilitates efficient reconstituted single strength operations. Table A-5 depicts the recent division of FCOJ into the pack categories mentioned above.

Retail FCOJ is sold either under nationally advertised manufacturers brand names or private, nonadvertised brand names of the manufacturer, wholesaler or retailer. Usually the retailer and the processor enter into annual supply contracts. Buyer protection is offered by processors for price increases as well as price decreases. In times of price weakness processors when reducing prices will also reduce all recent purchases to the newly established prices. This period could typically be say 20 days on all shipments east of the Mississippi and up to 30 days west of the Mississippi. This practice has developed to entice retailers into a relatively constant delivery pattern. On price increases buyers are notified usually two weeks ahead of a price increase allowing a buy-in period. The amounts that can be purchased during this buy-in period are a function of recent purchases by the buyer, i.e., the greater his recent purchases the greater amount he can purchase at the lower price.

Institutional FCOJ typically is sold through jobbers and/or wholesalers. The direct flow from processor to institutional use is minimal in part because of the rather large number of institutional buyers.

Table A-5

FCOJ pack in various forms (in gallons of 45° Brix)

Season	Retail	Institutional	Bulk	Reprocessed	Net
1973-74	129,097,916	14,605,590	111,689,164	83,516,774	171,845,896
1972-73	125,891,146	17,681,454	98,688,921	67,188,139	176,073,302
1971-72	110,140,496	11,749,416	71,101,493	58,762,254	134,229,151
1970-71	103,201,117	11,016,657	70,881,840	59,912,165	125,187,449
1969-70	96,108,017	9,514,119	63,987,394	44,722,070	124,947,460
1968-69	82,876,125	10,331,943	46,214,882	35,672,890	103,750,060
1967-68	76,811,218	6,861,198	40,253,859	40,229,228	83,697,047
1966-67	84,921,564	22,462,770	56,735,377	32,365,199	131,754,512

SOURCE: Florida Canners Association

The export market is relatively small and unimportant at the moment, amounting to less than 6 percent of all FCOJ consumption of the 1972-73 season. The FCOJ exported to Europe is 42° Brix rather than 45° Brix as used in the domestic and Canadian markets. This market is viewed as potentially large and important to the Florida orange industry particularly as domestic freezer capacity worldwide starts expanding. Methods of exploiting that market have been the cause of controversy within the industry for some time.

Another institution in the marketing scheme can be the marketing cooperative. A number of producing and/or processing cooperatives may feel they do not individually possess the skills or size to efficiently market their products. They may then join together and form yet another cooperative established for the purpose of marketing their aggregated production. These marketing cooperatives will be staffed with personnel who do possess the necessary experience, training and ability to insure proper and desired movement of product from producer to consumer. Citrus Central is an example of such a marketing association which represents a number of producing cooperatives and which markets concentrate amounting to an estimated 16½ to 17 percent of Florida's total concentrate[7] for the 1973-74 marketing season.

There are also coordinating institutions that, while they may not directly get involved in the physical handling of

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[7]Data presented by John St. John of Citrus Central, Inc., at a "Futures Trading Symposium" on January 9, 1974, in Lakeland, Florida. The whole presentation is part of the Proceedings of that meeting (23).

citrus products, do get involved in the marketing of these products. The discussions of the institutions to follow are not intended to be inclusive but rather are intended to cite the most influential.

The Florida Citrus Commission. This commission was established by the State Legislature in 1935. It is composed of 12 commissioners who are appointed by the Governor of Florida and who must be growers of citrus. They are charged with keeping the citrus fruit laws of the state which are collectively known as the Florida Citrus Code.

As regular duties the Commission handles the generic (nonbrand name) advertising. It has the power to establish state grade and quality standards. Research activities as appropriate to the citrus industry are funded through the Commission. With such research funds Dr. Lewis MacDowell and his colleagues discovered the concentration process which has become the basis for the FCOJ industry as it is known today. The Commission now invests in technology by funding studies in mechanical harvesting methods. The functions of the Commission are funded through an excise tax which is levied on each box of citrus marketed in any form.

Florida Citrus Mutual. Florida Citrus Mutual is a nonstock cooperative owned and controlled by growers of citrus. It represents and serves over 15,600 members as of the 1972-73 season after having been formed in 1949. It has a wide scope of activities but primarily is engaged promoting the selling and merchandising fruit, encouraging better production methods, working for better transportation rates, supporting tariffs on importation of citrus products, funding research in production, harvesting and marketing fruit, and finally the collection and distribution of numerous data on prices, production and other market information. Its funds are also recovered through a per box assessment to all members.

Other Groups. There are other groups such as the Growers' Administrative Committee and the Shippers' Advisory Committee which make recommendations about the Federal Marketing Agreements, regulate the grades and sizes for state inspections and devote study to the orderly marketing of fresh citrus. The Florida Canners Association is a trade group which includes all processors of citrus in Florida. Its major function has been to compile and publish extensive data on movement, yields, inventory and prices. It also lobbies for legislation affecting quality, packaging and other matters relating to processed products.

APPENDIX B
MODEL DATA

Table B-1

Data matrix for the price variation model[a]

SEASON	PVI_j	W_j	FT_j	$\bar{I}_{.j}$	FD_j	T
1958-59	7.219	0.17017	0	-1.08971	1.3921	1
1959-60	4.924	0.0	0	-0.24411	1.6129	2
1960-61	7.628	0.0	0	-2.87820	1.3031	3
1961-62	36.171	0.0	0	3.03291	5.8086	4
1962-63	127.882	1.73498	0	-.79277	7.6428	5
1963-64	0.518	0.0	0	1.14326	2.4607	6
1964-65	8.488	0.08816	0	9.2464	2.2709	7
1965-66	35.281	0.06796	0	3.1424	3.3997	8
1966-67	9.985	0.0	.25/.50	0.68474	7.8511	9
1967-68	5.824	0.0	1.0	-4.7264	8.2274	10
1968-69	9.513	0.32823	1.0	-4.84037	4.2972	11
1969-70	4.249	0.11014	1.0	1.87586	3.8343	12
1970-71	103.136	1.22214	1.0	-1.44897	5.3490	13
1971-72	1.441	0.0	1.0	-3.16529	2.1178	14
1972-73	0.344	0.0	1.0	0.00957	2.1909	15
1973-74	0.716	0	1.0	6.33614	3.166	16

[a] PVI_j = yearly relative variance of prices
W_j = seasonal weather (freeze) index
FT_j = futures trading variable
$\bar{I}_j$ = mean deviation from historical inventory patterns
FD_j = coefficient of variation of crop forecasts
T = time

SOURCE: Derived from Florida Canners Association (5) and Florida Citrus Mutual (6) data.

Table B-2

Data matrix for the price differential model[a]

SEASON	$\overline{PDI}_{\cdot j}$	ΔA_j	F_j	PI_j	FT_j
1958-59	3.828	-17.925	0.78095	0.4554	0
1959-60	6.763	15.255	0.0	0.4239	0
1960-61	8.982	-6.760	0.0	0.4078	0
1961-62	-1.839	11.485	0.0	0.3901	0
1962-63	9.417	29.779	27.0884	0.2783	0
1963-64	16.069	-44.008	0.0	0.3314	0
1964-65	0.485	14.722	0.38571	0.2899	0
1965-66	0.332	16.406	0.21957	0.2492	0
1966-67	-9.548	42.844	0.0	0.1751	.25/.50
1967-68	5.328	-19.585	0.0	0.2174	1.0
1968-69	1.542	15.053	4.05465	0.2354	1.0
1969-70	-6.097	18.661	0.57823	0.2004	1.0
1970-71	1.872	19.176	5.03235	0.1901	1.0
1971-72	-0.507	-20.555	0.0	0.2224	1.0
1972-73	-8.726	25.734	0.0	0.1764	1.0
1973-74	0.359	0.362	0.0	0.1945	1.0

[a] $\overline{PDI}_{\cdot j}$ = mean seasonal differential between cash and FOB derived delivered-in prices.

ΔA_j = % change in availability

F_j = seasonal freeze index

PI_j = cash fruit to total fruit ratio

FT_j = futures trading variable

SOURCE: Derived from Florida Canner Association (5) and Florida Citrus Mutual (6) data.

Table B-3

Selected data and calculations for the basis model (November contract)

Week Ending	Futures Price (FP^N)	Spot Price (SP^N)	Transformation Costs (TC)	Interest Rate (r)	Time to Maturation (t^N)
12- 2-67	62.500	39.677	6.161	6.00	352
12- 9-67	62.968	41.241	6.161	6.00	345
2-24-68	57.753	42.715	6.161	6.00	268
12-28-68	66.200	41.984	5.396	6.75	324
5-23-70	39.394	34.913	5.396	8.00	180
1-15-72	56.396	50.172	5.588	5.25	307
7-21-73	50.650	39.855	6.678	7.75	121

These data were selected to serve as examples for the calculations of the basis model (Equation 6.15). The complete set of data are maintained by the Florida Department of Citrus in Gainesville, Florida. They were far too numerous to append to the dissertation.

SOURCE: Derived from various sources including Citrus Associates of the New York Cotton Exchange, Florida Canners Association (5), Spurlock (27), Florida Citrus Mutual (6).

Table B-3 (Extended)

Carrying Costs (C)	Modified Basis (MB^N)	Interest and Risk Payment (VCP^N)	Stock Ratio (S)	Convenience Yield (CY)	Distortion Index (L^N)
.0057	14.282	2.296	1.1800	0	1.000
.0057	13.248	2.339	1.1764	0	1.133
.0057	7.066	1.882	.8828	.133	2.632
.0063	16.448	2.329	.6482	.543	1.484
.0063	-2.269	1.377	1.069	0	3.158
.0069	-1.741	2.230	.7347	.361	2.408
.0069	3.108	1.024	1.0445	0	4.297

Table B-3 (Extended)

Elapsed Freeze Time (EFT)	Freeze Bias (FB)	Current Crop Forecast (CF_i)	Previous Crop Forecast (CF_{i-4})	Beginning Availability (GH^D)	Crop Expectation (CX^N)
0	1.000	100.4	100.4	120.4	0
0	1.00	100.4	100.4	120.4	0
62	0	98.4	98.4	120.4	0
10	.915	136.0	133.0	138.5	.022
62	0	139.2	135.2	164.4	.033
27	.751	142.0	142.0	155.7	0
62	0	175.1	175.1	195.7	0

Table B-3 (Extended)

Achieved Temperature (DT)	Freeze Expectation (FX^N)	Season's Availability Ratio (MSA)	Adjusted Freeze Bias (FBA^N)
0	0	.779	.779
0	0	.779	.779
0	0	.779	0
4.25	4.080	.841	.770
0	0	.999	0
0	0	.946	.710
0	0	1.189	0

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Frank Arthur Dasse was born August 13, 1933, near Bridgman, Michigan. He attended elementary school in Bridgman and was graduated from Flint Central High School, Flint, Michigan, in June, 1951. He attended Flint Junior College for two years and received the degree of Bachelor of Science in Electrical Engineering from the University of Michigan in June, 1956.

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

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