A PRICE-FORECASTING MODEL FOR MICHIGAN FRESH APPLES

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ABSTRACT

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The Michigan fresh apple industry is subject to a great deal of uncertainty regarding prices received for fresh apples. This price uncertainty is greatest at the beginning of the marketing season. It is also at this time that quality price information is most valuable as many marketing decisions must be made which are based on expected price. The purpose of this research was to develop a price-forecasting model which can increase the amount and quality of price information available to fresh apple marketers at the beginning of the marketing season.

Econometric techniques were used to quantify the influences of important variables affecting the prices of Michigan fresh apple varieties. Price-forecasting equations were developed for MacIntosh, Red Delicious, and Jonathan apples. Furthermore, to increase the usefulness of the model, the marketing season was divided into three periods corresponding to the dates which the three varieties are removed from common, regular and controlled atmosphere storages. In this specification a total of nine price-forecasting equations were developed.

The results of this research show that price-forecasting equations can be developed which meet the accuracy and timeliness needs of fresh apple markets. Finally, it was demonstrated how the research may be used by fresh apple marketers.

ACKNOWLEDGMENTS

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CHAPTER I

INTRODUCTION

This chapter provides a background for research on Michigan fresh apple prices. It includes a discussion of the research problem. It also suggests an analytical framework to be used in the resolution of the research problem. The following section establishes the economic justification for examining the price structure of the Michigan fresh apple industry.

PROBLEM SETTING

The apple industry is one of Michigan's most important agricultural industries. According to 1978 figures there are 1,579 growers in the state.[1] In 1978 these growers produced a crop that had a total value of production amounting to $63.2 million.[2] The total value of apple production exceeded that of tart cherries, Michigan's second most important fruit in 1978, by almost $7 million.[3] Over the most recent five year period Michigan's total apple production has not ranked lower than

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[1]Michigan Department of Agriculture, Michigan Fruit Tree Survey, 1978 (Lansing, Michigan: Michigan Agricultural Reporting Service, 1979) p. 11.

[2]Michigan Department of Agriculture, Michigan Agricultural Statistics, 1979 (Lansing, Michigan: Michigan Agricultural Reporting Service, 1979) p. 31.

[3]Total value of production is equal to growers' gross receipts not excluding cost of production, harvesting, storage and marketing costs.

fourth nationally.[4] These figures illustrate the importance of apple production and its contribution to Michigan's entire economy. In addition to growers, there are packers, shippers, processors, and retailers to mention a few whose incomes are at least partially dependent on apple production and sales. Total value of production represents only a portion of the total value generated from apples.

Fresh apple sales are an important market outlet for a significant proportion of the apples utilized in Michigan. Although fresh apple utilization amounted to about 40 percent of total apple utilization, fresh apple sales represented close to 60 percent of the total value of production during the period from 1973 to 1978.[5] Fresh apple sales constitute a major source of income not only to many growers, but also to packers and shippers.

The magnitude of these figures suggests that even a small percentage increase or decrease in price could be significant to the industry. For example, if the average price per pound for fresh apples was a half cent lower in 1977, ceteris paribus, this would have amounted to $1 million in lost revenues to growers.[6] A small change in actual prices can cause relatively large losses for apple marketers. It is, of course, possible that gains may result from price changes also. Not only do price changes affect the livelihood of apple marketers, but the general level at which prices are established is also vital.

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[4]Ibid., various issues.

[5]Thomas C. Butler and Thomas G. Gregory, Processing Apple Crop Statistics and Marketing Analysis (Lansing, Michigan: 1979) p. 9.

[6]The average price paid for fresh apples in all market outlets in 1977 was 11¢ per pound. (Michigan Agricultural Statistics, 1979) p. 33.

Growers, packers and shippers face a great deal of uncertainty with regard to their everyday production and marketing activities and subsequent decision making. A large portion of this uncertainty is associated with prices. Some specific factors which ultimately affect prices include weather, size of the crop, production and marketing costs, availability of substitute products and consumer preferences. Assuming an inelastic demand, the price of agricultural commodities can be extremely volatile simply because of the biological nature of the production process involved. This basic instability in production due to the biological process and the vagaries of weather can lead to wide fluctuations in gross returns and therefore net income levels. Apples are no exception. For instance, the total value of production for Michigan apples fluctuated from $45 million to $63 million between the 1977 marketing season and the 1978 marketing season.[7] Net incomes fluctuate much more. Not all of this is attributable to crop size, but the difference in utilized production between the two years was over 200 million pounds. Wide fluctuations in producers' income and crop levels is a distinguishing feature of agriculture.

It has been hypothesized that the high degree of instability associated with production and farmers' income had led to reduced incentives for new investment and capital losses associated with existing investment.[8] It should be pointed out that not everyone totally agrees with this viewpoint. Robinson, in a paper presented before the AAEA's annual

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[7]Michigan Department of Agriculture, Michigan Agricultural Statistics, 1979 (Lansing, Michigan: Michigan Agricultural Reporting Service, 1979) p. 33.

[8]D. G. Johnson, Forward Prices for Agriculture (Chicago, University of Chicago Press, 1947) cited by K. L. Robinson (see below), p. 772.

meetings, makes a strong case for moderate levels of instability.[9] His argument is based on two major points. First, some recently collected empirical evidence indicates that instability causing high prices may induce higher levels of investment than in normal years. Second, a certain level of instability forces firm managers to operate on the production possibility frontier, or as Liebenstein refers to it, "X-efficiency."[10] Instability creates an uncertain environment where managers must operate efficiently or be forced out of business.

The point of this research, however, is not to reduce instability, but rather to help apple marketers cope with price uncertainty in part caused by instability in production. A related factor to price uncertainty and instability is the relative short run price inelasticity of the demand and supply functions for agricultural commodities. Even small shifts in inelastic supply and/or demand relations can have relatively large impacts on price and therefore incomes. This is true of apples. Although it may not be possible to eliminate instability due to biological and meteorological factors, it may be possible to reduce some of the price uncertainty associated with levels of information related to changes in the supply and demand of apples and other economic factors. The uncertainty associated with prices arising out of a lack of information concerning these factors can complicate the decision-making process for apple marketers.

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[9]K. L. Robinson, "Unstable Farm Prices: Economic Consequences and Policy Options," American Journal of Agricultural Economics, LVII (1975): pp. 769-777.

[10]Harvey Leibenstein, "Allocative Efficiency vs. 'X Efficiency'," American Economic Review, LVI (1966): p. 398.

In the case of fresh apples, as with many other agricultural commodities, there is a large degree of uncertainty concerning the level of prices received. What is the significance of price uncertainty for fresh apples? For apple packers and growers, price is an important decision variable. Growers must decide to which market, fresh or processed, they should sell their apples. Growers and packers must decide whether to sell their apples at harvest time or to store (and what type of storage) and sell at a later date. Many of these decisions are based on present apple prices in alternative markets and estimates of expected future prices. Some of these decisions are made many times over the course of the marketing season, but at no time is the uncertainty surrounding price as great as it is in the beginning of the marketing season. An incorrect decision based on price expectations early in the marketing season may unnecessarily cut profits or even cause losses.

Price uncertainty at the beginning of the season is the result of incomplete knowledge regarding certain key economic factors and their influence on price. Some of these economic factors are production, consumer income, availability of substitutes and consumer preferences. Price theory and the manner in which economic forces affect prices is known as price determination.[11] The complete results of this process are never known with certainty until the marketing season is over. An integral part of the phenomena is what Tomek and Robinson refer to as "price discovery."[12] The term is used to describe the process by which

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[11]William G. Tomek and Kenneth L. Robinson, Agricultural Product Prices (Ithaca, New York: Cornell University Press, 1972) p. 215.

[12]Ibid., p. 215.

buyers and sellers arrive at specific prices. The most prevalent price discovery mechanism used in the Michigan fresh apple market is individual negotiation at the shipper level.[13] The outcome of the negotiation process depends largely on the participants' view of market conditions and their relative bargaining skills and power. It is also influenced by shipper "bargaining," bargaining with grower money as fresh apples are most frequently sold on consignment. Since the price determination process is far from complete early in the marketing season, there is a lack of information to be used as an input into the negotiation process. Unfortunately for apple marketers, it is at the beginning of the marketing season when many important marketing decisions must be made. Increased information with regard to appropriate prices might provide potential for making the decision-making and marketing processes more efficient.

Presently, most growers, packers and shippers form their own expectations of season's average prices and use these expectations as a partial basis for their marketing decisions. The marketer forms these expectations either explicitly or implicitly based on variables which experience and/or tradition have led him to believe are important. This set of variables might include the size of the apple crop, quality of apples, personal judgments on demand and the like. While most packers take these variables into consideration they generally don't do it in a detailed, explicit, quantitative fashion. Their approach tends to be relatively informal.

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[13]Ralph B. Christy, A Review of Price Data in the Michigan Apple Market (unpublished M.S. thesis, East Lansing, Michigan State University, 1978) p. 12.

In response to this situation, it is possible to combine several of the same decision factors used by marketers in a more formal, analytical model. An analytical model can systematically quantify the factors' influences on fresh apple prices. Once the influence of a set of variables on fresh apple prices has been quantitatively estimated, it is possible to use these estimates to reduce some of the uncertainty with regard to the appropriate level of prices. There are other methods available to reduce price uncertainty such as supply control, allocation schemes to alternative markets, collective bargaining and improved vertical organization. Not all of these are mutually exclusive of each other or with price analysis, but they are not primarily concerned with reducing price uncertainty and all require a greater amount of collective action than does price analysis.

Price analysis seems especially applicable to fresh apples as a means to reduce price uncertainty. As Oldenstadt puts it, "Price analysis has as a primary objective the discovery and measurement of factors associated with the level and movement in price."[14] The fulfillment of this objective serves two purposes: the first is to forecast prices with a known level of confidence for a future point in time; and second, to obtain estimates of the parameters with the most influence on price. The estimated parameters may be used to determine the varied effects of alternative public or private policies. The emphasis in this study will be placed on fulfillment of the first purpose.

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[14]E. C. Pasour, Jr. and D. L. Oldenstadt, Farm Prices of Apples for Canning and Freezing, United States, 1951-61 (U.S. Department of Agriculture, Agricultural Economics Report No. 35, June 1963) p. 3.

In this study, statistical techniques coupled with adequate data will be used to forecast fresh apple prices. The results of this price analysis can then be used by individual marketers to reduce price uncertainty in decision making processes. Thus, price forecasts will give marketers additional information to improve decision making.

THE PROBLEM

The specific researchable problem derived from the level of uncertainty associated with prices and its influence on decision making is the formulation of an econometric model. This model can then be used to accurately forecast early, season's average prices for Michigan fresh apples F.O.B. at the packer-level. The model and resultant forecasts will aid producers, packers, and shippers in their marketing decisions and will improve the competitiveness of the Michigan fresh apple industry.

PURPOSE OF STUDY

The purpose of this study is to use econometric techniques to build a price forecasting model to forecast Michigan packer-level season's average F.O.B. prices of 12-3 lb. polybag containers for Jonathan, Red Delicious and MacIntoch apples. Specifically, this anlysis will produce price forecasting equations of the average prices for each of three marketing periods during the marketing year. These periods are: Period I--sales prior to November 1, Period II--sales made from regular storage after November 1, and Period III--sales made from controlled atmosphere storage. More detailed discussions of these specifications and calculations of the average prices are provided in Chapter II. Using the results of this research it will be possible to obtain estimates of apple prices early in the marketing season and thereby reduce some of

the uncertainty associated with prices. A sufficient reduction in uncertainty surrounding price can enhance marketers' decision making.

ECONOMIC RATIONALE

Many price analyses for apples have been conducted. A number of these studies are broad in scope, being done on a national basis. Recently, however, efforts have been undertaken on regional market bases, such as states. The need for research pertaining to early season price forecasts on a more localized level is well recognized. A comment by Pasour is typical of this sentiment. "This study has not considered the demand for specific grades, varieties, etc. of apples for different geographical locations. The individual producer is more interested in demand for specific varieties and sizes of apples rather than some general average."[15] The Michigan shipper is interested in the price he/she will recieve for his/her fruit. In a more general context, Lowry and Tomek as well as Greig have expressed as a need of the apply industry for accurate, early season, fresh price predictions.[16,17] O'Rourke concurred and said the need is for the elimination of the great uncertainty facing not only the producer but also the shipper who markets early.[18]

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[15]Ernest C. Pasour, An Analysis of Intraseasonal Apple Price Movements (unpublished Ph.D. thesis, Michigan State University, 1963) p. 177.

[16]Austin C. Lowry and William G. Tomek, Forecasting the Farm Price of Apples for Canning and Freezing in New York State (Cornell University, Department of Agricultural Economics, A.E. Report No. 219, 1967).

[17]William Smith Greig, Maximizing Total Dollar Sales of Apples and Apple Products by a Utilization Model (unpublished M.S. thesis, Michigan State University, 1962).

[18]Desmond A. O'Rourke, Factors Affecting Major Marketing Decisions for the Washington Apple Crop (Washington State University, College of Agricultural Research Center, Bulletin 793, 1974) p. 1.

It should be made clear that while both growers and shippers need price information, they use this information for different decisions. For example, growers may use the information in allocating supplies to different markets. Shippers, on the other hand, may use the information to set the rate of removal from storage and to decide on a fair price for the fruit. However, this can benefit the grower also as most sales are made on consignment.

Although there has been excellent work done in Michigan in forecasting prices for processed apple products,[19,20] the need for accurate early season fresh apple price information is present. As alluded to earlier, many decisions by shippers must be made early in the marketing season before the results of the price determination process are fully known. Most decisions shippers must make are made with some degree of uncertainty.

Price uncertainty can have a great impact on growers', packers' and shippers' incomes. "Wrong decisions" based on limited knowledge of the prices that will prevail throughout the marketing season can reduce the shippers; and growers' profitability. Two important decisions shippers must make which are critical at the beginning of the season are: what prices are favorable to sell at, and contingent on that decision, what should the type and quantity of storage be? Both decisions are based at least partially on expected price levels. It is not suggested

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[19]Donald J. Ricks, Applesauce Prices and Market Relationships (East Lansing, Michigan: Agricultural Economics Report No. 109, August 1968).

[20]Stanley E. Thompson and Leslie J. Butler, "Price Relationships for Frozen Apples and Tart Cherries," Journal of the Northeast Agricultural Economics Council Vol. VI, No. 2 (October 1977): pp. 147-156.

that the expected average price is the only 'price' which is important--intraseasonal price movements are also important. But it is suggested that greater information regarding the season's average price early in the season can reduce the possibility of following an adverse marketing policy.

As stated previously, many shippers form a price expectation using an informal approach based on their intuition and personal expertise. Once this expectation is formed, shippers decide what is the best course to follow in terms of marketing policies. If this perception is incorrect, they may unnecessarily cut their profits (growers' incomes as well) or even incur losses. For instance, suppose a shipper is debating whether to sell early or to store longer and sell at a later date. Based on his/her evaluation of market conditions the decision is made to sell a large quantity of apples now. Then to the shipper's chagrin, it later turns out that the prices received were too low--that is, it would have been more profitable to have stored the apples and sold them at a later date.

In this situation, a price analysis can give shippers added information to verify their own perceptions and adjust their marketing policy accordingly. Before making any decisions shippers can check current prices against the forecasted price. Using some subjective judgment to account for special conditions, i.e., poor quality, bad harvesting conditions, etc., it would be possible to determine whether current prices are substantially out of line with forecasted prices. If so, it might suggest that shippers alter their marketing strategy.

It is important to realize a forecasted average price will not tell the shipper what the price should be at any particular moment. This price will result from the price discovery process, but forecasts can be used as reference points in negotiation and decision making. This information should be especially useful early in the marketing period.

Simply put, economic justification for this research is that it is a low cost method to increase the information base concerning the price which results from the price determination mechanism. This additional information will reduce price uncertainty and increase efficiency with which marketing decisions are made. It will enhance pricing efficiency which will improve the allocation mechanism and thereby enhance the income situation of shippers and growers.

GENERAL OBJECTIVE OF THE STUDY

The primary objective of this research is to develop an econometric model which can be used to forecast the season's average prices F.O.B. at the packer.

SPECIFIC OBJECTIVES

1. To develop and test price forecasting equations for Jonathan, Red Delicous and MacIntosh apple varieties sold prior to November 1.

2. To develop and test price forecasting equations for Jonathan, Red Delicious and MacIntosh apple varieties sold from regular atmosphere storage after November 1.

3. To develop and test price forecasting equations for Jonathan, Red Delicious and MacIntosh apple varieties sold from controlled atmosphere storage.

ORGANIZATION OF THE STUDY

The first chapter has provided a basic framework for price analysis within the Michigan fresh apple market. It has also provided an economic justification for the study as well as fulfillment objectives of the study. The remainder of the study will proceed as follows: Chapter II will provide a description of the Michigan apple industry, a review of relevant literature and discussion of the economic model. This model will be the basis of the econometric model; Chapter III will present the specification of the econometric model to be used; Chapter IV will present and discuss the results of the price forecasting model; and Chapter V will contain a summary of the findings and a discussion of the policy implications of the price analysis.

CHAPTER II

THE ECONOMIC MODEL

To conduct price analysis a thorough understanding of the apple industry is necessary. This knowledge is then used to construct a model of the industry. The model is not only based on knowledge of the apple industry, but on sound economic theory as well. This chapter is intended to provide knowlege of the apple industry and use it to develop an economic model of the industry in Michigan. The first section of this chapter covers practices and patterns in apple production and consumption for the nation as well as Michigan. It is followed by a description of the Michigan apple industry. This description is used as an input into the construction of an economic model. The economic model is the basis for the remainder of this research.

PRACTICES AND PATTERNS IN U.S. APPLE PRODUCTION AND CONSUMPTION

Apple production is concentrated in several regions across the United States. The United States Department of Agriculture lists 35 states which produce apples on a commercial basis. By-far-and-away the most important apple producing region is the state of Washington. In the 1978 crop year it produced 30 percent of the nation's total apple crop.[1] Washington apples go predominantly into the fresh market. The

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[1]U.S. Department of Agriculture Statistical Reporting Service, Commercial Apples, 1979 Production by Vicinity (Washington, D.C.: Government Printing Office, 1980) p. 3.

next most important producing states are New York, Michigan, California and Pennsylvania, respectively. Along with Washington, these states produced over two-thirds of the nation's total production in 1978.[2]

The majority of Michigan's and New York's apples go into processing utilization. Washington provides stiff competition in the fresh market as its growers are blessed with especially favorable climatic conditions, high quality fruit for fresh market, and a higher percentage of high density plantings.[3] Washington also more actively promotes its apples than any other state and, through its promotion activities and high quality fresh products, appears to have established a degree of consumer franchise for its apples.

Over the past two decades total U.S. production has trended upward. From 1958 to 1978 apple production has increased by about 1,600 million pounds.[4] This is approximately a 30 percent increase. Much of this growth has been evidenced by Washington, but other states such as North Carolina have also increased greatly.[5] Accompanying this growth has been a change in the composition of growers' orchards. More and more standard trees are being replaced by dwarf rootstock. Dwarf rootstock, in general, can give higher yields per acre since the tree densities can be increased and involve less costly cultural and harvesting practices.

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[2]Ibid.

[3]Donald J. Ricks, "Regional Competitive Position of the Michigan Apple Industry Compared to Washington," (Michigan State University, Department of Agricultural Economics, Staff Paper No. 77-29, 1979) p. 2.

[4]Donald J. Ricks and Thomas R. Pierson, U.S. Apple Supplies--Trends and Future Projections (Department of Agricultural Economics, Michigan State University, 1979) p. 4.

[5]Ibid., p. 12.

The varietal composition of the orchards is also changing. For the most part, varieties being planted are fresh or dual purpose varieties, i.e., suitable for fresh sale or processing. Red Delicious led the way with Washington once again the primary contributor, but there are also substantial new plantings of this variety in Michigan and North Carolina. Processing varieties, those utilized only for processing purposes, in general are on the decline.[6]

Although processing varieties are on the decline, the void is being filled by dual purpose varieties. The decline in processing varieties has come in the face of a long term growth in demand for processed apple products. In the 1960's, demand for applecause and frozen apple slices for dessert filling showed strong growth. In the 1970's, this growth has been supplanted somewhat by rapid growth in demand for apple juice products.[7]

Growth in the demand for processed apple products has been fortunate for many growers. During the past 20 years per capita consumption of fresh apples has been relatively stable, although in the last ten years the trend appears to be increasing slightly (Figure 1). For Michigan growers, faced with a stable demand for fresh apples and stiff competition from Washington, the processing market has become the most important form of utilization. In this light, it may be somewhat surprising that the plantings of fresh varieties in Michigan is up. However, returns can still be good for high quality fresh apples.

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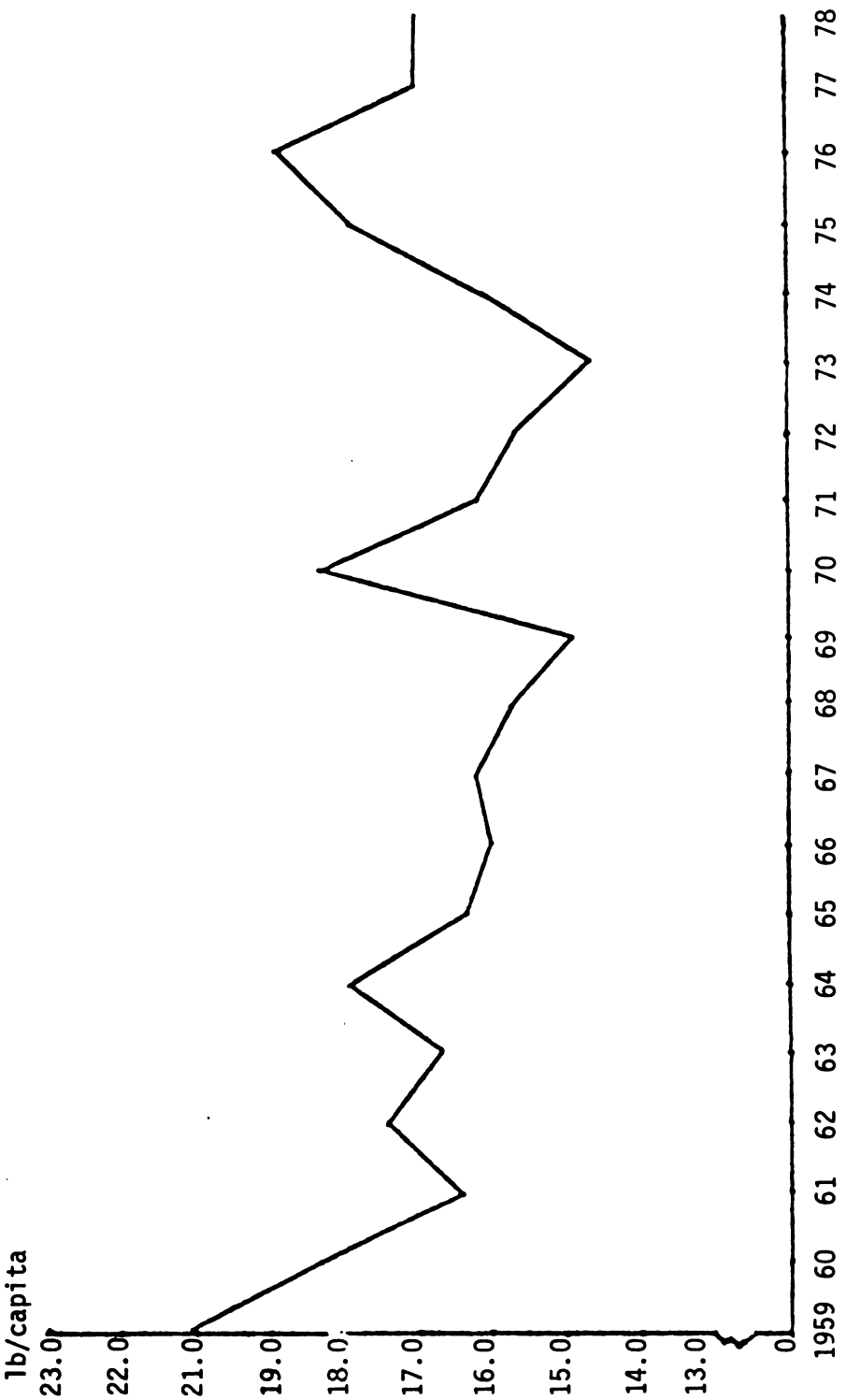
[6]Ibid., p. 8.

[7]Ibid., p. 4.

Figure 1. U.S. Per Capita Fresh Apple Consumption, 1959-1978



SOURCE: U.S. Agriculture Statistics, various issues.

THE MICHIGAN APPLE INDUSTRY

The Michigan apple industry is of considerable importance to the state's agricultural sector. According to Michigan Agricultural Statistics, in four of the past five years gross returns to growers from apples have been higher than any other fruit.[8] Apple orchards are concentrated in the Southwest and West Central portions of the state.[9] Almost 80 percent of the total acreage devoted to apples in the state is located in these two regions. These sites are highly conducive to apple production due to good soils and the moderating effect of Lake Michigan, which inhibits severe winter freezes and chances of frost.

As is the case for the nation as a whole, the composition of Michigan orchards is changing. These changes include introduction of new varieties, decreased plantings of some traditional varieties and more plantings of size-controlled trees. The most recent fruit tree survey (1978) reports a marked increase in the numbers of dwarf and semi-dwarf trees in the Michigan apple tree population. In 1973, size controlled trees constituted 35 percent of the total apple tree population, whereas in 1978 dwarf-type trees amounted to 54 percent of the population.[10] This transformation has been accomplished by the removal of old age standard trees and increased plantings of dwarf-type trees.

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[8]Michigan Department of Agriculture, Michigan Agricultural Statistics, 1979 (Lansing, Michigan: Michigan Agricultural Reporting Service, 1979) p. 31.

[9]The counties making up the Southwest region are Allegan, Berrian, Cass, Kalamazoo, Van Buren, and others. The major producing counties of the West-Central region include Ionia, Kent, Mason, Muskegon, Newaygo, Oceania, and Ottawa.

[10]Michigan Department of Agriculture, Michigan Fruit Tree Survey, 1978 (Lansing, Michigan: Michigan Agricultural Reporting Service, 1979) p. 10.

The four leading varieties in terms of tree numbers are Red Delicious, Jonathan, Golden Delicious, and MacIntosh.[11] In 1978, the top producing varieties were, respectively, Jonathans, Red Delicious, MacIntosh and Northern Spy.[12] These rankings are likely to change somewhat in the future. Ricks and Karony project that Red Delicous, a fresh variety, will increase in production as many young bearing trees reach full maturity.[13] Within Red Delicious plantings there has been a sizeable turnover from standard to size-controlled rootstocks. This increase in Red Delicous will most likely be accompanied by a decrease in MacIntosh and Jonathan production. Both varieties are considered dual-purpose. A large proportion of MacIntosh are old trees and most likely will be removed. The projected replacement rate will probably not compensate for the projected removals. Other dual purpose varieties such as Ida Reds will probably replace some of the Jonathan production. Although Michigan is a major processing state for apples, the production of traditional processing varieties (Northern Spies and Rhode Island Greenings) is likely to decline somewhat. This decline, however, in all likelihood will be made up by increased production of dual-purpose varieties.[14]

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[11]The tree numbers of these varieties are: Red Delicious--959,907; Jonathan--634,825; Golden Delicious--343,141; and MacIntosh--335,493. (Ibid., p. 18).

[12]The total production of these varieties was: Jonathans--194 million pounds; Red Delicious--165 million pounds; MacIntosh--140 million pounds; and Northern Spy--69 million pounds (Michigan Agricultural Statistics, 1979) p. 32.

[13]Donald J. Ricks and Susan Karony, Michigan Apple Production Trends and Future Projections (Michigan State University, Department of Agricultural Economics, Staff Paper No. 77-24, 1977) p. 6.

[14]Ibid., p. 4.

MARKET CHANNELS AND STRUCTURES

There are approximately 1,600 apple growers in Michigan. Depending on the composition of their orchards these growers may have the opportunity to market their apples via two marketing channels. Apples can either be utilized in the fresh market or the processing market. Both of these markets are composed of several smaller alternative channels. The processing market utilizes the majority of apples produced in Michigan. Over the last five years (1974-1978) processing has utilized about 60 percent of the apple crop.[15] Even though fresh apple utilization is smaller than processed utilization, it earned about 60 percent of the total value of production for all apples over the same period.[16] Which channel to market in depends on a set of interrelated factors such as variety, time of harvest, quantity, and quality of apples. Any specific combination of these factors may leave the grower little discretion in the decision as to which market is the appropriate channel.

THE FRESH MARKET

The fresh apple market is made up of several alternative marketing channels. It encompasses F.O.B. sales through packers, direct to consumer sales, the Benton Harbor City Market, and bulk sales to brokers (See Figure 2). The direct-to-consumer sales includes farmers' markets, roadside stands and u-pick orchard sales. As much as 23 percent of all

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[15]The specific percentages of total utilization going to processing in the past five years are: 1974--64%; 1975--54%; 1976--55%; 1977--61%; and 1978--61%. (Apple Crop Statistics and Market Analysis, 1979) p. 8.

[16]The specific percentages of value of production earned by fresh utilization are: 1974--54.9%; 1975--58%; 1976--59.6%; 1977--55%; and 1978--56.9% ((bid., p. 9).

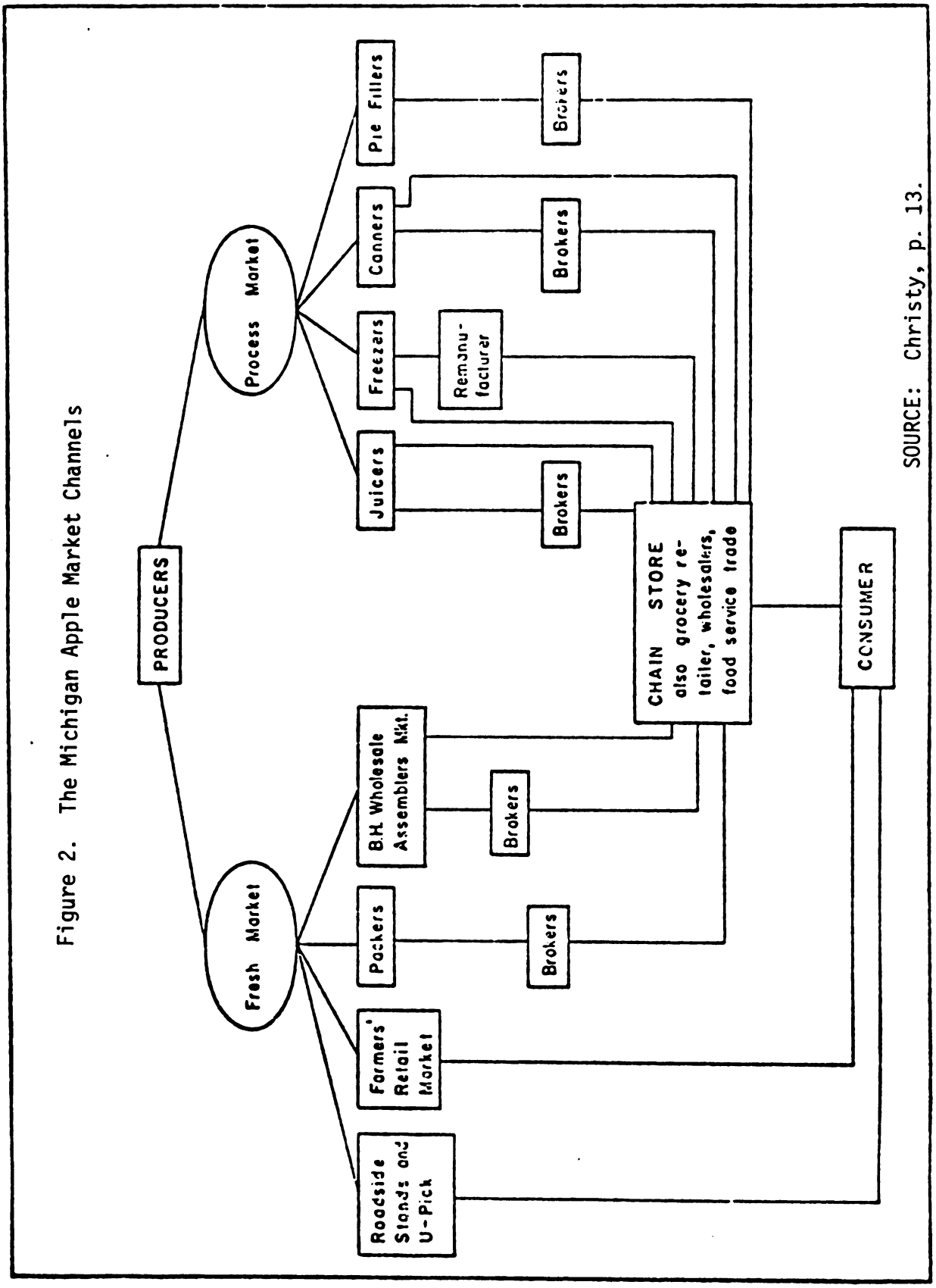

Figure 2. The Michigan Apple Market Channels

SOURCE: Christy, p. 13.

fresh apples in Michigan may be sold through this channel.[17] The Benton Harbor City Market is an organized exchange market handling about 5 percent of the fresh utilization. Bulk sales are highly variable and depend on the size and quality of the apple crop. Bulk sales by growers are usually made directly to packers or storage operators on a cash basis.

The most important form of fresh sales for growers is through shippers. Shippers handle approximately 56 percent of all fresh sales in Michigan.[18] Shipper sales are usually on a consignment basis and are priced F.O.B. at the packinghouse. The price analysis conducted in this research deals exclusively with developing a model to forecast the "period's" average price at the packer level. There are compelling reasons why this should be the case. The volume moved by shippers is one reason to predict the F.O.B. price. Another reason is that the sales are made on a consignment basis, so not only will the shippers be interested in this price, but growers as well.[19] Finally, data for prices at this level are much more well defined and more reliable than other fresh apple price series. This price will be discussed more fully in later sections.

Once apples are in the first handler's possession, the packers' functions are performed. The apples can then be sold immediately or placed in storage. There are three types of storage facilities: common

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[17]Christy, A Review of Price Data in the Michigan Apple Market, p. 12.

[18]Ibid., p. 12.

[19]A consignment or sale on consignment is merely an authorization or agency to sell.

storage, regular atmosphere or cold storage, and controlled atmosphere (CA) storage. Common storage provides no capacity to slow down the respiration rate of the apples. Regular storage is basically a refrigerated room. Apples stores in this facility usually are marketed in late fall and early winter. Apples stored for longer periods in cold storage begin to lose their firmness and dry out. In controlled atmosphere storage, the oxygen level is reduced and the carbon dioxide and nitrogen levels are increased to slow the respiration rate of the fruit. Most fresh apples marketed late in the winter and through the spring are controlled atmosphere apples. After the apples are sold, shippers deduct handling, storage and marketing charges from their price and the growers receive the remainder.

THE PROCESSING MARKET

The majority of apples grown in Michigan go into processing utilization. Given the slackening of growth in demand for fresh apples and the strength of Washington in the fresh apple market in recent years, it is fortunate that Michigan has a viable processing market. Most apples for processing are moved directly from growers to processors.

There are four general types of apple processing forms. These firms are: 1) canners, 2) freezers, 3) juicers, and 4) pie filling manufacturers. Many firms actually fall into at least two of these categories. Canners utilize about a fifth of the total Michigan processing pack, much of which is applesauce. Their products are priced F.O.B. at the processor, who deals directly or through brokers with retail chains.

Apple juice production has been growing and now amounts to about one-quarter of the total Michigan processed pack. Apple juice is marketed in the same manner as canned apple products. Michigan is the leading producer of frozen apple products and they account for about one-fifth of the total pack. Frozen apple slices are sold to remanufacturers who use the apple slices for pies and other manufactured dessert fillings. Apple pie filling accounts for only a small percentage of the total pack and is sold F.O.B. through marketing channels similar to sauce and juice.[20]

MARKET STRUCTURE

The fresh apple market is composed of atomistic growers who face somewhat concentrated storage, packing and shipping segments. Most of the fresh apples handled by shippers are sold through them on a consignment basis. This relationship shifts the price risks to growers. The shippers, in turn, deal with firms that may possess significant buying power. The outcome of the negotiation process between shippers and retail firms, in effect, determines growers' prices.

The relationship between growers and processors is different than that found in the fresh market. In 1973 Michigan passed and signed into law Public Act 344 which permits good faith bargaining between processors and a grower bargaining association. Bargaining has the potential to affect price and other terms of trade. For the specifics of the Act please refer to An Interpretation . . . The Michigan Agricultural Marketing and Bargaining Act of 1972, Michigan Farm Economics, James D.

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[20]Christy, A Review of Price Data in the Michigan Apple Market, p. 14.

Shaffer (1973). The Act changes the power relationship between growers and processors. At the present time, the legality of the Act is being argued in the courts. Even if the Act is upheld as constitutional, it will be some time before its full impacts will be known. When bargaining under P.A. 344, a great deal depends on the negotiators' relative bargaining skills as well as crops and economic situations in other apple processing states.

THE ECONOMIC MODEL

The preceeding sections of this chapter were intended to provide a basis and a background for the economic model which underlies this research. The model provides the theoretical economic underpinnings of the econometric model. The structural equations making up the econometric model are derived from the economic model. It is critical that the hypothesized relationships of the economic model be correctly formulated in order for the econometric model to give useful results. During the discussions on the economic and econometric models references will be made to past apple price analyses where relevant.

Apples have a relatively long history of being the object of price analysis. There are several reasons for price analysts' interest in apples. Apples are a commodity which have considerable importance in many parts of the country. The biological processes associated with apples are conducive to price analysis. That is, the process is fairly long with production determined to a considerable extent years in advance. Apple trees take anywhere from 6 to 12 years to reach their full bearing potential. This enables price analysis to be conducted using relatively simple demand models. Also of considerable importance

is that price data for apples, although far from perfect, is reliable enough to get meaningful results.

Even though apples as a commodity lend themselves to price analysis, it is necessary to understand the apple industry to ensure a successful completion of the analysis. From this understanding of the Michigan apple industry, selection of key variables affecting the price of Michigan fresh apples can be done. The emphasis must now be placed on those factors which significantly affect the price of Michigan fresh apples. This may include some aspects of the processing sector hypothesized to have some influence on the price of fresh apples. It may become necessary, though, to sacrifice some theoretical rigor for the sake of clarity and to keep the problem manageable.

THE PRICE SERIES

From an examination of the Michigan apple industry it was found that more fresh apples are priced F.O.B. at the packer than any other form of fresh sale. Therefore, this will be the price for which the price forecasting equations will be developed. The apples are transferred from growers to packer-shippers on a consignment basis. There is no grower price per se under this market relationship. The price growers receive is the F.O.B. price at the packer minus handling, storage and marketing charges of the packer and shipper. The specific pack price to be forecast will be the F.O.B. price of cartons of 12, 3-lb. bags (12-3's). There are several advantages in working with this price. Cartons of 12, 3-lb. bags are the major pack of Michigan packing houses.[21]

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[21]U.S. Department of Agriculture, Economics Research Service. Harvesting, Storing, and Packing Apples for the Fresh Market: Regional Practices and Costs (Washington, D.C.: Government Printing Office, MRR 1009, 1973) p. 40.

Their price is very important and useful to shippers and growers.

F.O.B. apple prices for 12-3's are published annually in Marketing Michigan Apples by the Federal-State Market News Service. The publication details weekly F.O.B. price quotes for different varieties, packs, and grades of apples. It also tells what type of storage the apples were removed from. With this type of detail the price analyst and decision maker have a clearer idea of what price is being forecast. One of the biggest drawbacks with the prices received by growers series is that it is a blend price of all the different forms of fresh sales. The prediction of this price may not help any particular apple marketer. However, the F.O.B., packer-shipper price data doesn't suffer from this problem. Both shippers and growers know fairly clearly the form of fresh sale these prices represent, although there are still quality differences.

The price data to be used in this research is broken down by varieties, thus price-forecasting equations will be developed for 12-3's of Jonathan, MacIntosh and Red Delicious. These are the three most important fresh varieties packed in Michigan. In 1978 they represented over 60 percent of the total storage holdings of packers.[22]

It is extremely fortunate that the price series also indicates the type of storage the apples were sold from, i.e., regular cold storage or controlled atmosphere. This allows for separate price forecasting equations to be developed for each type of storage. It also facilitates the development of a model which more closely corresponds with apple

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[22]Michigan Department of Agriculture, Marketing Michigan Apples, 1978 Crop (Benton Harbor, Michigan: Federal-State Market News Service, 1980) p. 15.

marketers' views of the season. The marketing season is often viewed as consisting of three periods. Period I is for fall sales. It is characterized by a great deal of uncertainty when marketers lack information regarding supply and other economic conditions. During this period apples spend little time in any sort of storage facility. Period II coincides with late fall and early winter when most apples sold are removed from regular-cold storage rooms. The third period is associated with sales from controlled atmosphere storage. The available price data is conducive to this formulation of the marketing seasons. Although the delineation between Periods I and II is necessarily somewhat arbitrary,as sales from common storage and regular storage are not always clearly delineated.

ECONOMIC FACTORS

In economic theory and the real world the price of a commodity is partially dependent on its supply. The relationship between price and quantity is hypothesized as being an inverse relationship. That is, as the supply of a commodity increases the price paid for that commodity decreases, ceteris paribus. In developing price forecasting equations for Michigan fresh apples there are several alternative definitions that could be used. For example, Michigan apples are marketed in a national or at least a large regional market competing with apples produced in other regions. A case can be made that it is total U.S. production of apples that most influences the prices of Michigan apples. That the supply of apples in other states affects the F.O.B. price is certainly logical, but a supply variable defined as national production obscures the influence of Michigan's production on its own prices.

This definition of supply also confounds the measurement of the independent effect of other regions' production on Michigan price. For instance, Washington, a major competitor of Michigan, has been able to achieve a limited degree of product differentiation for their fresh apples. It would be useful to Michigan marketers to know what effect the size of Washington's crop has on the price of Michigan fresh apples.

Another possible definition of supply would be the production of fresh varieties in the state. This is especially pertinent since this research will forecast the prices of specific varieties. This definition of supply also would be compatible with economic theory. However, there may be other problems. Price forecasts for apples will require estimates (ancillary forecasts) of the independent variables. Errors in the ancillary forecasts can lead to additional errors in the price forecast. O'Rourke found that as the level of aggregation rose in crop estimates the degree of error in the crop estimate fell.[23] Crop estimates for particular varieties or regions tend to average out when aggregated. In Michigan, the percent error for crop estimates for a single variety or even all fresh varieties is likely to be higher than the percent error associated with the estimate for the total Michigan apple crop. Therefore, this definition will not be used as a variable for Michigan supply.

It should be recognized that when predicting the price for a single variety, other varieties in the state may be regarded as substitutes. Ideally, it would be appealing to include as independent variables the

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[23]Desmond A. O'Rourke, Factors Affecting Major Marketing Decisions for the Washington Apple Crop (Washington State University, College of Agricultural Research Center, Bulletin 793, 1974), p. 4.

production of other varieties in Michigan. Unfortunately, this specification would use up degrees of freedom. It is also doubtful that any single variety other than the variety whose price is being estimated would have any significant effect on the estimated price. In lieu of these problems, the primary definition of supply for Michigan fresh apples will be total Michigan production.

Unfortunately, economic theory is not as clear cut and simple as price being dependent on quantity. The quantity of a commodity available or produced is also dependent on the price it can command in the market. Price and quantity are interdependent. Much of the interdependency between price and total supply in the development of price-forecasting equations for fresh apples may be ignored, however. Apples are perennial crops and, due to their long biological process, production decisions are made years in advance. Production of apples for a given crop year are constrained to a large degree by planting decisions made four to six years prior to that year's harvest.[24] Therefore, in any particular crop year it is reasonable to assume that total supply is fixed or predetermined. Of course weather will greatly affect supply in any given year. This assumption is strengthened when, as in Michigan, the size of economic abandonment historically has been low.[25] Treating total supply as given is not meant to imply that the price of fresh apples is not dependent on the size of the Michigan apple crop.

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[24]Depending on the variety and type of tree (dwarf or standard) it takes anywhere from 6 to 12 years for a tree to reach maturity.

[25]In the past 15 years (1964-1978), the level of abandonment in Michigan has varied from virtually zero to six percent of total production. In most years, abandonment has been closer to zero (Marketing Michigan Apples, various issues).

Even treating total production for a given year as predetermined and with negligible abandonment, problems of interdependency between price and quantity may still exist if there is more than one market outlet available for apples. In Michigan there are two major markets for apples, the fresh market and the processing market. The relative prices in the market could affect the amount of apples allocated by growers to each market. This would also mean the prices in each market would depend somewhat on the allocation pattern selected by growers. This problem arises when growers have a great deal of latitude in selecting the market for their apples. In actuality, they may not have this latitude at harvestime or after. Tomek and Ben-David point out that growers may not have much discretion in selecting the market in which they sell their apples.[26] Each market, fresh or processed, prefers particular grades and varieties of apples. An apple which is suitable for the processing market may not possess the quality characteristics to make it suitable for fresh utilization or vice versa. The market open to growers is greatly dictated by planting decisions (which variety) and cultural practices (apples for fresh market require greater care, incur higher costs, and hence require greater returns). This situation simplifies the economic model and leads to the assumption that the quantities of apples going to the fresh market and processing market may (for the most part) be treated as predetermined within a given crop year. It is realized that the processing market may provide a market of last resort for fresh apple producers and in so doing influence the fresh price by

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[26]Shaul Ben-David and William G. Tomek. Storing and Marketing New York State Apples, Based on Intraseasonal Demand Relationships (Cornell University, Agricultural Experiment Station Bulletin No. 1007, 1965) p. 5.

establishing a floor to the lower range of fresh prices. The statistical considerations brought up by the interdependency between price and quantity will be discussed in Chapter III.

The availability of substitutes and complementary products is theorized to affect the price of any particular product. An increased availability of substitutes is hypothesized to have a negative effect on price, while increased availability of complements is hypothesized to enhance the price of the product under consideration. Recalling the discussion on the definition of supply for forecasting Michigan prices, total national supply was rejected. In part, this was done because it seems more appropriate to view the apple production of other states as close substitutes for Michigan apples as suggested by Tomek and Robinson. "In a price equation for an individual state, the analyst must not forget the most important substitute for the product grown in the state is the same product grown in other states."[27] The production of apples in other states may be viewed as close substitutes for Michigan apples. In terms of this research, those states producing predominantly fresh varieties should be especially significant. For example, an increase in the size of the Washington crop is expected to have a depressing effect on the price of fresh apples in Michigan. This reasoning is further supported by the fact that Washington markets in Michigan's geographic market during much of the same season.

Other fruits consumed in fresh form may serve as substitutes for Michigan fresh apples as well. Some fruits that may be effective substitutes are oranges, bananas, peaches, and pears. These and other

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[27]William G. Tomek and Kenneth L. Robinson, Agricultural Product Prices (Ithaca, New York: Cornell University Press, 1972) p. 329.

fruits will be tested as substitutes in the price analysis, taking advantage of the fruits' seasonality and the fact that apples from different types of storage are marketed at different times of the year.

It is more difficult to establish a relationship for complementary products for fresh apples. In fact, it is difficult to even think of a true complement for fresh apples. The existence of complements will not be actively pursued as there is a high probability that if one exists it will have a minimal influence on price.

A final set of variables hypothesized to influence demand (price) includes consumer income, population, the general price level and consumer tastes and preferences. For most goods, income is hypothesized to exhibit a positive relationship with demand (price). There is some disagreement whether apples are an inferior good or a normal good.[28] Most studies hypothesize that fresh apples are a normal good, i.e., there is a positive relationship between income and demand. Tomek, however, hypothesized that apples were an inferior good.[29] His hypothesis was supported by results he obtained from price analysis for the 1950s and early 60s. Income, though, is highly trended and may be acting as a proxy for other variables besides income.

The demand for goods is expected to rise as the population increases, ceteris paribus. Total consumption of fresh apples has risen

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[28]An inferior good is defined as a good whose consumption falls when income rises.

[29]William G. Tomek, An Analysis of Changes in the Utilization of Apples in the United States (Cornell University, Department of Agricultural Economics, A.E. Res. 137, 1963) p. 14.

with the population from 1963 to 1977.[30] Population in some form will be included in the econometric model.

Consumers' tastes and preferences are important variables affecting the price of apples. Unfortunately, for all practical purposes, they defy quantification. The most consistent assumption is that, barring any dramatic occurrence, tastes and preferences will follow the same trend in the future as they have in the past. Although, if they do, their influence may be picked up by some other trended variable such as income. It is possible that the negative relationship between apple consumption and income observed by Tomek was a reflection of a change in consumer tastes and preferences captured by the income statistics. More of this matter is discussed in the chapter on the econometric model.

The general price level is also hypothesized as having a positive relationship with the price of fresh apples. As the general price level rises (falls) the price of fresh apples is expected to rise (fall), ceteris paribus. Usual measures of the general price level are some form of price index. This, too, is explored more fully in the section discussing the econometric model.

SUMMARY

Chapter II has provided an overview of the Michigan apple industry. This was done to focus on variables appropriate for the price analysis. After describing the apple industry, a discussion of the key variables as provided by economic theory followed. Chapter III will use the

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[30] Total fresh apple consumption has increased gradually from about 3,000 million pounds in 1963 to almost 4,000 million pounds in 1977. (U.S. Agricultural Statistics, 1978) p. 204.

economic model outlined in the previous section as the basis for an econometric model.

CHAPTER III

THE ECONOMETRIC MODEL

The development of the econometric model used in this research is presented in this chapter. Uses of econometric models are discussed and a summary is provided of the economic relationships incorporated into the econometric model of this research. The rationale and strengths of the three period-three variety model used in this analysis are also discussed. On the basis of this discussion, the general form of the price forecasting equation is shown for three varieties--Jonathan, Red Delicious and MacIntosh--in the three periods--first period or common storage, second period or regular storage, and the third period or controlled atmosphere storage. The statistical assumptions for the estimation procedure, ordinary least squares, are outlined, as well as other assumptions that must hold to make the estimation procedure valid. Finally, selection of the time period and hypotheses regarding the selected variables are provided.

USE OF ECONOMETRIC MODELS

The use of econometric models has grown rapidly in the last half century. A greater understanding of statistical procedure and the availability of high speed computers probably has had much to do with this. Econometrics, as the names implies, is the use of statistical procedures applied to economic research. Econometric models may be

viewed as mathematical representations of an economic model of a particular economic activity. In this case, the particular economic activity or entity is the Michigan fresh apple industry.

Econometric models can be used to quantify behavior, changes in structure or changes in other economic variables. Basically, econometrics takes historical relationships and behavior of economic variables, analyzes the past behavior using statistical procedures, and produces quantitative measures (coefficients) of the economic relationships. One use of the results of econometric analysis is to forecast changes in economic variables based on the estimated relationships among the variables in the econometric model. In other uses, the coefficients are important for policy considerations. The value of the coefficient can lead to an estimate of the impact of a change in policy variables on the dependent variable, ceteris paribus. Income and price elasticities are frequently found examples of coefficients in econometric models.

This research uses econometric techniques to conduct a price analysis of the Michigan fresh apple industry. Specifically, econometric theory is used as a tool to establish the price relationships of selected price determining variables for given varieties of fresh apples at the packer level. The resulting equations can then be used to forecast future apple prices. Although the coefficients generated in this analysis will be important, the research is primarily oriented to the development of a reliable forecasting model rather than determining and analyzing the influence of any particular variable.

SUMMARY OF THE RELATIONSHIPS IN THE ECONOMIC MODEL

The important factors within the Michigan apple industry are briefly summarized so that the relationship between the economic model and the econometric model can be more clearly understood. Of particular importance is the relationship between different types of storage facilities and the timing with which apples from various storage types are marketed.

Many fresh apples are not sold immediately and thus many apples are stored. Fresh apples may be placed in three different types of storage. They are common storage, regular atmosphere or cold storage, and controlled atmosphere storage. Timing of apple removals from storage varies considerably among the three types of storage. Removals from common storage for fresh sales are made early in the marketing season. When using common storage no attempt is made to slow the respiratory process of the apples and quality declines rapidly.

Regular atmosphere storage is basically a refrigerated room. A major form of storage, regular atmosphere storage, provides apples an intermediate storage life. Significant removal of apples from regular storage in Michigan begins in November and usually continues into January or early February.

Controlled atmosphere storage uses decreased oxygen levels to slow down the respiration rate. Most apples certified to be from CA storage must be kept under CA conditions for at least 90 days. Jonathans are an exception as they acquire CA quality characteristics after 60 days. This fact, combined with the greatly extended storage life of CA apples, are prime reasons that the CA season usually begins in January and extends throughout the rest of the marketing year.

The differences among storage types form the basis for the derivation of three different sets of price forecasting equations for Jonathan, MacIntosh and Red Delicious. Although the price forecasting equations are based on differences in storage, the entire model comes close to approximating a three-period intraseasonal model for fresh apples; however, there is not a complete one-to-one correspondence. The period characteristics are created by the variation in removal dates among types of storage. Variation in removal dates is based on storage life characteristics for each type of storage.

The first period includes apples sold prior to November 1.[1] Price data used in the construction of the price forecasting equations for this storage period are for regular storage apples sold prior to November 1. However, it seems likely after discussion with industry experts that many of the fresh apples sold prior to November 1 are actually from common storage or have spent minimal time in regular storage. Admittedly, the November 1 cutoff date is somewhat arbitrary, but it does coincide with the first bi-weekly storage report of the season put out by the Michigan Apple Committee. A look at these reports over the years shows that in most years, regular storage holdings are highest as of November 1. Additionally, by November 1 the bulk of the harvest is concluded and most apples sold thereafter have probably been in storage for more than just a short while.

The second period or regular storage period extends from November 1 to the end of regular storage removals. The period's average price for forecasting purposes is calculated from the weekly price quotes for

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[1]Although period is a slight misnomer, it will be used throughout the rest of the analysis to designate the change in time reference based on storage removals.

apples sold from regular storage after November 1. The third period or controlled atmosphere period consists solely of apple sales made from controlles atmosphere storage. The opening and closing dates for CA apples vary considerably from year to year, but generally it opens around January 1 and diminishes to relatively small movements by April.

The use of the word period conveys a false sense of finality between the opening and closing of different types of storage facilities. There is some overlap of removals between regular storage and controlled atmosphere storage. And the break between the first two periods is arbitrary. So it would be more accurate to call the econometric model a designated-storage model rather than a three-period model. However, the word period does convey differences in timing present in the model.

The forecasting equations consist of: a set of price forecasting equations for apples sold prior to November 1; a set of price forecasting equations for apples sold from regular storage after November 1; and a set of price forecasting equations for fresh apples sold from controlled atmosphere storage. Each set of price forecasting equations contains three equations: Jonathan, MacIntosh and Red Delicious. In essence, the econometric model forecasts three sets of period's average price for each of the three varieties.

This conceptualization of the econometric model is not unique. Both Pasour and O'Rourke have used multiperiod models based on the timing and duration of harvest and movements from storage.[2]

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[2]Ernest L. Pasour, Jr. An Analysis of Intraseasonal Apple Price Movement (Ph.D. dissertation, Michigan State University, 1963). O'Rourke, Factors Affecting Major Marketing Decisions for the Washington Apple Crop.

STRENGTHS OF A THREE PERIOD-THREE VARIETY MODEL

There are considerable advantages associated with the construction of three different sets of price forecasting equations based upon the differences in storage technology and timing. One is the greater volume and specificity of information generated from this formulation of the econometric model. This type of information should enable packer-shippers to better determine marketing patterns, timing of storage removals, and a better allocation among types of storage. Additionally, price forecasts resulting from this specification may be more accurate then those produced from a specification forecasting average price for an entire season.

Each equation is designed for a specific variety of apple as well as for a specific type of storage. This enables the model to incorporate variables which may be especially pertinent to a specific variety of apple and to a particular marketing season. Even if the overall accuracy of the model is not improved vis-a-vis a single "period" composite variety model, the results may be more useful. Rather than obtaining an amalgamated price for all varieties of apples for the entire season, this formulation is able to generate price forecasts for specific varieties of apples coming from various types of storage. Shippers are better able to judge tradeoffs among marketing strategies with regards to timing and the relative profitability of types of storage. Thus, the results more closely correspond to the needs of decision makers.

THE PRICE-FORECASTING EQUATIONS

In each of the storage periods equations are developed to forecast the price of 12-3 lb. film bags, F.O.B. at the packer for Jonathans,

Red Delicious and MacIntosh varieties. The price forecast is an average price associated with each type of storage. This means that for each marketing year three separate prices are forecast for each variety. The explanatory variables in these equations are expected to vary with varieties and types of storage. It is logical to expect some variation in the explanatory variables for different varieties and that the importance of the variables may change over the course of the marketing season. Thus, for each of the three varieties three equations are developed corresponding to the three periods--leading to a total of nine forecasting equations.

FORM OF THE PRICE-FORECASTING EQUATIONS

The general form of the price forecasting equations is:

$$P_{fa} = f(Q_{ma}, Q_{ap}, Q_{sf}, Q_{dinc}, I_{nf}, T)$$

Where:

P_{fa} = the price of fresh apples per 12-3 lb. bag container F.O.B. at the packer.

Q_{ma} = total utilized production of Michigan apples, millions of pounds.

Q_{ap} = total production of apples in alternative production areas, millions of pounds.

Q_{sf} = quantity of substitute fruits produced or sold.

Q_{dinc} = personal disposable income, billions of dollars per year.

I_{nf} = price index, in 1967 dollars.

T = a trend variable.

The variable representing the production in competing regions is defined to meet the needs of the individual equation. It is logical to

expect that the price of each variety under consideration may be influenced by a different regional production. This variation in influence is caused by differences among producing regions in varietal composition, harvest dates as well as marketing practices and patterns. For example, Washington production may influence the price of Michigan Red Delicious, while New York production may be more appropriate in the price forecasting equation for Michigan MacIntosh. Various forms of this hypothesis will be tested.

A similar situation may also exist in the cast of substitute fruits. Although it is likely that one fruit or group of fruits may be a suitable substitute for all three varieties, the composition of this variable may change as the marketing season progresses. Early in the marketing season, i.e., the first period, other deciduous fruits such as peaches and pears are plentiful. However, by the time the regular storage period is in full swing the marketing of these fruits have declined and oranges or other citrus fruits may be more dominant factors influencing the price of Michigan fresh apples. Several definitions of substitute fruits are tested, the results of which, including units of measurement, are presented in Chapter IV. Other variables in the general formulation of the equation will be discussed in a later section.

FIRST PERIOD EQUATIONS

Price forecasting equations have been developed for 12-3 lb. packs of Jonathan, Red Delicious, and MacIntosh sold during the first period. These equations are based on the general formulation given in the preceding section. However, the equations that follow are specific to each variety. They are more specific in that they contain definitions of the

independent variables which have been tentatively hypothesized as influencing the price of each particular variety. Although, various other definitions or measures of the independent variables are also tested: The equations are:

1. Jonathan: $P_{J1} = f(X_1, X_{13}, X_{33}, X_9, X_{10})$
2. MacIntosh: $P_{M1} = f(X_1, X_{35}, X_{33}, X_9, X_{10})$
3. Red Delicious: $P_{D1} = f(X_1, X_2, X_{33}, X_9, X_{10})$

Where:

P_{J1} = average price of Jonathan for the period, dollars per carton of 12-3 lb. bags, F.O.B. at the packer.

P_{M1} = average price of MacIntosh for the period, dollars per carton of 12-3 lb. bags, F.O.B. at the packer.

P_{D1} = average price of Red Delicious for the period, dollars per carton of 12-3 lb. bags, F.O.B. at the packer.

X_1 = Michigan production, millions of pounds.

X_2 = Washington production, millions of pounds.

X_{13} = Eastern production, millions of pounds.[3]

X_{35} = New England and New York production, millions of pounds.[4]

X_9 = consumer price index, 1967 dollars.

X_{10} = consumer disposable income, billions of dollars

X_{33} = index of noncitrus fruit production, thousands of tons.[5]

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[3]Eastern production includes the states of New York, Pennsylvania, Virginia, North Carolina, West Virginia, Massachusetts, New Jersey, Maine, Maryland, New Hampshire, Connecticut, South Carolina, Delaware and Rhode Island.

[4]New England plus New York production includes the states of New York, Massachusetts, Maine, New Hampshire, Connecticut, and Rhode Island.

[5]The index of production of noncitrus fruits includes grapes, nectarines, peaches and pears.

The basic difference among the equations lies in the definition of alternate areas of apple production. It is reasonable to assume the production in different geographical regions may affect the price of each variety of Michigan apples somewhat differently depending on the varietal makeup of a region's production. Washington dominates in the production of Red Delicious. So its production may have more influence on the price of Michigan's Red Delicious than on other Michigan varieties. Although, because of the size of Washington production it probably influences the price of all varieties in Michigan. In the case of Michigan Jonathan, Eastern states' production may be a more appropriate definition of alternative production as Jonathan production is predominantly located in the eastern United States. Outside of Michigan, MacIntosh production is predominantly located in the Northeast, especially New York, which is the largest producer of MacIntosh.

Although these definitions are tentatively hypothesized as being significant, other definitions may also be appropriate. Two other likely definitions of areas of alternative production are United States production excluding Michigan and Midwestern production excluding Michigan.[6] Each of the above definitions are tested in each of the equations. However, the above equations seem a priori to be the most logical specifications. Although, there may be underlying relationships which are not readily apparent leading to a different specification.

The definition of the substitute fruit variable which seems most appropriate for the first period equation is a quantity index of noncitrus fruit production. Four noncitrus fruits--peaches, pears, grapes

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[6]Midwestern production includes the states of Ohio, Illinois, Wisconsin, Indiana, Missouri, Minnesota, Kentucky, Arkansas, Kansas, Iowa and Tennessee.

and nectarines--have been selected to form this index. An index or composite variable is used because it is believed that the influence on the price of Michigan fresh apples of any particular noncitrus fruit is too small to measure. The timing with which these fruits are marketed is important. Apples are sold virtually year-round. However, noncitrus fruits are most prevalent at retail early in the harvesting and marketing seasons of Michigan apples.[7] The influence they exert on the price of Michigan apples is most likely to be felt in the first peiod. Nonetheless, other definitions of substitute fruits not shown in the preceding equations are also tested. These measures of substitute fruits are bananas (metric tons) and sales of fresh oranges (boxes).

REGULAR STORAGE PERIOD EQUATIONS

Price forecasting equations have been developed for apples sold from November 1 on from regular storage. The price forecast is for 12-3 lb. bag, cartons of Jonathans, MacIntosh and Red Delicious. The general formulation of each equation is approximately as follows:

1. Jonathans: $P_{J2} = f(X_1 \text{ or } X_{30}, X_{13}, X_6 \text{ or } X_8, X_9, X_{10})$
2. MacIntosh: $P_{M2} = f(X_1 \text{ or } X_{31}, X_{35}, X_6 \text{ or } X_8, X_9, X_{10})$
3. Red Delicious: $P_{D2} = f(X_1 \text{ or } X_{32}, X_2, X_6 \text{ or } X_8, X_9, X_{10})$

Where:

P_{J2} = average price of Jonathans for Period II, dollars per carton of 12-3 lb. bags, F.O.B. at the packer.

P_{M2} = average price of MacIntosh for Period II, dollars per carton of 12-3 lb. bags, F.O.B. at the packer.

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[7] Except for some Washington pears and California grapes the marketing season for these fruits ends by December. U.S. Department of Agriculture, Fruits and Tree Nuts Bloom and Marketing Dates and Principal Producing Counties by States, Agricultural Handbook No. 186, (Washington, D.C.: Government Printing Office, 1966).

P_{D2} = average price of Red Delicious for Period II, dollars per carton of 12-3 lb. bags, F.O.B. at the packer.

X_{30} = Michigan regular storage holdings of Jonathans as of November 1, thousands of bushels.

X_{31} = Michigan regular storage holdings of MacIntosh as of November 1, thousands of bushels.

X_{32} = Michigan regular storage holdings of Red Delicious as of November 1, thousands of bushels.

X_6 = sales of fresh oranges, thousands of boxes.

X_8 = imports of bananas, thousands of metric tons.

X_1, X_2, X_{13}, X_9, X_{10} as defined previously.

The difference between the first period and regular storage period equations is the defining of own quantity as the regular storage holdings of each variety as of November 1. This is a departure from the economic model discussed in Chapter II. However, fairly accurate figures are available for regular storage holdings as of November 1 and in most years this date represents the peak level in holdings.[8] These holdings represent the supply available for the regular storage season for each variety and theoretically should have significant explanatory power in forecasting the average period's prices for each variety. However, total regular storage holdings are dependent to some degree on total Michigan production. In fact, because the size of the Michigan crop may set the price tone for the entire season and individual varietal storage holdings may not account for any substitution effect between varieties, Michigan production may be a superior definition of own quantity in the price forecasting equation. Both hypotheses are tested.

[8]See Marketing Michigan Apples.

The definition of the substitute variable also differs initially between the first period and regular storage period formulations. As was the case in the first period equations, selection or definition of the substitute variable was based on marketing dates of the candidate fruits. During the regular storage period marketings of noncitrus fruits decline and the marketing or oranges and bananas become relatively more important. Therefore, it is hypothesized that as the marketing season progresses, the importance of competing fruits changes. As the season progresses, noncitrus fruits become less important and oranges and bananas become more important. This hypothesis is tested. However, noncitrus fruits are also tested as a substitute variable in the regular storage equations.

CONTROLLED ATMOSPHERE STORAGE EQUATIONS

The exact opening date for controlled atmosphere apple sales varies from year to year, but normally occurs around January 1. Controlled atmosphere apple sales are interesting from several respects. One is that over the last decade CA holdings have shown a dramatic increase in Michigan and in the nation as a whole.[9] This occurrence is probably explained by a second aspect of controlled atmosphere. Although storage costs per unit are higher for CA apples than for regular storage apples, in most years the per unit net return is also higher. This situation might be explained by a third phenomena. Many shippers believe that consumers view CA apples as being distinct from regular storage apples. In general, due to the storage process CA apples have better

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[9] Marketing Michigan Apples (various issues).

quality characteristics. It is likely that better quality apples are put into CA. If shippers' perceptions of consumers are correct, then CA apples having achieved some product differentiation may command a higher price at retail than regular storage apples.[10] Given these characteristics, especially the increasing importance of CA apples, a period's average price for CA apples should be very useful. In an effort to forecast this price, the following initial specifications of price forecasting equations were developed:

1. Jonathan: $P_{J3} = f(X_1 \text{ or } X_{36}, X_{13}, X_6 \text{ or } X_8, X_9, X_{10})$
2. MacIntosh: $P_{M3} = f(X_1 \text{ or } X_{37}, X_{35}, X_6 \text{ or } X_8, X_9, X_{10})$
3. Red Delicious: $P_{D3} = f(X_1 \text{ or } X_{38}, X_2, X_6 \text{ or } X_8, X_9, X_{10})$

Where:

P_{J3} = average price of Jonathan for Period III, dollars per carton of 12-3 lb. bags, F.O.B. at the packer.

P_{M3} = average price of MacIntosh for Period III, dollar per carton of 12-3 lb. bags, F.O.B. at the packer.

P_{D3} = average price of Red Delicious for Period III, dollars per carton of 12-3 lb. bags, F.O.B. at the packer.

X_{36} = controlled atmosphere holdings of Jonathans as of November 1, thousands of bushels.

X_{37} = controlled atmosphere holdings of MacIntosh as of November 1, thousands of bushels

X_{38} = controlled atmosphere holdings of Red Delicious as of November 1, thousands of bushels.

X_1, X_2, X_{35}, X_6, X_8, X_{13}, X_9, X_{10} are defined as before.

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[10]Some of this product differentiation achieved by CA apples is undoubtedly based on real quality differences. How much, if any, is based on perceived but imaginary differences is hard to tell.

CA storage holdings are a logical selection to serve as the supply variable in the CA price forecasting equation. Almost the same rationale that was used to justify storage holdings as the supply variable in the regular storage equation can be used in this case. Similarly, the same reasons given in the section on regular storage equations can also be applied in this section as to why Michigan production may serve as a better supply variable. Both hypotheses are tested.

All the hypotheses regarding the best definitions of alternative areas of production and a substitute variable are also tested--as was the case in the preceding two periods.

ESTIMATION PROCEDURES AND ASSUMPTIONS

In this section, the strengths and weaknesses of ordinary least squares (OLS) and two stage least squares (TSLS) are discussed. Based on this discussion, a decision is made on which estimation procedure to use and the assumptions underlying that procedure are given. This is followed by a discussion of the problems encountered when the assumptions are not fully met.

Ordinary least squares has been a valuable tool in price forecasting for many years. It is computationally simpler than TSLS and may provide as much accuracy even when not all the assumptions are met. However, in lieu of full compliance with the assumptions, OLS may give biased and inconsistent estimates of the coefficients while a correctly formulated TSLS model will not.

For the purposes of this analysis the crucial factor in deciding between OLS and TSLS is whether or not all the independent variables may be treated as predetermined or exogenous. If some of the independent

variables are determined simultaneously with the dependent variable a simultaneous equation estimation procedure (TSLS) seems in order. More rigorously stated, for the assumption of independence to be met, the explanatory variables must not be correlated with the error term. If they are not independent of the error term they are simultaneously determined with the dependent variable. Of course, strictly speaking, in almost all cases, supply and demand are simultaneously determined to some degree. The question then is to what degree are the independent variables predetermined and how much violence can be done to the assumption of independence before the results from OLS become invalid.

In Chapter II a rationale was given for treating total Michigan apple production as predetermined. It merits a brief repetition. Within a given crop the total production (supply) may be treated as given. For apples, production decisions are actually made years in advance when tree planting decisions are made. The argument is strengthened by the fact that economic abandonment in Michigan has been historically low if not nonexistent.

Using total production as the supply variable does not completely respond to the question of allocating supplies between the processing market and fresh market. Economic theory would indicate that the prices in both markets are simultaneously determined with quantities allocated to each market. However, a case was made in Chapter II that the degree of simultaneity between the two markets is much less than the theory would indicate. Due to cultural practices, quality characteristics of the apples, and institutional marketing arrangements (bargaining), the grower actually has less discretion than would appear at first glance.

The processing market does provide a price floor for the fresh market by furnishing a market of last resort for fresh apple growers.

A final criticism can be leveled against the assumption of non-simultaneity between price and the supply variable. This criticism hinges on the degree of simultaneity among the three storage periods. The concern is that the allocations to all types of storage are simultaneously determined by price or, more accurately, by expected price. However, after careful consideration, this concern also appears not to be of great importance for several reasons. First, if total Michigan production is used as the supply variable for all three storage periods it may certainly be treated as predetermined. Thus, the problem arises only when storage holdings are used as the supply variable in the regular storage and controlled atmosphere storage periods. Based on price expectations, packers would be expected to allocate varying amounts to regular storage and CA storage facilities. This allocation would, in turn, be expected to influence the prices received by apples removed from the storages. The resolution to this dilemma hinges on timing. In normal years the bulk of the harvesting of Michigan apples is completed by November 1--the start of the regular storage period. That is, by the start of the regular storage period and well in advance of the CA period the allocation to the two storages have been completed. Therefore, in terms of the model formulated for the research, if storage holdings are used as the supply variable they are predetermined for the periods for which prices are forecasted. It is recognized that the results of this research could be used to make allocation decisions based on forecasted prices. However, it is doubtful that the allocation of decisions of individual packers would significantly influence price.

The question of simultaneously determined dependent and independent variables seems to have been the most serious objection of OLS for forecasting prices. Therefore, OLS is used to estimate the parameters of the model and forecast prices. However, a TSLS formulation including the processing market is used initially for comparative purposes.[11]

ASSUMPTIONS OF ORDINARY LEAST SQUARES

Ordinary least squares (OLS) is used to estimate the relationships in the model and to develop the price forecasting equations. Hypotheses concerning variables included in the model are also tested by the use of least squares regression analysis. OLS estimation procedures minimize the square of the unexplained residual term (μ). The following assumptions about the residual term (μ) are made:

1. The μ term for each equation is a normally distributed random variable. $N(0, \sigma^2)$.
2. The expected value of μ is equal to zero; $E(\mu) = 0$.
3. The μ's have a constant variance; $E(\mu_t^2) = \sigma^2$
4. The μ for one set of observations is not correlated with that for any other set of observations, i.e., they are independent of each other; $E(\mu_t, \mu_s) = 0$; $s \neq t$.
5. The μ is not correlated with any of the independent variables in the equation; $E(X_i, \mu_i) = 0$.

Two other assumptions of OLS not concerned with the error term are:

6. The dependent variable is linear in its parameters.
7. The independent variables are fixed, but random.

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[11]The TSLS formulation was dropped from consideration after initial runs were made and the results compared with those of OLS. The OLS specification gave better forecasts and coefficients more consistent with economic theory.

Assumption 5 has already been discussed at length. Of the remaining assumptions, the fourth, which is concerned with the independence among error terms, is the most likely to be violated. Nonindependence of the residual term or serial correlation can occur when using time series analysis. If it exists, estimation of the ∂'s and β's are unbiased, but not efficient. Estimations of the variance of the β's are biased, which means that t-tests and confidence intervals are not valid.

A standard test for serial correlation is the Durbian-Watson test. This statistic tests the hypothesis that Rho or ρ, a measure of serial correlation, is equal to zero. The alternative hypothesis is that Rho is not equal to zero. The test statistic is:

$$d = \frac{\sum_{t=2}^{T} (\hat{\mu}_t - \hat{\mu}_{t-1})^2}{\sum_{t=1}^{T} \hat{\mu}_t^2}$$

Upper and lower bounds (d_u, d_1) are set for various levels of significance to form an interval. When doing a two-tailed test (testing for both positive and negative serial correlation) the possible results are:

if $d < d_1$ or $u > 4 - d_1$; reject H_o

if $d_u < d < 4 - d_n$; do not reject H_o

if $d_1 \leq d \leq d_u$ or $4 - d_u \leq d \leq 4 - d_1$; inconclusive[12]

In a case of zero serial correlation $\epsilon = 0$ and $d \simeq 2$. There are standard tables to check the significance levels. This statistic is generated as part of the analysis. Unfortunately, in many cases results of the Durbin-Watson test are inconclusive.

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[12]Jan Kmenta, Elements of Econometrics (New York, New York: Macmillan Publishing Company, Inc., 1971) p. 295-297.

SELECTION OF TIME PERIOD

Proper selection of the time period for price analysis is instrumental in obtaining useful analysis. There are two major considerations in selecting a time period for analysis. One is the consistency of the historical relationships and the second is the quality of data. Normally, the longer the time period the better. However, there are tradeoffs involved in the selection of a longer time period versus a shorter one. A longer time series not only gives the analyst more degrees of freedom, but more importantly, if structural conditions have remained relatively constant, more information. There may be a hazard, though. The estimated relationships obtained from OLS are based upon historical relationships. If unknown structural changes have occurred and are not accounted for in the model, the performance of the price forecasting equation may be seriously lacking. A shorter time period, based on more recent history without significant structural change, may give better performance, but it does suffer from fewer degrees of freedom.

Based upon discussions with industry experts it does appear that the Michigan apple industry has undergone major structural changes over the past 25 years. There has been a large decrease in the number of growers and packers. The processing apple industry has grown substantially in relative importance. There have also been major changes in the varietal composition of the apple crop. In addition, the use of CA storage has increased rapidly in the state, thus extending the marketing season.

In addition to the structural changes that have occurred, there are limitations to the data. Although there are data for the past 25 years, they are not consistent. Two major changes took place in the reporting of apple data. First, in 1964 the U.S. Department of Agriculture

started reporting apple production in millions of pounds rather than thousands of bushels. The conversion factor given by the U.S. Department of Agriculture did not coincide with their own results. It was then realized that the weight of a bushel of apples varied from state to state due largely to varietal differences. Based upon a period of overlap in the forms of reporting data a conversion factor was developed to convert bushels of apples into millions of pounds. Using this conversion factor estimates were obtained which differed from those based upon the USDA's conversion factor. Therefore, it was felt that use of a conversion factor to convert bushels into pounds for the period prior to 1964 would introduce more measurement error than already existed. This supports the choice of a shorter time period for analysis.

The second change was in the reporting of the price series for Michigan packed apples. Prior to 1968 F.O.B. prices at the packer were reported for the 10-4 lb. film bag container of apples. However, due to the growth in importance of 12-3 lb. packs a change was made in 1968 to report F.O.B. packer prices for 12-3 lb. film bag containers. It is possible to convert the prices to a pound basis, but again, there are problems with the consistency of results produced from the conversion factor. More importantly, to be truly useful to apple marketers, the price forecast should be reported in the terms of sale in which they currently deal.

Considering these two factors: 1) the change in structure, and 2) the change in the data base, it was decided to use the time period from 1968 to 1978 in the development of the price forecasting model.

HYPOTHESIS AND RATIONALE FOR SELECTION OF VARIABLES

Although referred to several times previously, it seems appropriate to systematically discuss hypotheses regarding the variables and rationale for their selection. Previous studies are cited where instructive. Problems associated with variables are also discussed.

1. Total Production of Michigan Apples and Storage Holdings

The principle of demand postulates that the price of Michigan apples should be inversely related to their supply. Two measures of supply have been defined in this analysis: Michigan production, and individual variety holdings in regular and controlled atmosphere storage. It is hypothesized that increased Michigan production or storage holdings, ceteris paribus, will mean a decreased price for Michigan apples. The sign of the coefficient is expected to be negative.

2. Quantities of Apples Produced in Other Areas

This variable may be considered as a substitute or as another component of supply for Michigan apples. Depending on the variety, Michigan apples compete in regional or national markets against apples produced in other states. As with Michigan production, the relationship between the price of Michigan apples and other states' production is hypothesized as being an inverse relationship. The signs of the coefficients are expected to be negative.

3. Index of Non-Citrus Fruits

Non-citrus fruits which include pears, peaches, grapes and nectarines are a natural choice to serve as a substitute fruit for apples sold in the first (fall) period. During this period, the marketing

seasons for these fruits and apples coincide. However, later in the fall the marketings of some of these fruits begin to taper off.

The availability of these and other substitute fruits, such as other states' apples, affects their prices inversely at retail. When fruits are substitutes for each other their prices are positively correlated. Therefore, an increase in the supply of substitute fruits for fresh Michigan apples will lead to a decrease in the prices of those substitutes, ceteris paribus. This decrease in the price of substitutes will put downward pressure on the price of Michigan fresh apples since they have a competitive relationship. However, the prices of substitute fruits cannot be used in the price forecasting equation for Michigan fresh apples as this may introduce substantial amounts of multicollinearity. The prices of the substitute fruits are a function of many of the same variables that influence the price of Michigan fresh apples, such as population, disposable income and other regions' apple production, all of which are in the price forecasting equation. In addition, even though the prices of competing fruits affect the price of Michigan apples, their own prices are affected by the prices of Michigan apples. Thus, the prices of competing fruits are not exogenous or independent. They are partially determined within the system or endogenous.

These problems can to a great extent be avoided, though. The inclusion of quantities of competing fruits reduces some of the multicollinearity and many of the endogenous characteristics. As was the case with Michigan production, for any given year the quantities of competing fruits may be treated as predetermined for many of the same reasons. The relationship between supplies of competing fruits and the price of

Michigan apples is hypothesized to be an inverse relationship. The signs of the coefficients are expected to be negative.

4. Quantities of Oranges and Bananas

The economic rationale for the selection of these fruits is identical to that for the other substitute fruits. The hypothesized relationships and signs are identical as well. These fruits are included because the drop in the marketings of non-citrus fruits during the regular storage and controlled atmosphere storage periods is expected to reduce their influence on Michigan fresh apple prices. The decline in the marketings of non-citrus fruits should increase the relative influence of oranges and bananas on fresh apple prices. Quantities of these fruits are used. The expected sign of the coefficient is negative.

5. United States Disposable Income

Economic theory stipulates that if a product is a normal good, consumption of this good will rise if incomes rise, ceteris paribus. The hypothesis in this research is that fresh apples are a normal good and a positive sign is expected. Since apples are a nonessential item in most diets a relatively high positive value is expected for the income elasticity. As incomes rise the demand for fresh apples is expected to rise, ceteris paribus, and the price of apples is also expected to rise. However, Tomek, Pasour and O'Rourke have all conducted price analysis on apples and obtained negative income elasticities.[13] Income is highly trended and may be acting as a proxy for other variables such as changes

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[13]Tomek, An Analysis of Changes in the Utilization of Apples in the United States; Pasour, An Analysis of Intraseasonal Apple Price Movement; O'Rourke, Factors Affecting Major Marketing Decisions for the Washington Apple Crop.

in consumers' tastes and preferences. Therefore, the effect of income by itself is unclear or as Tomek puts it, "Any positive effect of income on fresh utilization is obscured by other factors."[14]

6. General Price Level

According to economic theory, prices of Michigan fresh apples are expected to increase or decrease with fluctuations in the general price level. There are many price indices which measure the change in the general price level. There are two methods to account for the influences of changes in the price level on fresh apple prices. One method is to deflate the price and income levels by the appropriate price index and the second is to include the price index as a separate variable in the price forecasting equation. Ideally, for this research the latter method is preferred. In this manner, an explicit measure of a change in the price level on fresh apple prices can be obtained. In addition, marketers make their decisions based on nominal prices. It would facilitate the use and dissemination of this research if nominal prices could be forecast directly. However, there are problems with this specification. Both the price level and income are highly trended and they are also highly correlated. This can lead to difficulties in accurately estimating the parameters of either one or both when they are in the same equation. Therefore, the price forecasting equations will also be estimated in real terms. More of this matter is discussed in Chapter IV.

The consumer price index is used as the deflator. The sign of the coefficient of the index is hypothesized to be positive. In other

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[14]Tomek, An Analysis of Changes in the Utilization of Apples in the United States. p. 6.

words, as the general price level rises the price of fresh apples is also expected to rise.

7. Trend Variables

In any price analysis it is impossible to account for all the variables influencing price. However, in many cases the variables left out are important and their exclusion can lead to spurious results. Consumers' tastes and preferences are known to be important variables affecting demand. There may be other factors which remain unknown to the analyst, but still influence demand. The problem with consumers' tastes and preferences and the like is how to antify their influence. In most cases, if it is done at all, a proxy measure for these variables is included. The form of this variable is usually a trend variable, i.e., a variable that increases by one every time period.

Although this specification of the model may improve its statistical properties and the accuracy of the forecasts, the coefficient of the trend variable defies economic interpretation. It also assumes that whatever is being measured changes in a continual linear fashion.

As originally specified, the model doesn't contain a trend variable. However, if problems are encountered in estimating the parameters of either disposable income or the CPI, the trend variables will be included. Since fresh apple consumption has been declining or relatively stable over the period of analysis a negative sign is expected. Although in the past four or five years fresh apple consumption has shown a slight upward trend.

8. Population

For most food goods, as the population increases the demand for the goods increases. According to the data cited in Chapter II, total consumption has increased with population growth. Therefore, a positive sign would be expected for the coefficient associated with population. However, in order to save on degrees of freedom, all quantity variables are put on a per capita basis.

SUMMARY

This chapter developed the econometric model for the research. The general and specific formulations for the price forecasting equations were discussed. The equations will be estimated using ordinary least squares since the assumptions underlying OLS seem to have been sufficiently met to merit its use. Selection of the time period for analysis was discussed. Based on the structural changes and changes in data reporting it was decided that a shorter time period is preferred. Finally, the hypotheses regarding the independent variables were laid out. Chapter IV presents the results of this analysis.

CHAPTER IV

PRESENTATION AND ANALYSIS OF RESULTS

The purpose of this chapter is to present results obtained from the price-forecasting model. The chapter is organized into five major sections: 1) criteria for the selection of equations; 2) presentation of the price-forecasting equations for Red Delicious apples; 3) presentation of the price-forecasting equations for Jonathan apples; 4) presentation of the price-forecasting equations for MacIntosh apples; and 5) a test of the predictive ability of the model. In each section where equations are presented there will be a brief discussion of the strengths and weaknesses of the equations in addition to an economic interpretation of the equations. Chapter V discusses the overall conclusions and implications drawn from the research. It also presents possible uses of the model and needs for future research.

CRITERIA FOR SELECTION OF EQUATIONS

Econometric theory has several standard tests or criteria for evaluating the reliability and accuracy of price-forecasting equations. The most important criteria is, does the equation make economic sense? The basic model and economic considerations were discussed in Chapter II. Great care was taken to make the model logical and consistent with market reality. This requirement had to be met prior to any analysis.

Other criteria relate to the statistical properties of the price-forecasting equations. Two criteria, which are closely associated with the economic model, are the significance of the variables and the "correctness" of their signs. The economic model is the basis for selection of relevant variables and for hypotheses regarding their signs. The "proper" level of significance depends upon the needs of the decision maker and the relative costs of making a Type I or Type II error. Although this issue is not dealt with here and only the levels of significance are reported, significance levels were used as a decision criterion for the inclusion of any particular variables. In most instances, variables not statistically significant at the 20 percent level were omitted from the equation.

There are other criteria which are useful for evaluating a model's ability to forecast. These include: 1) high values for R^2's; 2) the model's ability to capture the direction of price changes; 3) the model's ability to capture large changes; and 4) the size of the standard error of regression. A fairly high R^2 value is expected since the model is based on time series data. However, a high R^2 alone is not sufficient. A price-forecasting model may capture the trend fairly well, but may not be particularly good at capturing changes in price from one time period to the next. The coefficient of determination, or R^2, " simply is the proportion of the variation of Y that can be attributed to the variation in X."[1] R^2 is a measure of correlation and not causation. So it is possible to find two variables highly correlated, but with little predictive ability.

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[1]Kmenta, Elements of Econometrics, p. 232.

In forecasting apple prices (as well as anything else) a low standard error of regression is desirable. It is possible to obtain a high R^2 and still have a large standard error of regression. The "permissible" size of the standard error of regression will vary with the needs of the decision maker. In this research a standard error of regression of $\pm$ 25¢ per 12-3 lb. film bag container was deemed necessary to fit the needs of shippers. This converts to price forecasts reliable to within $\pm$ 25¢ per 12-3 lb. bag master containers. It is thought that this level of reliability would provide useful information for the apple marketer's decision process. This criterion was based on an inspection of price data and the observation that most price changes occur in 25¢ increments. It has also been reported that normally a minimum 25¢ charge in the shipper's price is needed to induce a price change at retail. Although this criterion is the target sought, data problems and the degree of price fluctuations within a period may not always make this standard possible.

A good forecasting model should be able to predict the direction of change in prices. If the model can't do this within the sample period, it is unreasonable to expect the model to do so outside of the sample period. A price-forecasting model which often forecasts changes in price movements incorrectly is of little value to apple marketers. However, the severity of incorrectly forecasted price movements may be mitigated to some extent if they are rare and if the forecast is still within an acceptable range for the standard error of regression. This means the standard error of regression is small and there is a strong likelihood of the actual price falling within the standard error of

regression. In addition, weighting missed turning points too heavily as a criterion may be inappropriate. In some instances a forecast may miss a turning point from one year to the next, but come closer to the actual price than in forecasts which did not involve a turning point. Although if this happens frequently, it means there are problems in the model.

There are still several other criteria by which a price-forecasting equation may be evaluated. No single criterion is completely adequate for selecting the best performing equation. Ideally, the perfect equation would satisfy all criteria simultaneously. But realistically this will probably not be the case. Choices are made between equations that meet the above criteria with varying degrees of success. The selection is based on which equations exhibit the best overall performance. Although, no equation is selected that is not consistent with economic theory.

THE TREND VARIABLE

As originally specified the model did not include a trend variable. The difficulty with trend variables is giving them an economic interpretation. In many demand analyses trend variables are interpreted as representing changes in consumers' tastes and preferences. It is also assumed that these changes occur in a continuous linear fashion. However, there is always the danger that the trend variable is in reality acting as a proxy for some other variable or set of variables.

It became apparent as the first runs were made (especially when the prices were estimated in nominal terms) that both income and/or the explicit deflator were acting as a trend variable; both variables being highly trended. To overcome this problem the price-forecasting equations were estimated in real terms and a trend variable was added. Economic

theory offers little logical expectation of what the sign on the coefficient of the trend variables should be.[2] However, looking at the trends in apple consumption should give some indication of what can be expected. Over the twelve-year period under analysis fresh apple consumption has remained relatively constant, although the trend seems to be increasing slightly.[3] A positive sign is therefore expected. This, of course, assumes that the general trend evidenced over this historical period will continue. Obviously, this may not be the case. To insure that results are not spurious the model should be continually updated. Given the increased concern over health and nutrition the positive trend could very well become more pronounced. In the discussion of results to follow no lengthy discussion on the economic interpretation of the trend variable is included. However, whenever the trend variable is mentioned the researcher should add "if the trend continues."

NOMINAL VERSUS REAL PRICES

The model as originally formulated was an attempt to estimate prices in nominal terms. This was done to facilitate the presentation of the results to the apple marketers, since the prices they face are nominal. However, with the exception of the price-forecasting equation for Red Delicious, the results were not satisfactory. In the original model the deflator was included as an independent variable. Not surprisingly this

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[2]Although, it does to some degree. If you know in what direction tastes and preferences are changing in terms of the product studied. The sign on the coefficient should be in the same direction.

[3]U.S. Department of Agriculture, U.S. Agricultural Statistics, 1978 (Washington, D.C.: Government Printing Office, 1979) p. 254.

variable was strongly trended and was highly intercorrelated with the other explanatory variables.

When deflating prices and income by the consumer price index, the assumption being made is that the appropriate demand function is actually the relationship of relative prices and real income to quantity. This appears to be the case for Jonathan and MacIntosh apples as the price-forecasting equations were improved considerably.[4]

PRICE-FORECASTING EQUATIONS FOR RED DELICIOUS

The basic econometric model outlined in Chapter III was used to estimate price-forecasting equations for three varieties of apples--Jonathans, MacIntosh, and Red Delicious.

The results from the price-forecasting equations for Red Delicious are presented in this section. In addition to the restuls for each price-forecasting equation, an economic interpretation is given for the coefficient and a comparison between the actual prices and the forecasted prices is offered.

FIRST PERIOD EQUATIONS FOR RED DELICIOUS

The first period has been defined as consisting of apple sales made before November 1. In Michigan the length of this period can vary from one year to the next and by variety. For instance, MacIntosh are usually harvested two to three weeks before Red Delicious. Therefore, it is possible for the period's average price of any particular variety to be

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[4]For reasons unknown to the author the price-forecasting equation for Red Delicious generally exhibited better statistical properties when estimated in nominal terms. However, in an effort to maintain consistency, the results presented for Red Delicious are in real terms.

constructed on the basis of only one or two weekly observations. Since, it is still early in the marketing season the process of price discovery must be conducted on a limited informational base with regard to the level of all the critical values that go into the "discovery" of price. This is a period of trial and error in individual negotiations. Apple marketers are still trying to clarify market conditions, i.e., supply and demand. The aggregation of the price discovery process leads to price determination, which should reflect conditions of supply and demand. Due to uncertainty surrounding the price discovery mechanism results of the price determination process are also uncertain.

These two factors, shortness of the first period and incomplete market information, lead to greater price variability within the period than is the case for the regular storage period and the CA storage period.

Due to the "softness" of market conditions, because of early period uncertainty, apple prices may appear relatively unaffected by supply and demand factors. It is more difficult to get accurate measures of the influence of critical factors on apple prices. Therefore, it is a more difficult task to obtain reasonable price-forecasting equations for this period than it is for the other periods. A price-forecasting model for this period will hopefully reduce some of the uncertainty and facilitate the price discovery process.

Red Delicious apples are the preferred variety of dessert apple for many U.S. consumers. They have an appearance which consumers desire and they also possess good storage characteristics. In Michigan there are projected increases in the production of Red Delicious based on planting decisions of growers.[5]

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[5]Ricks and Pierson, U.S. Apple Supplies Trends and Future Projections, p. 17.

A price-forecasting equation was developed for Red Delicious sold prior to November 1. Several equations were tested. Only one independent variable was tested for Michigan supply, total utilized Michigan production (total production minus abandonment). Various measures were experimented with to determine the best variable for alternative areas of production. These measures included: the rest of the United States; Washington production; Eastern states' production; New York and New England states' production; and Midwestern states' production excluding Michigan. Three different variables were tried as substitutes, sales of fresh oranges, a quantity index of non-citrus fruit excluding apples, and bananas. Real per capita disposable income and a trend variable were also included in the analysis. From these experiments the price-forecasting equation for Red Delicious sold during the first period was chosen. It is presented in Table 1. Four variables; 1) Michigan production of apples, 2) total utilized production of Midwest apples, 3) per capita disposable income and 4) a trend were able to explain about 80 percent of the variation in the average price of Red Delicious apples sold in the first period.

A quick inspection of the equation shows that Michigan production is not highly significant. Economic theory would tend to support the hypothesis that Michigan quantity should be a significant factor influencing the price of Michigan Red Delicious. There are two possible explanations for the estimated relationship above. First, as mentioned previously, there is some uncertainty regarding the size of the apple crop during the first period. Therefore, its effect is not as measureable in the determination of price as it will become later in the

Table 1. Results of Price-Forecasting Equations for Red Delicious[a]

Equation	Dep. Var.	Explanatory Variables								Summary Statistics		
		Const.	X_1	X_{38}	X_{32}	X_{39}	X_2	X_{10}	T	S.E.	R^2	D.W.
1. First Period	P_{D1}	-2.34013 (7.32629)	-.339830 (.272876)*			-1.07178 (.629430)**		4.39008 (2.70905)	-.303913 (.139695)***	.363988	.7972	1.3947
2. Regular Storage	P_{D2}	-4.60932 (5.74905)		-.376373 (.0828338)***		-.258436 (.443598)		4.86533 (2.13319)**	-.378099 (.112656)***	.286978	.8817	1.5379
3. Controlled Atmosphere	P_{D3}	-6.65965 (3.20542)***			-.371470 (.0624198)***		-.169349 (.063855)***	5.11973 (1.33585)***	-.185841 (.0888762)***	.209477	.9137	1.8582

[a]These equations are based on data for the 1968-1979 period.
*** Indicates significant at the 5% level.
** Indicates significant at the 10% level.
* Indicates significant at the 20% level.

Where:

P_{D1} = average F.O.B. price at the packer level per carton 12-3 lb. bags of Red Delicious sold during the first period, expressed in real terms (1967 dollars)

P_{D2} = average F.O.B. price at the packer level per carton 12-3 lb. bags of Red Delicious sold from regular storage, expressed in real terms (1967 dollars)

P_{D3} = average F.O.B. price at the packer level per carton 12-3 lb. bags of Red Delicious sold from controlled storage, expressed in real terms (1967 dollars)

X_1 = total utilized production of Michigan apples (lb./capita)

X_{38} = total regular storage holdings of Red Delicious apples as of November 1 (bushels per capita)

X_{32} = total controlled atmosphere storage holdings of Red Delicious apples as of November 1 (bushels per capita)

X_{39} = total utilized production of Midwestern apples (lb./capita)

X_2 = total utilized production Washing apples (lb./capita)

X_{10} = per capita disposable income, expressed in real terms

T = trend variable

NOTE: Numbers in parentheses are standard errors.

marketing season. Contributing to its non-significance is the fact that since apples sold in the first period are the first to be marketed they may be able to earn a permium over what would be normally expected, given the supply. After months of eating apples from storage, consumers may be willing to pay a higher price for the first apples of the season. This reasoning is supported by the fact that for all three varieties the mean first period price is higher than the mean regular storage price.

A second explanation and not mutually exclusive of the first is centered around the variable for Midwestern production. Although the level of Midwestern production is subject to the same uncertainty as Michigan's, since it is a more aggregated figure the level of uncertainty may not be as great. It may be a better barometer of the total supplies available to the markets in which Michigan competes, than the Michigan production alone. Hence, perhaps in the first period Midwestern production has greater influence on Michigan price than Michigan quantity. The low significance of Michigan production may also be a result of the correlation between the two and some of the influence of Michigan's production is being picked up in the variable for Midwest production.

In the equations where Washington production was used as a measure of alternative production, it was somewhat surprising to find that Washington production was not significant. The resolution of this puzzle seems to lie in timing. Given that Washington is a strong competitor in the CA season when the Midwestern states are weak, it seems likely Midwestern apple marketers sell the major portion of their apples in the first two periods. Since the other Midwestern states sell in the same markets as Michigan, it is logical to think that they are Michigan's primary competitors in the early period, even for Red Delicious. Over

the course of the first two periods and especially during the CA period this situation changes. Apples from controlled atmosphere are able to command a premium price over regular storage apples. It is also likely that due to better promotional activities CA apples from Washington may command a premium over other states' CA apples. This should be particularly evident in the case of Red Delicious--Washington's leading variety. Therefore, CA apples and notably Washington CA apples can absorb transportation costs more easily than apples sold in the first or regular storage period. If this is the case, the importance of Midwestern apples as a competitor for Michigan Red Delicious should decrease as the marketing season progresses.

A suitable measure for a substitute fruit was not found.

ECONOMIC INTERPRETATION OF THE PRICE-FORECASTING EQUATION FOR RED DELICIOUS SOLD DURING THE FIRST PERIOD

The price-forecasting equation for Red Delicious shown above can be given the following economic interpretation.

1. An increase in total Michigan production of one pound per capita, ceteris paribus, will result in a decrease in the average price received by shippers for Red Delicious sold during the first period of 34¢ per carton 12-3 lb. film bags, in real terms.

2. An increase in Midwest production of one pound per capita, ceteris paribus, will result in a decrease in the average price received by shippers for Red Delicious sold during the first period of $1.07 per carton 12-3 lb. film bags in real terms.

3. An increase in the real per capita income of $100, ceteris paribus, will result in an increase in the average price received by

shippers for Red Delicious sold during the first period of 44¢ per carton 12-3 lb. film bags in real terms.

4. The passage of time from one year to the next, ceteris paribus, will result in a decrease in the average price received by shippers for Red Delicious sold during the first period of 30¢ per carton 12-3 lb. film bags in real terms.

COMPARISON OF ACTUAL PRICES WITH ESTIMATED PRICES OF RED DELICIOUS SOLD DURING THE FIRST PERIOD

For the twelve-year period that the price-forecasting equation was estimated comparisons were made between the actual prices and the estimated prices. Table 2 shows the series of two prices. Also shown in Table 2 are the absolute differences and the percentage differences between the actual prices and the estimated prices. Graphically this comparison can be seen in Figure 3. From 1968 to 1979 the mean absolute difference was 23.2¢ while the mean percentage difference was .067 percent.

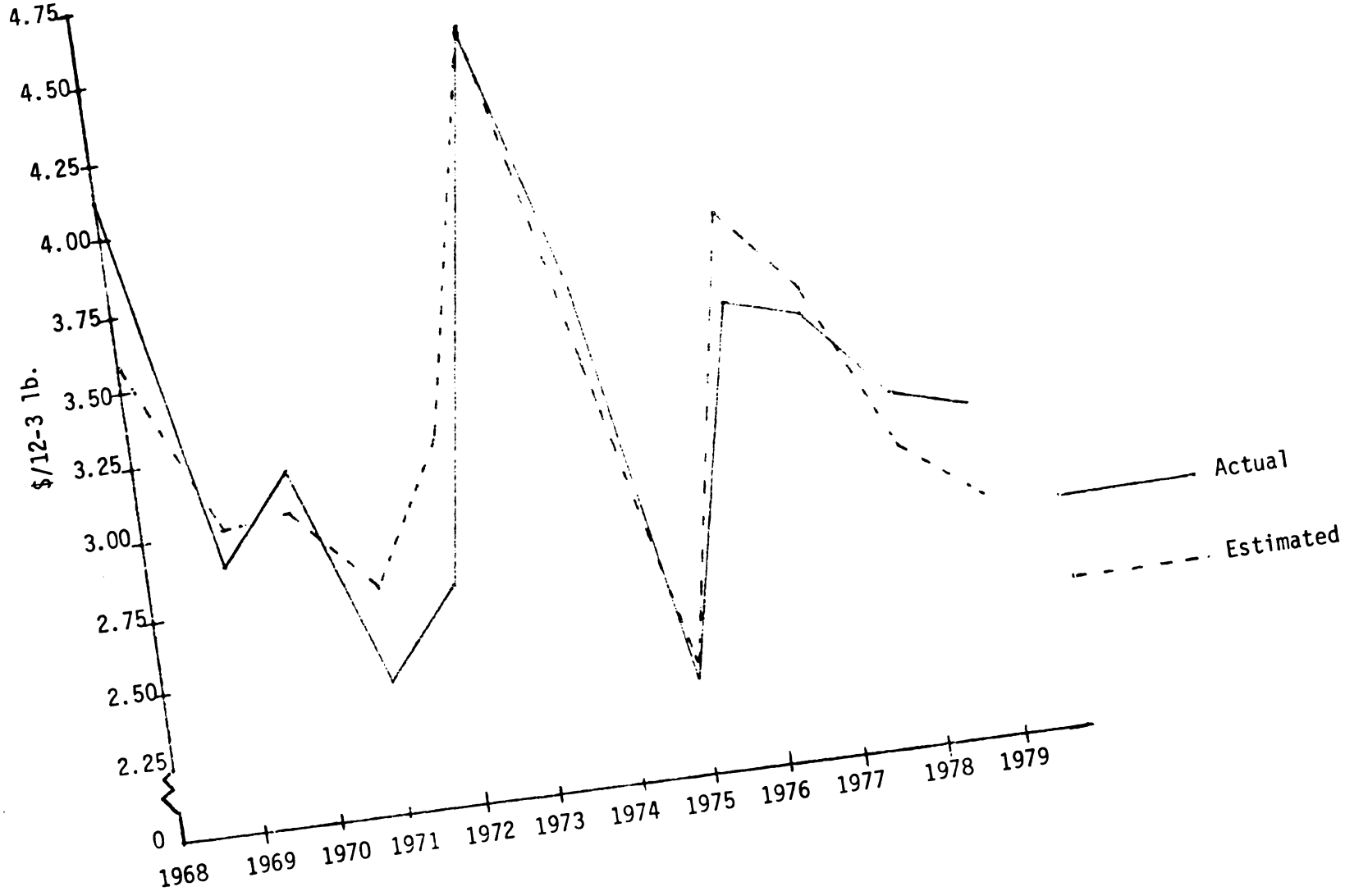
REGULAR STORAGE EQUATIONS FOR RED DELICIOUS

Regular storage has long been the predominant form of storage for fresh apples. However, with the advent of controlled atmosphere storage and a growing consumer preference for CA apples, the dominance of regular storage is slowly slipping. Regular storage will never be completely replaced, though, since apples must remain in controlled atmosphere storage for certain lengths of time to be legally sold as CA apples. In Michigan, apple sales from regular storage are an important component of the fresh market. As previously defined, the regular storage season extends from November 1 until supplies run out, roughly the first of the new year.

Table 2. Actual and Estimated Real F.O.B. Prices for Red Delicious Sold During the First Period, 1968-1979

Year	Actual Prices ($/12-3 lb)	Estimated Prices ($/12-3 lb)	Difference ($/12-3 lb)	Percent Difference
1968	4.379	3.836	.543	12.4
1969	3.129	3.259	-.130	4.2
1970	3.424	3.281	.143	4.2
1971	2.696	3.014	-.319	11.8
1972	2.989	3.456	-.467	15.6
1973	4.763	4.797	-.0345	.7
1974	3.869	3.635	.233	6.0
1975	2.569	2.614	-.0455	1.8
1976	3.771	4.074	-.303	8.0
1977	3.699	3.784	-.0852	2.3
1978	3.390	3.232	.159	4.7
1979	3.335	3.029	.306	9.2

Figure 3. Actual and Estimated Real F.O.B. Prices, Packer Level, for Red Delicious Sold During the First Period, 1968-1979



Equation 2, presented in Table 1, is the regular storage equation for Red Delicious. The general model on which the estimated equation is based is the same as presented in Chapter III and similar to the model used for the early season price-forecasting equation. There is one difference between the first period equation and the regular storage period equation. In the early season, there is essentially no storage function as much of the early harvest is quickly moved through packinghouses and marketed. However, by November 1 the great majority of the harvest is over and removals from regular storage are in progress. Therefore, given the timing of various marketing functions, an appropriate variable for the Michigan quantity in the price-forecasting equations for all three varieties is the respective regular storage holdings of each variety. For example, the price-forecasting equation for the price of Red Delicious apples removed from regular storage would contain the level of Red Delicious apples held in regular storage as of November 1.

Although in normal years regular storage holdings are a good measure of the total supply available for that period and the reasoning is economically consistent, there may be problems associated with this variable. Regular storage levels of specific varieties as of November 1 may not always be representative of the total quantity of fresh apples available for market during this period. Also, in some years, this value is in a state of flux since removals from and additions to regular storage are still occurring if the harvest is late. If so, it is difficult to tell if the November 1 value is a good indicator of total stocks available for regular storage. Or if the harvest is early and small, regular storage levels may already be declining by November 1. This means that the general price level for the regular storage period was

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established in the preceding period.[6] Either of these situations could reduce the utility of using regular storage levels as a quantity measure. Therefore, total Michigan production will also be tested as a quantity measure in the regular storage period equation, even though it too suffers from estimation error. It is also consistent with economic theory that total production will affect the price throughout the season.

Red Delicious are rapidly becoming Michigan's most important dessert apple. They possess many qualities consumers prefer. Their appearance is uniform and they have a bright red luster. They have good storage properties and are the preeminent CA apple. They are almost as important as a resulr storage apple.

The regular storage equation presented in Table 1 is the result of many experiments to determine the best forecasting equation for the price of Red Delicious removed from regular storage. As has been the practice with all the price-forecasting equations, various measures and combinations of Michigan quantity have been tested. In addition, various measures and combinations of alternative producing areas and substitute fruits had been tried. The equation presented in Table 1 was selected from the various trials. It was estimated in real terms.

Four variables: 1) regular storage holdings of Red Delicious; 2) Midwestern production; 3) per capita disposable income; and 4) a trend explained about 90 percent of the variation in the price of Red Delicious removed from regular storage. As was the case in the first period, no suitable measure was found for substitute fruits. However, regular storage holdings as of November 1 of Red Delicious did prove to be a significant factor influencing their price. As will be shown later this

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[6]If this is the case, a model specifying price lagged by one period might be appropriate. Nevertheless, in an effort to keep the model simple and to reduce the probability of introducing more estimation error, this specification was not chosen.

was not the case with Jonathans or MacIntosh. Why this should be the case for Red Delicious and not Jonathan or MacIntosh may lie in the timing of placements into and removals from regular storage. According to data available, removals of Red Delicious begin later in the season than they do for MacIntosh or Jonathans.[7] In addition, Red Delicious have very good storage characteristics. These apples may receive highest priority in the filling of storage facilities. If this is the case, regular storage holdings may be a reliable estimate of Red Delicious supply. This condition will be reinforced if relatively few Red Delicious have been marketed in the first period and the price tone (level) for Red Delicious has not been solidified in the previous period.

Problems arose with finding a suitable measure for alternative producing measures. Although Midwest production, excluding Michigan, was not significant at a high level, it was the most significant of all measures tried and had the correct sign. As stated previously, it was expected that Washington production would be a significant factor influencing the price of Red Delicious. Washington is the leading apple producing area and a majority of its apples are Red Delicious. However, this did not prove to be the case. It is possible that due to the timing of harvest and proximity to markets in which Michigan sells, the Midwestern states are bigger competitors with Michigan than is Washington at this time. As the season progresses, Midwest supplies dwindle. By the time the CA season arrives, Washington apples become more prevalent in markets in which Michigan competes. CA apples can command a premium and therefore cover higher transportation costs.

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[7]Michigan Department of Agriculture, Marketing Michigan Apples, various issues.

ECONOMIC INTERPRETATION OF THE PRICE-FORECASTING EQUATION FOR RED DELICIOUS REMOVED FROM REGULAR STORAGE

The preceding equation may be given the following economic interpretation:

1. An increase in total regular storage holdings as of November 1 of one bushel per 1,000 people, ceteris paribus, will result in a decrease in the average price received by shippers for Red Delicious apples removed from regular storage of 38¢ per carton 12-3 lb. film bags, in real terms.

2. An increase in total Midwest production of one pound per capita, ceteris paribus, will result in a decrease in the average price received by shippers for Red Delicious sold from regular storage of 26¢ per carton 12-3 lb. film bags, in real terms.

3. An increase in real per capita disposable income of $100, ceteris paribus, will result in an increase in the average price received by shippers for Red Delicious sold from regular storage of 49¢ per carton 12-3 lb. film bags, in real terms.

4. The passage of time from one year to the next, ceteris paribus, will result in a decrease in the price received by shippers for Red Delicious sold from regular storage of 38¢ per 12-3 lb. film bag, in real terms.

COMPARISON OF ESTIMATED PRICES WITH ACTUAL PRICES OF RED DELICIOUS SOLD FROM REGULAR STORAGE

For 12 years of data, 1968-1979, the estimated prices of Red Delicious sold from regular storage were compared with the actual prices. Table 3 gives this comparison along with the absolute difference and percentage difference between the actual prices and estimated prices. Figure 4 has a graphic representation of this comparison. Over this

Table 3. Actual and Estimated F.O.B. Prices for Red Delicious Sold During the Second Period, 1968-1979

Year	Actual Prices ($/12-3 lb)	Estimated Prices ($/12-3 lb)	Difference ($/12-3 lb)	Percent Difference
1968	4.495	4.130	.365	8.1
1969	2.664	2.677	-.0135	.5
1970	3.195	3.157	.0386	1.2
1971	2.558	2.469	.0896	3.5
1972	2.687	3.189	-.502	18.7
1973	4.293	4.333	-.0402	.7
1974	3.103	3.144	-.0407	1.3
1975	2.467	2.666	-.199	8.1
1976	3.299	3.393	-.0940	2.8
1977	3.725	3.816	-.0919	2.5
1978	2.774	2.499	.275	9.9
1979	3.036	2.822	.214	7.0

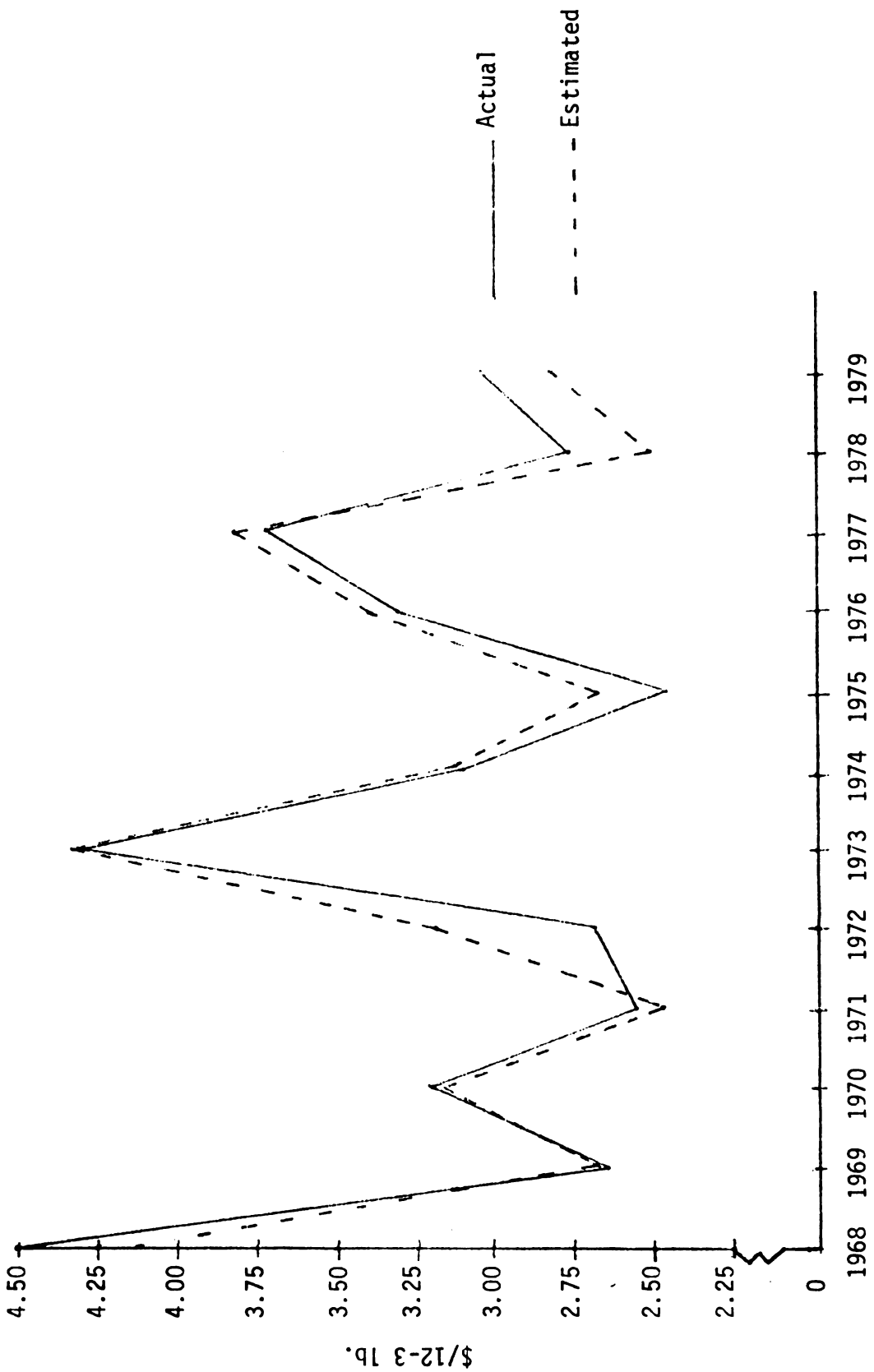

Figure 4. Actual and Estimated Real F.O.B. Prices, Packer Level, for Red Delicious Apples Sold from Regular Storage, 1968-1979

12-year span the average absolute difference between actual price and the estimated price was 15.6¢. The average percentage difference over this time was 5.4 percent.

CONTROLLED ATMOSPHERE EQUATIONS FOR RED DELICIOUS

The price forecasting equations for Red Delicious apples sold as controlled atmosphere apples appear below. Apples, with the exception of Jonathans, must remain under controlled atmosphere conditions for at least 90 days before they may be legally sold as such. This means that in Michigan, CA apples are generally not sold prior to the first of the year.

Several equations were run with various combinations of alternative apple production outside of Michigan and various measures of substitute fruits. Three different measures of Michigan quantity were experimented with. The first measure was total Michigan production, which was the identical Michigan quantity variable used in the early period and regular storage period equation. The second measure was CA holdings for each particular variety as of November 1. The third measure is combined CA holdings of MacIntosh, Jonathan and Red Delicious apples. Although the level of CA holdings is directly related to Michigan production, it is logical to expect CA prices to be more closely correlated with CA holdings than with Michigan production. However, there are reasons why this might not be the case. The size of the crop will certainly influence the packers' decisions on how many apples to allocate to CA storage. If the correlation is strong, Michigan production may make as good of a quantity measure as CA holdings. Second, the size of the crop tends to set the tone of the price (price level) earlier in the marketing season. Once this price level has been established, prices for CA apples may simply

follow suit after adjustment for increased storage charges and quality differences. Therefore, it is possible that Michigan production could prove to be as significant in forecasting CA price as are CA holdings.

Red Delicious are now the second most important variety in the state. In terms of CA holdings, though, Red Delicious apples have arrived. They most often rank as the leading apple sold from CA storage. They are preferred by many consumers. As such, a price-forecasting equation for Red Delicious apples removed from CA storage could be very useful to apple marketers.

Equation 3 in Table 1 is the result of analysis to develop such an equation. As with the preceding regression analyses, various measures and combinations of Michigan quantity, alternate production and substitutes were experimented with.

The relationship was estimated in real terms. All the signs were as hypothesized and significant at a 95 percent level. It is obvious from inspection that a suitable measure for a substitute variable was not found. As in all the previous analyses, the signs and coefficients on the substitute variables were either insignificant or of the wrong sign. However, CA holdings of Red Delicious apples did prove to be significant as was expected. In addition, the state of Washington's production was significant and exhibited the hypothesized relationship. This was not surprising since not only is Washington the country's largest producer of apples, but is especially strong in the CA season and in Red Delicious.

ECONOMIC INTERPRETATION OF THE PRICE-FORECASTING EQUATION FOR RED DELICIOUS APPLES REMOVED FROM CA STORAGE

The economic interpretation of the coefficients of the independent variables in the price-forecasting equation for Red Delicious sold from CA storage is:

1. An increase in total CA holdings of Red Delicious apples as of November 1 of 1 bushel per 1,000 people, ceteris paribus, will result in a decrease in the average price received by shippers for Red Delicious sold from CA storage of 37¢ per carton 12-3 lb. film bags, in real terms.

2. An increase in the total production of apples in Washington of one pound per capita, ceteris paribus, will result in a decrease in the average price received by shippers for Red Delicious apples sold from CA storage of 17¢ per carton 12-3 lb. film bags, in real terms.

3. An increase in the real per capita disposable income of $100, ceteris paribus, will result in an increase in the average price received by shippers for Red Delicious sold from CA storage of 51¢ per carton 12-3 lb. film bags, in real terms.

4. The passage of one year, ceteris paribus, will result in a decrease in the average F.O.B. price received by shippers for Red Delicious apples sold from CA storage of 19¢ per carton 12-3 lb. film bags, in real terms.

COMPARISON OF ESTIMATED PRICES WITH ACTUAL PRICES OF RED DELICIOUS SOLD AS CA APPLES

Using data from the period 1968-1979, actual prices for Red Delicious sold from CA storage were compared with estimated prices and are presented in Table 4. The absolute difference and percentage difference between actual prices and estimated prices for the time period are also shown

Table 4. Actual and Estimated Real F.O.B. Prices for Red Delicious Sold During the Third Period, 1968-1979

Year	Actual Prices ($/12-3 lb)	Estimated Prices ($/12-3 lb)	Difference ($/3-12 lb)	Percent Difference
1968	5.141	4.858	.284	5.5
1969	3.481	3.623	-.142	4.1
1970	3.893	4.084	-.191	4.9
1971	3.303	3.467	-.164	5.0
1972	4.090	3.917	.173	4.2
1973	4.761	4.778	-.017	.4
1974	3.673	3.759	-.0863	2.3
1975	3.364	3.158	.206	6.1
1976	3.687	3.590	-.0973	2.6
1977	4.344	4.566	-.203	4.7
1978	3.699	3.754	-.0532	1.5
1979	3.626	3.528	-.0987	2.7

in Table 4. Graphically this comparison is shown in Figure 5. Over this time period the average absolute difference was about 15¢ or approximately 4 percent.

PRICE-FORECASTING EQUATIONS FOR JONATHANS

According to the data available, Jonathans are marketed approximately the same time as Red Delicious.[8] Jonathans are considered a dual purpose apple and many are consumed in fresh form. In the future, as now, Jonathan will be an important variety for fresh markets.

FIRST PERIOD EQUATIONS FOR JONATHAN

An effort was made to construct a price-forecasting equation for Jonathan sold during the first period. Michigan production was used as the quantity variable for Michigan. Various definitions of alternative production and of substitute fruit were tested. This testing included experimenting with different combinations of these various measures. Out of these experiments the price-forecasting equation shown in Table 5 was chosen for Jonathan sold during the first period. The equation was estimated in real terms. Four variables: 1) Michigan production; 2) Midwest production; 3) per capital disposable income; and 4) a trend, were able to explain about 88 percent of the variation in the average price of Jonathan apples sold during the first period.

As in the case of Red Delicious the variable for Michigan production in the Jonathan equation is not significant. Both explanations given in the section on Red Delicious for this result apply equally as

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[8]Michigan Department of Agriculture, Marketing Michigan Apples, various issues.

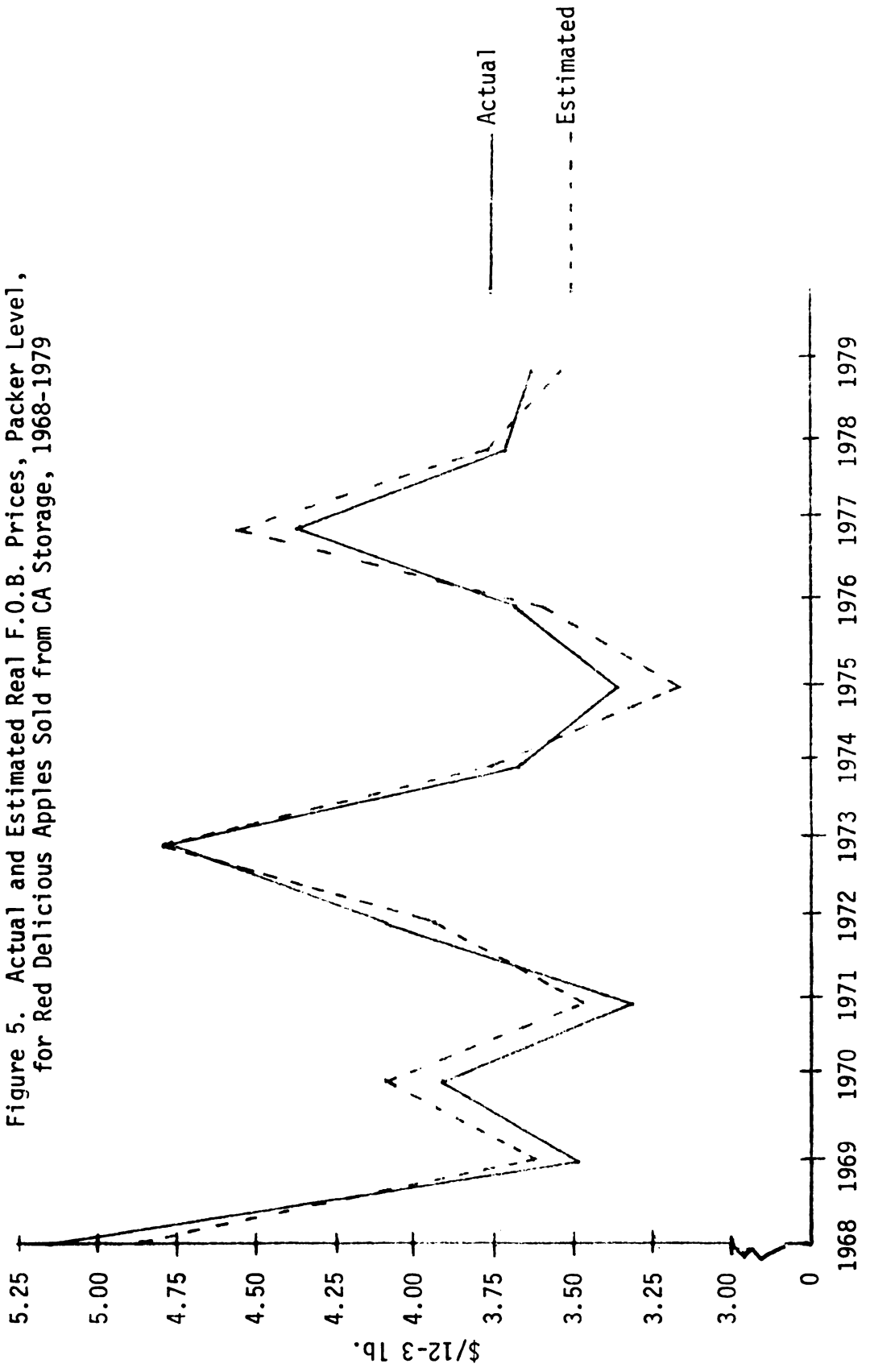


Figure 5. Actual and Estimated Real F.O.B. Prices, Packer Level, for Red Delicious Apples Sold from CA Storage, 1968-1979

Table 5. Results of Price-Forecasting Equations for Jonathan[a]

Equation	Dep. Var.	Explanatory Variables					Summary Statistics		
		Const.	X_1	X_{39}	X_{10}	T	S.E.	R^2	D.W.
1. First Period	P_{J1}	-11.7277 (6.47902)**	-.0757898 (.241316)	-1.22904 (.556611)***	7.58208 (2.39575)***	-.408493 (.123540)***	.321893	.8751	1.8384
2. Regular Storage	P_{J2}	9.43823 (3.80198)***	-.557324 (.141609)***	-.902851 (.326627)***	7.13176 (1.40586)***	-.436994 (.0724949)***	.188891	.9585	1.9221
3. Controlled Atmosphere	P_{J3}	-10.6911 (3.93068)***	-.464393 (.146403)***	-.486083 (.337684)	7.30147 (1.45345)***	-.440801 (.074949)***	.195286	.9360	1.8064

[a]These equations are based on data for 1968-1979 period.
*** Indicates significant at the 5% level.
** Indicates significant at the 10% level.
* Indicates significant at the 20% level.

Where:

P_{J1} = the average F.O.B. price at the packer per carton of 12-3 lb. film bags of Jonathan apples sold during the first period, expressed in real terms (1967 dollars)

P_{J2} = average F.O.B. price at the packer per carton of 12-3 lb. film bags of Jonathan apples sold from regular storage, expressed in real terms (1967 dollars)

P_{J3} = average F.O.B. price at the packer per carton of 12-3 lb. film bags of Jonathan apples sold from CA storage, expressed in real terms (1967 dollars)

X_1 = total utilized production of Michigan apples (lb./capita)

X_{39} = total utilized production of Midwest apples (lb./capita)

X_{10} = per capita disposable income, expressed in real terms (1967 dollars)

T = trend variable

NOTE: Numbers in parenthesis are standard errors.

well here. It is highly likely that Michigan production and Midwestern production are strongly correlated. This possibility combined with the fact that both regions compete in some of the same markets would support the hypothesis that early in the marketing year total Midwestern supply is more important than just Michigan supply in determining the price of Jonathans. It must also be remembered that if the two variables are correlated, one variable will tend to obscure the effect of the other. Midwest production seems to be obscuring and accounting for some of the impact of Michigan production.

No other measures of alternative areas production proved to be significant in forecasting the price of Jonathans. No satisfactory measure of substitute fruit was found. In all cases the variable proved insignificant.

ECONOMIC INTERPRETATION OF THE PRICE-FORECASTING EQUATION FOR JONATHANS SOLD DURING THE FIRST PERIOD

The preceding price-forecasting equation for Jonathans may be interpreted economically in the following manner.

1. An increase in the production of Michigan apples of one pound per capita, ceteris paribus, will result in a decrease in the average price received by shippers for Jonathans sold during the first period of 8¢ per carton of 12-3 lb. film bags, in real terms.

2. An increase in the production of Midwest apples of one pound per capita, ceteris paribus, will result in a decrease in the average price received by shippers for Jonathans sold during the first period of $1.23 per carton of 12-3 lb. film bags, in real terms.

3. An increase in the real per capita disposable income of $100, ceteris paribus, will result in an increase in the average price received by shippers for Jonathan sold during the first period of 76¢ per carton of 12-3 lb. film bags, in real terms.

4. The passage of time from one year to the next, ceteris paribus, will result in a decrease in the average price received by shippers of 41¢ per carton 12-3 lb. film bags, in real terms.

COMPARISON OF ESTIMATED PRICES WITH ACTUAL PRICES OF JONATHANS SOLD DURING THE FIRST PERIOD

A comparison was made between the actual prices and the estimated prices for the time interval from 1968 to 1979. The results of this comparison are shown in Table 6. Also shown in Table 6 are the absolute differences and the percentage differences between the actual and estimated prices. Figure 6 shows this comparison in graphic form. The average absolute difference over the entire time span was almost 20¢.

The average percentage difference was about 7 percent during the interval.

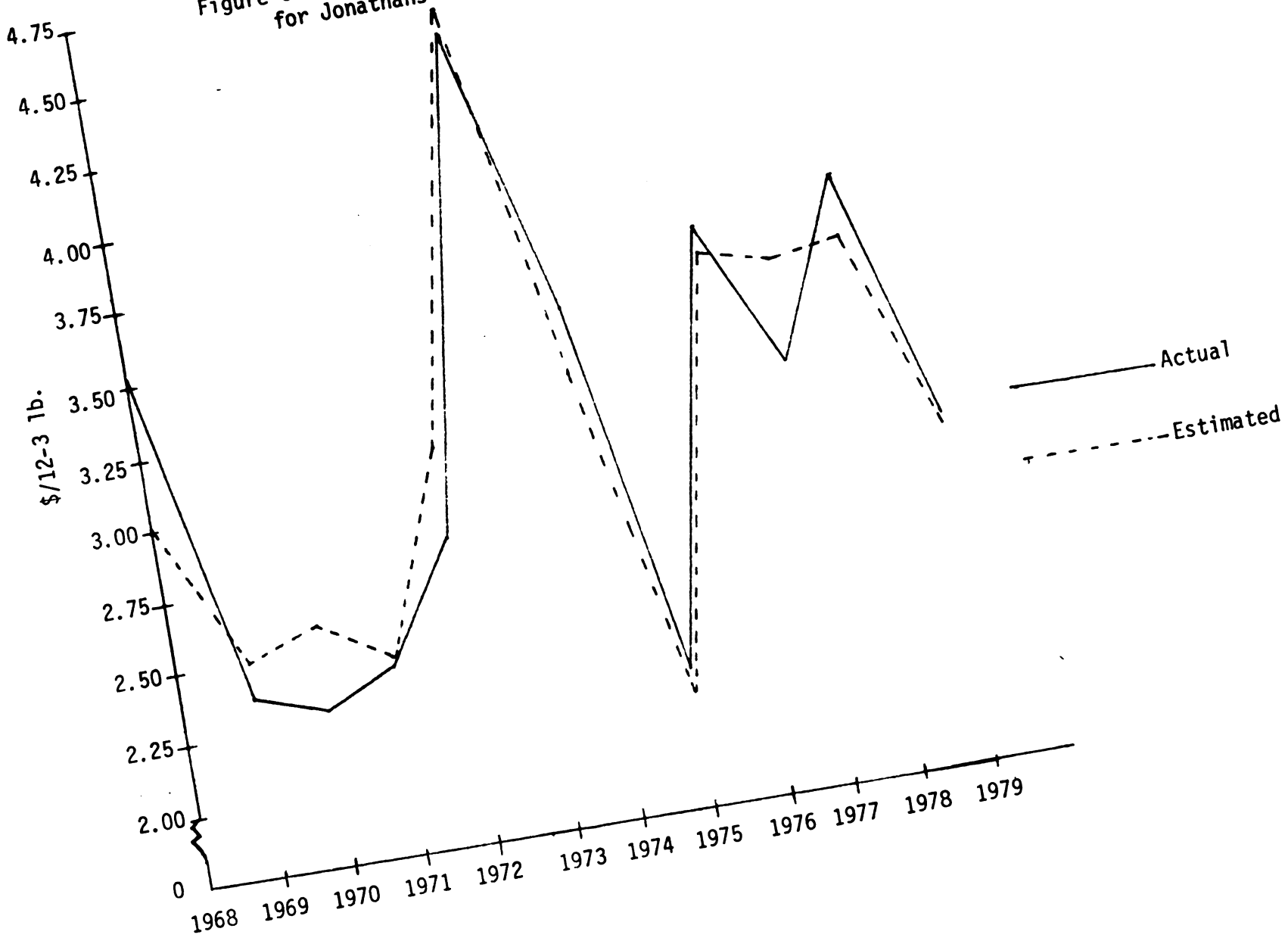
REGULAR STORAGE EQUATIONS FOR JONATHANS

Real F.O.B. prices at the packer for Jonathan apples in containers of 12-3 lb. film bags removed from regular storage were estimated using OLS for the period from 1968 to 1979. In order to find the best possible equation several runs were made with various measures and combinations of the independent variables. Three different measures of Michigan production were experimented with: 1) total Michigan production; 2) regular storage holdings of Jonathan apples as of November 1; and 3) regular storage holdings of all three varieties--Jonathan, MacIntosh and Red

Table 6. Actual and Estimated Real F.O.B. Prices for Jonathans Sold During the First Period, 1968-1979

Year	Actual Prices ($/12-3 lb)	Estimated Prices ($/12-3 lb)	Difference ($/12-3 lb)	Percent Difference
1968	3.512	2.995	.518	14.7
1969	2.379	2.504	-.125	5.3
1970	2.308	2.582	-.274	11.9
1971	2.407	2.451	-.0439	1.8
1972	2.812	3.139	-.327	11.6
1973	4.525	4.620	-.0951	2.1
1974	3.536	3.327	.208	5.9
1975	2.241	2.158	.0831	3.7
1976	3.730	3.625	.105	2.8
1977	3.231	3.582	-.351	10.9
1978	3.838	3.591	.247	6.4
1979	2.973	2.919	.0546	1.8

Figure 6. Actual and Estimated Real F.O.B. Prices, Packer Level for Jonathans Sold During the First Period, 1968-1979



Delicious. Several measures of alternative areas of apple production were tried and three measures of substitute fruits were also experimented with. They were a quantity index of non-citrus fruits excluding apples, bananas, and fresh orange sales. All quantity variables were put on a per capita basis and all prices and income are on a real basis (1967 dollars). From this procedure a price-forecasting equation for Jonathans sold from regular storage, shown in Table 5, was selected.

All the signs of the coefficients are consistent with a prior expectation and the coefficients are significant at a 95 percent level. Four variables: 1) Michigan production; 2) Midwest production; 3) per capita disposable income; and 4) a trend, explain almost 96 percent of the variation associated with the average real price F.O.B. at the packer of Jonathans removed from regular storage.

The most interesting observation of this equation, and in general the other equations estimated for Jonathans in different periods, is that total Michigan production proved to have more explanatory power (greater significance) than did regular storage or CA storage holdings of Jonathan. Reasons why this might be the case were presented earlier. One equation where regular storage holdings of Jonathan did prove significant is contained in Appendix B. However, it was omitted from presentation here since the coefficient on oranges, while significant, is of the wrong sign. In general, the coefficient for the substitute variables were insignificant and/or had the wrong sign. When the price-forecasting equations for Jonathans were estimated using total regular storage holdings of all three varieties, the results were comparable to just using Jonathan regular storage holdings.

ECONOMIC INTERPRETATION OF THE PRICE-FORECASTING EQUATION FOR JONATHAN APPLES SOLD FROM REGULAR STORAGE

The coefficients on the independent variables in the price-forecasting equation may be given the following economic interpretation:

1. An increase in the total utilized production of apples in Michigan of one pound per person, ceteris paribus, will result in a decrease of the average price received by shippers for Jonathans sold from regular storage of 56¢ per carton of 12-3 lb. film bags, in real terms.

2. An increase in the total utilized production of apples in all other states of one pound per person, ceteris paribus, will result in a decrease in the average price received by shippers for Jonathan apples sold from regular storage of 90¢ per carton of 12-3 lb. film bags, in real terms.

3. An increase in the real per capita disposable income of $100, ceteris paribus, will result in an increase in the average price received by shippers of 71¢ per carton of 12-3 lb. film bags, in real terms.

4. The passage of one year from the next, ceteris paribus, will result in a decrease of the average price received by shippers for Jonathans sold from regular storage of 44¢ per carton of 12-3 lb. film bags, in real terms.

COMPARISON OF ESTIMATED PRICES WITH ACTUAL PRICES OF JONATHAN SOLD FROM REGULAR STORAGE

Real prices for Michigan Jonathan apples were estimated for a 12-year period from 1968 to 1979. These estimated prices were compared with the actual prices for this period. This comparison is presented in Table 7 as well as the percentage differences and absolute differences between

Table 7. Actual and Estimated Real F.O.B. Prices for Jonathans Sold During the Second Period, 1968-1979

Year	Actual Prices ($/12-3 lb)	Estimated Prices ($/12-3 lb)	Difference ($/12-3 lb)	Percent Difference
1968	3.506	3.205	.301	8.6
1969	2.417	2.431	-.0338	1.4
1970	2.255	2.419	-.163	7.2
1971	2.210	2.224	-.0137	.6
1972	2.588	2.767	-.179	6.9
1973	4.556	4.606	-.0501	1.1
1974	2.959	2.930	.0287	1.0
1975	1.900	1.892	.0079	.4
1976	3.572	3.476	.0961	2.7
1977	3.009	3.243	-.234	7.8
1978	2.695	2.535	.160	5.9
1979	2.442	2.363	.079	3.2

the actual and estimated prices. Figure 7 shows the comparison between actual and estimated prices in a graphic form. The average absolute difference for the entire 12-year period was 11.2¢ per 12-3. The average percentage difference for the same period was 3.9 percent.

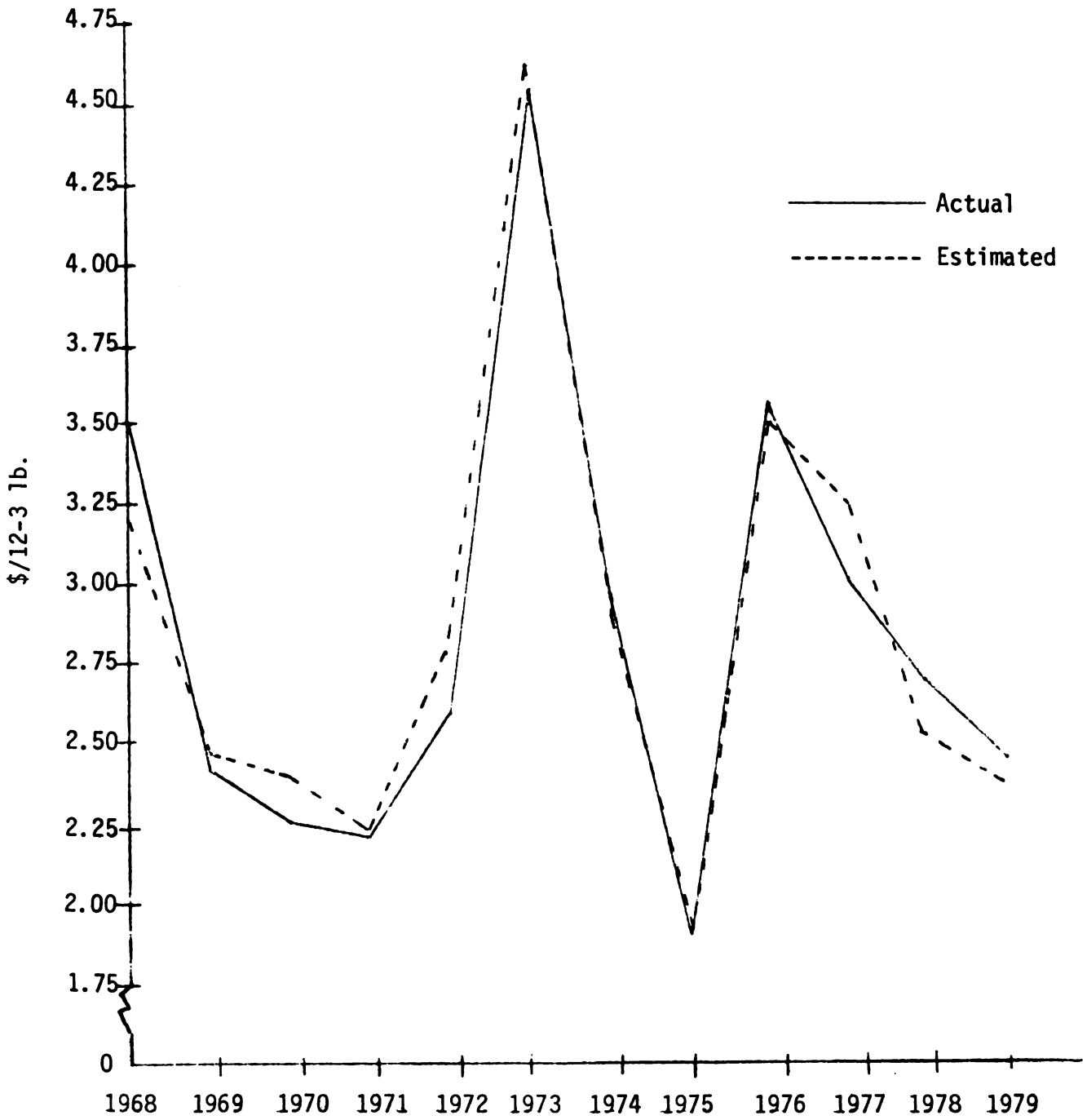
CONTROLLED ATMOSPHERE STORAGE EQUATIONS FOR JONATHANS

Jonathan apples are the most heavily produced apple in Michigan. However, this preeminence does not carry over the CA marketings where CA holdings of Jonathan have recently ranked second behind Red Delicious. A price-forecasting equation was estimated for Jonathan apples sold F.O.B. from CA storage in 12-3 lb. film bags. The analysis included those independent variables which were hypothesized to be important factors in determining the price of Jonathans from CA storage. Alternative measures of several of the independent variables were tested. From the various measures and combinations of the independent variables, the price-estimating equation in Table 5 for Jonathan CA sales was selected.

As was the case for the first two periods, estimating the price-forecasting equation in real terms gave more satisfactory results than did estimating the relationship in nominal terms. These same independent variables contained in the previous Jonathan equations explain almost 93 percent of the variation in the price of Jonathans sold from CA storage.

Several independent variables included in the general model are noteworthy because of their absence. Although several variations and different measures were experimented with, a suitable measure for a substitute fruit was not found. An alternative price-forecasting equation presented in Appendix B does contain an index of non-citrus fruit

Figure 7. Actual and Estimated Real F.O.B. Prices, Packer Level, for Jonathan Apples Sold from Regular Storage, 1968-1979



significant at the 90 percent level. Unfortunately, it has the "wrong" sign. Given the time of the year when CA apples are marketed, it was hypothesized that oranges would prove to be a substitute for CA apples since the marketing seasons overlap.

It should be mentioned that in almost all the equations containing CA holdings of Jonathans, as the quantity variable for Michigan supply, the variable was insignificant. The possibility of this occurrence was discussed previously. In the case of Jonathan apples, the total Michigan production is a very significant factor influencing the price of CA apples. As mentioned earlier, the size of the apple crop seems to be setting the tone or price level and the prices for CA Jonathan are a continuation of this level. Jonathans (and MacIntosh) seem subject to this phenomena. However, for forecasting purposes this may actually be a plus. At the time when the price forecasts are to be made it will be an easier task to estimate total crop size than it will be to estimate varietal CA holdings.

ECONOMIC INTERPRETATION OF THE PRICE-FORECASTING EQUATION FOR JONATHANS REMOVED FROM CA STORAGE

The economic interpretation of the price-forecasting equation for Jonathans sold as CA apples estimated above can be summarized as follows:

1. An increase in total utilized production of apples in Michigan of one pound per person, ceteris paribus, will result in a decrease in the average price received by shippers for Jonathans sold as CA apples of 46¢ per carton of 12-3 lb. film bags, in real terms.

2. An increase in the total production of apples in all other Midwest states of one pound per person, ceteris paribus, will result in

a decrease in the average price received by shippers for Jonathans sold as CA apples of 49¢ per carton of 12-3 lb. film bags, in real terms.

3. An increase in real per capita disposable income of $100, ceteris paribus, will result in an increase in the average price received for Jonathans sold as CA apples of 73¢ per carton of 12-3 lb. film bags, in real terms.

4. The passage of time of one year to the next, ceteris paribus, will result in a decline in the average price received by shippers for Jonathans sold as CA apples of 44¢ per carton 12-3 lb. film bag, in real terms (see discussion on trend variables).

COMPARISON OF ESTIMATED PRICES WITH ACTUAL PRICES OF JONATHANS FROM CA STORAGE

Real prices for Michigan Jonathan apples sold from CA storage were estimated for 12 years of data covering the period from 1968 to 1979. These estimated prices are presented in Table 8 as well as the actual prices during the same period, the absolute differences between the two prices, and the percentage differences from the actual prices. This comparison between actual and estimated prices is presented graphically in Figure 8. The prices in Table 8 show that for the 1968 to 1979 period the average absolute differences between actual and estimated price was 12¢ or about 4 percent.

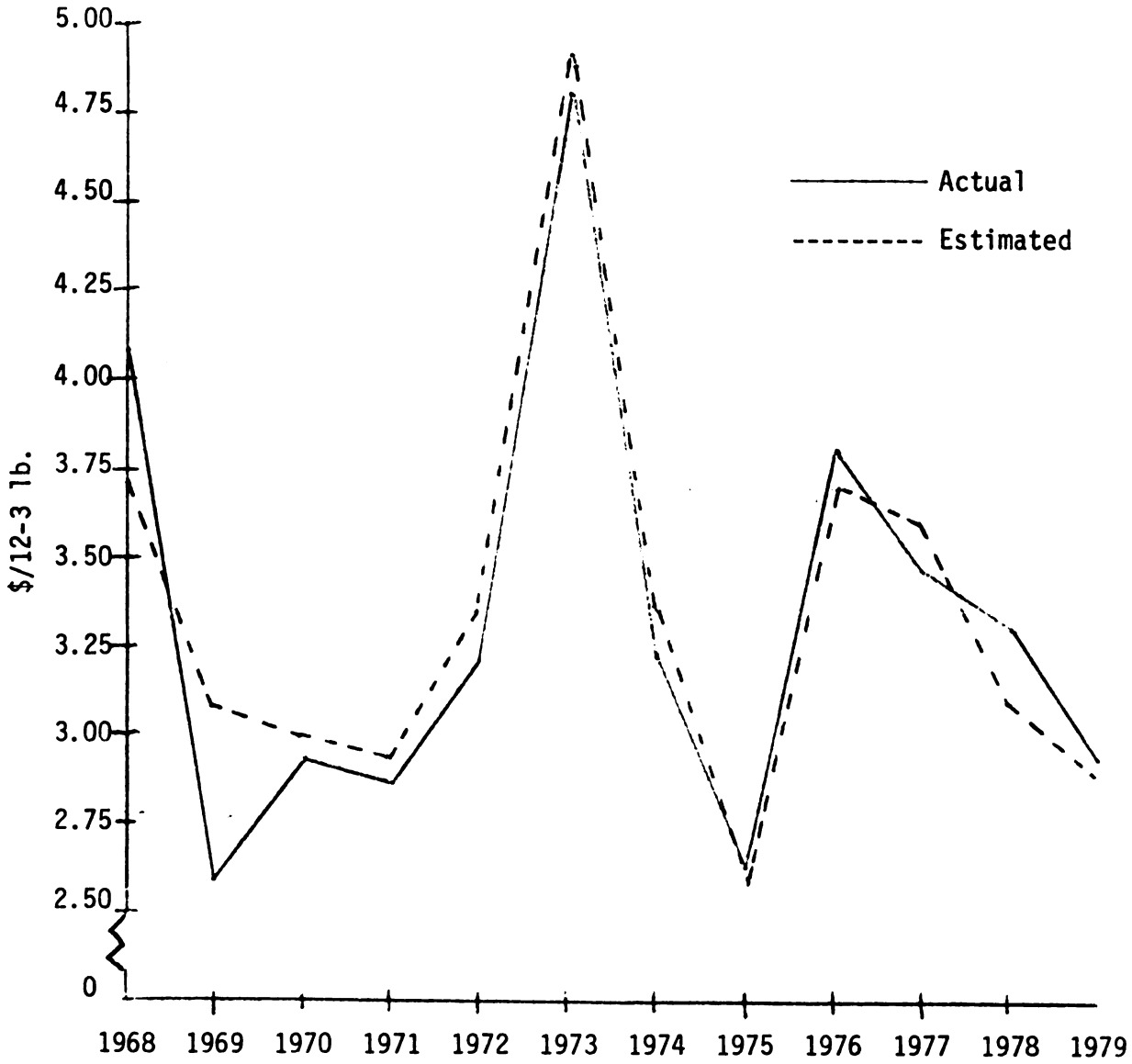
PRICE-FORECASTING EQUATIONS FOR MACINTOSH

Although MacIntosh are declining in importance in Michigan, they are still an important variety. Many people prefer the taste of a good MacIntosh. However, they are prone to wide quality variation and their storage characteristics are inferior to other fresh varieties such as

Table 8. Actual and Estimated Real F.O.B. Prices for Jonathans Sold During the Third Period, 1968-1979

Year	Actual Price ($/12-3 lb)	Estimated Price ($/12-3 lb)	Difference ($/12-3 lb)	Percent Difference
1968	4.079	3.716	.363	8.9
1969	2.594	3.080	-.127	4.9
1970	2.923	2.992	-.0683	2.3
1971	2.878	2.910	-.0325	1.1
1972	3.211	3.348	-.137	4.3
1973	4.808	4.891	-.083	1.7
1974	3.232	3.365	-.133	4.1
1975	2.625	2.615	.0099	.4
1976	3.789	3.689	.101	2.7
1977	3.458	3.595	-.136	3.9
1978	3.303	3.103	.200	6.1
1979	2.921	2.878	.0431	1.5

Figure 8. Actual and Estimated Real F.O.B. Prices, Packer Level, for Jonathan Apples Sold from CA Storage, 1968-1979



Red Delicious. Even so, MacIntosh apples still are a major apple variety in terms of fresh consumption in Michigan.

FIRST PERIOD EQUATION FOR MACINTOSH

MacIntosh apples are normally the first variety of the three varieties under analysis to be harvested and marketed. Therefore, the first period for them is the longest of the three varieties. Thus the factors influencing the price of MacIntosh during this period have more opportunity to have their effect measured. If this is the case, a more accurate estimate should be obtained for MacIntosh apple prices than for Jonathan or Red Delicious during this period.

In the regression analysis for MacIntosh sold during the first period the various hypotheses given in Chapter III were tested. Only one independent variable was tested for Michigan supply which was total utilized Michigan production. Various measures were experimented with to determine the best variable for alternative areas of production. The same hypotheses were tested as were tested in the Red Delicious and Jonathan equations. The same was done to determine the best measure for substitute fruits. Real per capita income and a trend variable were also included in the analysis.

Various combinations of the hypothesized variables were experimented with. From these regressions runs the equation shown in Table 9 was selected. Four variables: 1) Michigan production; 2) Midwestern production; 3) per capita disposable income; and 4) a trend, explained a little over 90 percent of the variation in the price of MacIntosh sold during the first period.

Table 9. Results of Price-Forecasting Equations for MacIntosh[a]

Equation	Explanatory Variables						Summary Statistics		
	Dep. Var.	Const.	X_1	X_{39}	X_{10}	T	S.E.	R^2	D.W.
1. First Period	P_{M1}	-11.0902 (5.08588)***	-.549425 (.189430)***	-.427860 (.436927)	7.05844 (1.88061)***	-.371997 (.096976)***	.252679	.9043	1.6024
2. Regular Storage	P_{M2}	-12.6607 (4.94328)**	-.928257 (.184118)***	-.733202 (.424676)	7.86260 (1.82788)***	-.411194 (.0942569)***	.245594	.9358	1.9609
3. Controlled Atmosphere	P_{M3}	-10.7839 (3.76179)***	-.614109 (.140112)***	-.303634 (.323174)*	7.14160 (1.39100)***	-.392840 (.0717285)***	.186895	.9437	1.7284

[a]These equations are based on data for the 1968-1979 period.
*** Indicates significant at the 5% level.
** Indicates significant at the 10% level.
* Indicates significant at the 20% level.

Where:

P_{M1} = the average F.O.B. price at the packer per carton of 12-3 lb. film bags of MacIntosh apples sold during the first period, expressed in real terms (1967 dollars)

P_{M2} = average F.O.B. price at the packer per carton of 12-3 lb. film bags of MacIntosh apples sold from regular storage, expressed in real terms (1967 dollars)

P_{M3} = average F.O.B. price at the packer per carton of 12-3 lb. film bags of MacIntosh apples sold from controlled atmosphere storage, expressed in real terms (1967 dollars)

X_1 = total utilized production of Michigan apples (pounds per capita)

X_{39} = total utilized production of Midwest apples (pounds per capita)

X_{10} = per capita disposable income, expressed in real terms (1967 dollars)

T = trend variable

NOTE: Numbers in parentheses are standard errors.

Michigan production was highly significant and the sign was as expected. Midwestern production was slightly significant and did exhibit the correct sign. All other measures of alternative production were insignificant or showed a sign inconsistent with economic theory.

No satisfactory measure of a substitute fruit was found. This was somewhat expected as previous researchers also have had difficulty finding a suitable variable for substitute. In most instances, the variable for substitutes was insignificant and when significant it displayed the wrong sign, i.e., positive. An explanation for the nonsignificance of the substitute variable is that the cross elasticities are extremely small between any particular fruits or even perhaps, between groupings of fruit. Therefore the price-quantity interactions between MacIntosh apples and substitute fruits were too small for the model to pick up. Why there should be a significant positive relationship in some cases is somewhat puzzling. It could be that the two items are actually complements. More likely is that,given the specification for that particular equation, the substitute variable is acting as a proxy for some unknown variable not included in the equation.

ECONOMIC INTERPRETATION OF THE PRICE-FORECASTING EQUATION FOR MACINTOSH SOLD DURING THE FIRST PERIOD

The price-forecasting equation for MacIntosh sold during the first period may be given the following economic interpretation.

1. An increase in total utilized production of apples in Michigan of one pound per capita, ceteris paribus, will result in a decrease in the average price received by shippers for MacIntosh sold during the first period of 55¢ per carton of 12-3 lb. film bags,in real terms.

2. An increase in the total utilized production of apples in all other Midwestern states of one pound per capita, ceteris paribus, will result in a decrease in the price received by shippers for MacIntosh sold during the first period of 43¢ per carton of 12-3 lb. film bags, in real terms.

3. An increase in the real per capita disposable income of $100, ceteris paribus, will result in an increase in the average price received by shippers for MacIntosh sold during the first period of 71¢ per carton of 12-3 lb. film bags, in real terms.

4. The passage of one year to the next, ceteris paribus, will result in a decrease in the average price received by shippers for MacIntosh apples sold during the first period of 37¢ per carton of 12-3 lb. film bags, in real terms.

COMPARISON OF ESTIMATED PRICES WITH ACTUAL PRICES OF MACINTOSH SOLD DURING THE FIRST PERIOD

Real prices for Michigan MacIntosh sold during the first period were estimated for the 12 year span of time. This interval covered the years from 1968 to 1979. The estimated and actual prices are given in Table 10. In addition to these prices the absolute difference between the actual prices and estimated prices is shown as well as the percentage difference between the two. Figure 9 shows this information in a graphic form. Over this 12 year interval the average absolute difference between actual prices and the estimated prices was 15¢. The average percentage difference for the period was approximately 5 percent.

Table 10. Actual and Estimated Real F.O.B. Prices for MacIntosh Sold During the First Period, 1968-1979

Year	Actual Price ($/12-3 lb)	Estimated Price ($/12-3 lb)	Difference ($/12-3 lb)	Percent Difference
1968	3.539	3.148	.391	11.0
1969	2.476	2.536	-.06	2.4
1970	2.386	2.496	-.11	4.6
1971	2.439	2.465	-.0266	1.1
1972	2.594	2.935	-.341	13.1
1973	4.561	4.589	-.0276	.6
1974	3.216	3.081	.135	4.2
1975	2.375	2.427	-.0528	2.2
1976	3.565	3.583	-.0181	.5
1977	3.252	3.515	-.263	8.1
1978	3.119	2.955	.169	5.4
1979	3.105	2.896	.209	6.7

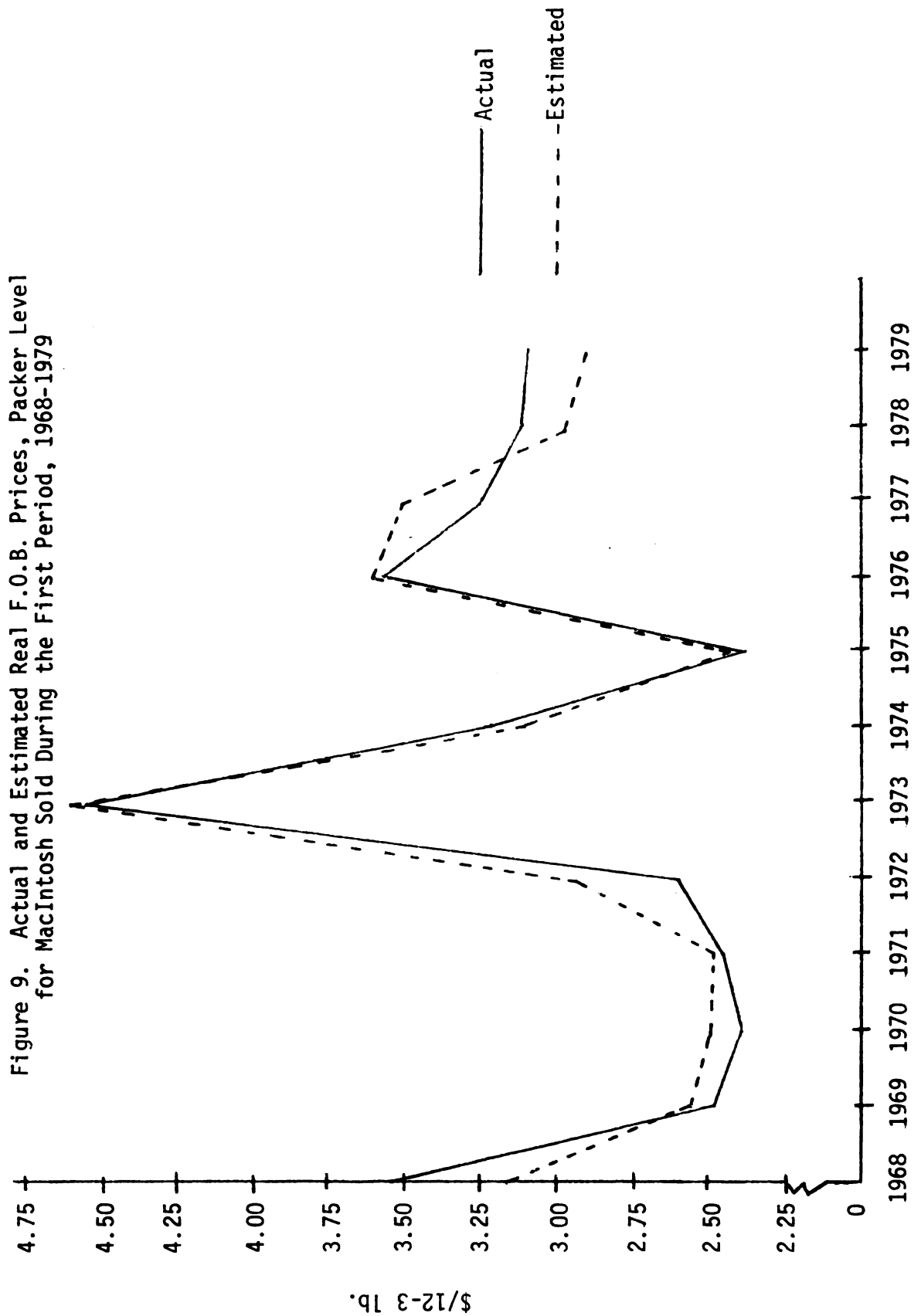


Figure 9. Actual and Estimated Real F.O.B. Prices, Packer Level for MacIntosh Sold During the First Period, 1968-1979

REGULAR STORAGE EQUATIONS FOR MACINTOSH

A price-forecasting equation was developed for MacIntosh apples sold from regular storage in 12-3 lb. films. The analysis included testing all the hypotheses regarding the independent variables set forth in Chapter III. To do so required running numerous trials with various measures of the independent variables and various combinations of the independent variables. From the trials, Equation 2 in Table 9 was selected.

This relationship was estimated in real terms. Ninety-four percent of the variation in the price of MacIntosh sold from regular storage was explained by: 1) Michigan production; 2) Midwest production; 3) per capita disposable income; and 4) a trend.

A quick glance at the equation will lead to the observation that many of the variables hypothesized to influence the price of MacIntosh are not included. Probably the most striking absence is that of regular storage holdings of MacIntosh. Logically, total holdings of MacIntosh in regular storage should be a significant factor influencing the price of MacIntosh sold from regular, but they are not. As was the case for Jonathans, reliable information concerning the total holdings of MacIntosh in regular storage may come too late to be of much use in the price discovery process. If this is so, apple marketers must turn to another indicator of storage holdings to get a basis of total supply. The most obvious is the size of the total crop. Crop size and total regular storage holdings are highly correlated. Although the level of apple production is not known with certainty until late in the season, apple marketers may have better and more timely knowledge of overall production than they do of regular storage holdings. Therefore, in the individual negotiations

of the price discovery mechanism for regular storage apples total production is used as the basis of supply rather than regular storage holdings. Appendix B does present an equation for MacIntosh sold from regular storage where the quantity variable for Michigan is regular storage holdings of MacIntosh.

One other measure for total supply was used. Several trials were conducted to see if total regular storage holdings of all varieties as of November 1 had any explanatory power. The results obtained were similar to those obtained using just the regular storage holdings of MacIntosh. Several measures of alternative areas of production were also experimented with. Midwestern production, excluding Michigan, was found to give the best results, although it is not highly significant. No measure of a substitute variable was found to give satisfactory results.

ECONOMIC INTERPRETATION OF THE PRICE-FORECASTING EQUATION FOR MACINTOSH REMOVED FROM REGULAR STORAGE

The following economic interpretation may be given to the coefficients on the independent variables in the price forecasting for MacIntosh sold from regular storage.

1. An increase in total Michigan production of one pound per capita, ceteris paribus, will result in a decrease in the average price received by shippers for MacIntosh sold from regular storage of 93¢ per carton of 12-3 lb. film bags, in real terms.

2. An increase in total Midwest production of one pound per capita, ceteris paribus, will result in a decrease in the average price received by shippers for MacIntosh sold from regular storage of 73¢ per carton of 12-3 lb. film bags, in real terms.

3. An increase in the real per capita income of $100, ceteris paribus, will result in an increase in the average price received by shippers for MacIntosh apples sold from regular storage of 79¢ per carton of 12-3 lb. film bags, in real terms.

4. The passage of time from one year to the next, ceteris paribus, will result in a decrease in the average price received by shippers for MacIntosh apples sold from regular storage of 41¢ per carton of 12-3 lb. film bags, in real terms.

COMPARISON OF ESTIMATED PRICES WITH ACTUAL PRICES OF MACINTOSH APPLES SOLD FROM REGULAR STORAGE

The estimated prices derived from the price-forecasting equation for MacIntosh sold from regular storage were compared with the actual prices for the 12-year period from 1968 to 1979. The estimated prices and the actual prices are shown in Table 11 as well as the absolute difference and the percentage difference between the two series of prices. Figure 10 shows this comparison graphically. For the 12-year period, the average absolute difference was 13.5¢ per 12-3 lb. film and the average percentage difference was 4.7 percent.

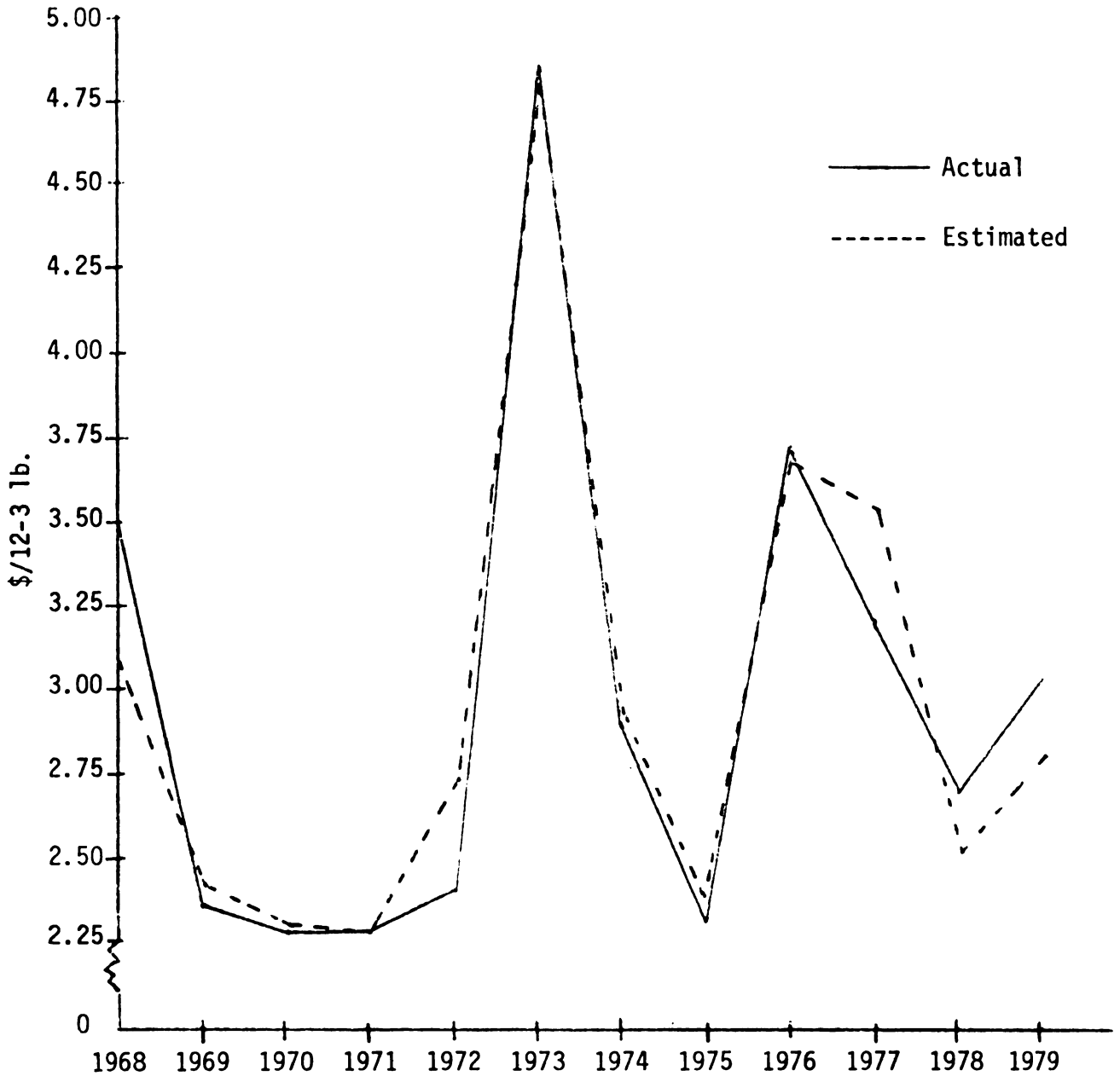
CONTROLLED ATMOSPHERE STORAGE EQUATIONS FOR MACINTOSH

In most years MacIntosh is the third leading variety sold from CA. A price-forecasting equation was estimated for MacIntosh apples sold F.O.B. from CA storage in 12-3 lb. bag cartons. As with Jonathans and Red Delicious, the analysis included all those independent variables which were hypothesized to be significant factors influencing the price of MacIntosh. This included various measures and combinations of the

Table 11. Actual and Estimated Real F.O.B. Prices for MacIntosh Sold During the Second Period, 1968-1979

Year	Actual Prices ($/12-3 lb)	Estimated Prices ($/12-3 lb)	Difference ($/12-3 lb)	Percent Difference
1968	3.503	3.203	.299	8.5
1969	2.358	2.397	-.0388	1.7
1970	2.282	2.294	-.0120	.5
1971	2.288	2.290	-.0019	.1
1972	2.405	2.733	-.328	13.6
1973	4.849	4.817	.0315	.7
1974	2.896	2.910	-.0142	.5
1975	2.313	2.380	-.0663	2.9
1976	3.719	3.657	.0624	1.7
1977	3.181	3.532	-.352	11.1
1978	2.687	2.509	.178	6.6
1979	3.043	2.801	.242	8.0

Figure 10. Actual and Estimated Real F.O.B. Prices, Packer Levels, for MacIntosh Apples Sold from Regular Storage, 1968-1979



independent variables. From this analysis price-forecasting equations shown in Table 9 for average MacIntosh CA price was selected.

The relationship was estimated in real terms. All the signs were correct and significant at a 95 percent level. The price-forecasting for MacIntosh apples is identical with the price-forecasting equation for Jonathans for the same periods. CA storage holdings of MacIntosh were, in general, not found to be a significant explanatory variable in the price-forecasting equations for MacIntosh removed from CA storage. This result was somewhat surprising. Equally surprising was that Eastern states' production, when used as the variable for alternative areas of production, did not give as good results as the above equation. An alternative equation, shown in Appendix B, gave almost equal performance with regard to predictive ability as the selected equation and had both CA storage holdings of MacIntosh and Eastern states' production. Unfortunately, the statistical fit and overall predictive ability was inferior to the selected equation.

For both Jonathans and MacIntosh the same specification gave the best results in all three periods. This does not mean that price-forecasting equations are identical for all three periods. The coefficients of the variables change from period to period and so do the variables' influence on the periods' prices. Many of the hypothesized relationships between either Jonathan or MacIntosh prices and storage holdings and alternative areas of production could not be established with any consistency.

A partial explanation of this result would seem to lie in the competitiveness of Jonathan and MacIntosh apples. The markets in which these varieties are competitive due to the prices they command are more

localized than in the case of Red Delicious. Therefore, supplies of MacIntosh apples may be the predominant competitor for marketers of Michigan Jonathans and MacIntosh apples. This seems to be the case even as the marketing season progresses.

Why storage holdings should be a significant explanatory variable in forecasting Red Delicious prices and not Jonathans or MacIntosh is not so easily explained. One hypothesis is that because of harvest and marketing dates, the price "tone" may be set earlier in the season for the latter two varieties than for the former variety. Therefore, the influence of the total crop size is of a more lasting nature on the prices of Jonathan and MacIntosh apples than it does on Red Delicious prices. A second hypothesis is that Red Delicious storage holdings are less highly correlated with crop size than are storage holdings for Jonathans and MacIntosh. Since, in general, Red Delicious are the most preferred dessert apple and have superior storage characteristics, emphasis is placed on having an adequate supply of this variety in storage. Obviously, the level of storage holdings of Red Delicious is dependent on the size of the crop, but to a lesser degree than for Jonathans or MacIntosh. Therefore, as the season progresses the price of Red Delicious is more accurately forecast using storage holdings of Red Delicious as an explanatory variable than total Michigan production. The variables included: Michigan production; Midwestern production; per capita disposable income; and a trend, and they explained over 94 percent of the variation in the F.O.B. price of CA MacIntosh.

Of the variables excluded from the price-forecasting equations, the most important was a measure of substitute fruits. Many variations were

tried, however, most were insignficant or lacked the proper sign. An alternative price-forecasting equation is given in Appendix B, which does include oranges, but with the wrong sign. It also contains Midwest states' apple production as a measure of alternative production.

ECONOMIC INTERPRETATION OF THE PRICE-FORECASTING EQUATION FOR MACINTOSH REMOVED FROM CA STORAGE

The economic interpretation of the coefficients on the independent variables in the price-forecasting equation for MacIntosh from CA may be summarized as follows:

1. An increase in total Michigan production of one pound per capita, ceteris paribus, will result in a decrease in the average price received by shippers for MacIntosh sold as CA apples of 61¢ per carton of 12-3 lb. film bags, in real terms.

2. An increase in the total production of apples in Midwestern states of one pound per capita, ceteris paribus, will result in a decrease in the average price received by shippers for MacIntosh sold as CA apples of 30¢ per carton of 12-3 lb. film bags, in real terms.

3. An increase in the real per capita disposable income of $100, ceteris paribus, will result in an increase in the average F.O.B. price received by shippers for MacIntosh sold as CA apples of 71¢ per carton of 12-3 lb. film bags, in real terms.

4. The passage of time, of one year to the next, ceteris paribus, will result in a decrease in the average F.O.B. price received by shippers for MacIntosh sold as CA apples of 39¢ per carton of 12-3 lb. film bags, in real terms.

COMPARISON OF ESTIMATED PRICES WITH ACTUAL PRICES OF MACINTOSH SOLD AS CA APPLES

Real prices for Michigan MacIntosh apples sold from CA storage were compared with the estimated prices for 12 years of data covering the period from 1968 to 1979. These estimated prices are presented in Table 12. The absolute difference per year between actual prices and estimated prices plus the percentage difference are also shown in Table 12. This is shown graphically in Figure 11. For the period the average absolute difference between actual prices and estimated prices was 11.6¢ per 12-3 lb. film. This is about a 4 percent difference.

OWN-PRICE ELASTICITY

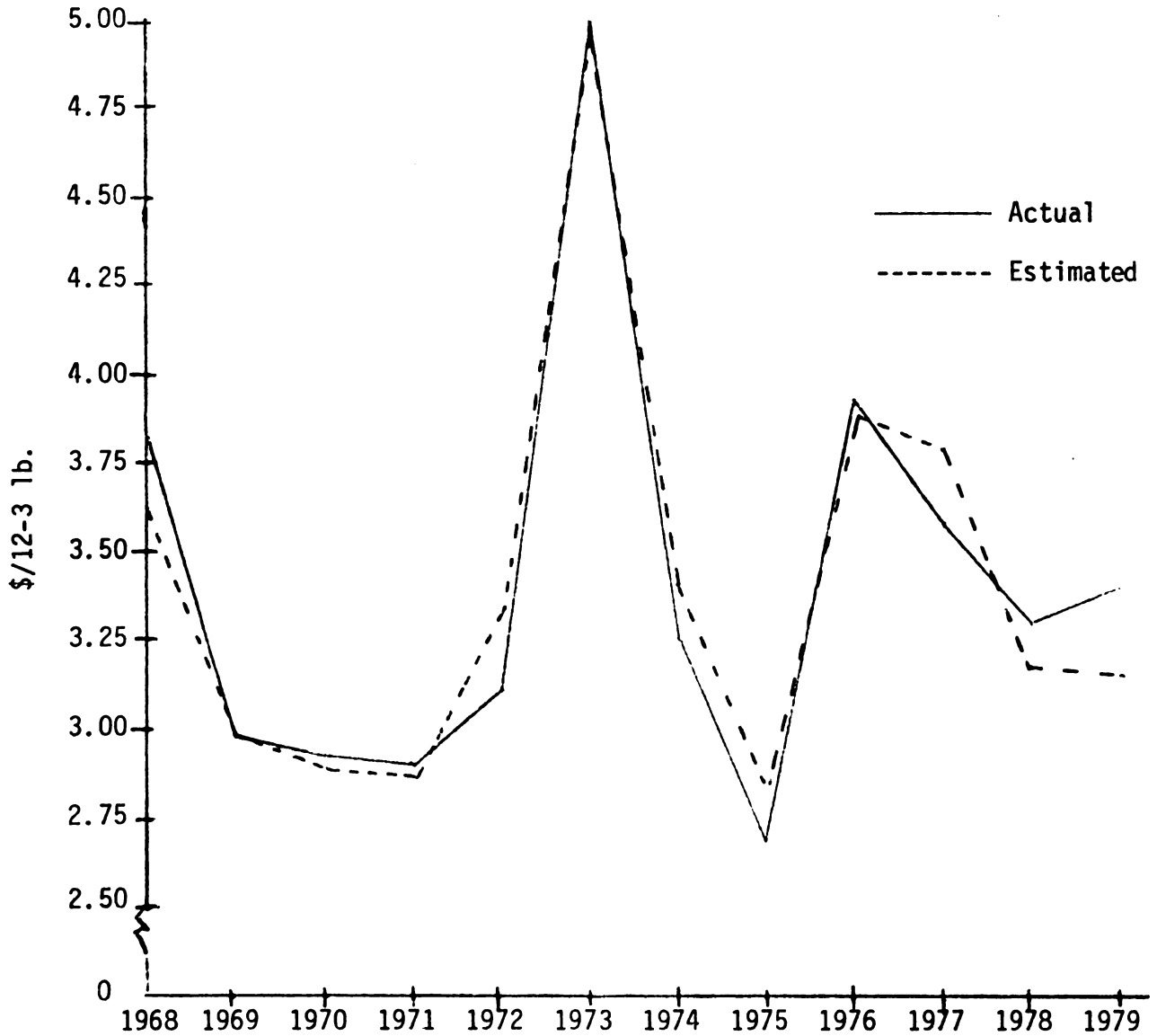
Although the development of a model to forecast prices was the major objective of this research, the own-price elasticities of demand derived from the estimated coefficients of the Michigan quantity variable are also of interest. Although the own-price elasticities are not directly deriveable from the coefficients, they may be calculated from the coefficient. In the model formulated for this research, price was specified as the dependent variable. Therefore, the coefficients represent own-price flexibilities. The distinction between price flexibilities and price elasticities is simple. Both measure the relationship between price and quantity, but they differ as to which variable they treat as being dependent. The own-price elasticity concept measures the percent change in quantity demanded due to a given percent change in price. Mathematically, this may be represented as:

$$E_P = \frac{\frac{\Delta Q}{Q}}{\frac{\Delta P}{P}} = \left(\frac{\Delta Q}{\Delta P}\right) = \left(\frac{P}{Q}\right)$$

Table 12. Actual and Estimated Real F.O.B. Prices for MacIntosh Sold During the Third Period, 1968-1979

Year	Actual Prices ($/12-3 lb)	Estimated Prices ($/12-3 lb)	Difference ($/12-3 lb)	Percent Difference
1968	3.839	3.636	.203	5.3
1969	2.977	2.987	-.0094	.3
1970	2.938	2.908	.0299	1.0
1971	2.900	2.880	.0202	.7
1972	3.109	3.305	-.196	6.3
1973	5.001	4.974	.0263	.5
1974	3.259	3.402	-.144	4.4
1975	2.689	2.805	-.116	4.3
1976	3.942	3.888	-.0538	1.4
1977	3.576	3.808	-.231	6.5
1978	3.287	3.162	.125	3.8
1979	3.396	3.158	.238	7.0

Figure 11. Actual and Estimated Real F.O.B. Prices, Packer Level, for MacIntosh Apples Sold from CA Storage, 1968-1979



The price flexibility concept measures the percent change in price associated with a given percent change in quantity or:

$$F_P = \frac{\frac{\Delta P}{P}}{\frac{\Delta Q}{Q}} = \left(\frac{\Delta P}{\Delta Q}\right)\left(\frac{Q}{P}\right)$$

A price flexibility treats price as the dependent variable, which was the case in this study.

Under certain conditions the price elasticities may be treated as approximately equal to the reciprocal of the price flexibilities. A price flexibility implies that price is a function of quantity of that product plus quantities of substitutes. A price elasticity implies that quantity is a function of own product price plus prices of other products. Since the two concepts hold different variables constant, the reciprocal of one may not be a good approximation of the other. To be a good approximation the cross effects must be near zero, i.e., no substitutes. More of this matter will be discussed later. The price flexibility does set the lower limit of the price elasticity.

$$\left|E_{ii}\right| \geq \left|\frac{1}{F_{ii}}\right|^{9}$$

This section will examine the own-price elasticities derived from the price flexibility coefficients to determine if any conclusions may be drawn from them. In a strict sense price elasticities are evaluated at a single point on the demand curve, so the price elasticities generated will be for average quantities and average prices.

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[9] E_{ii} represents own-price elasticity and F_{ii} represents own-price flexibility. Tomek and Robinson, Agricultural Product Prices, p. 53.

The first obstacle to a direct interpretation has already been mentioned. For the reciprocal of the price flexibilities to be a good approximation of the price elasticities, the cross effect must be small. Although no non-apple substitutes were clearly identified, there are certainly cross effects beteen apples and oranges. These cross effects may be relatively large when all other fruits are considered. This problem is magnified when the model specified in this research is considered. The model specified estimated prices for a particular variety, grade and pack. This means not only apples produced in other regions may be considered as substitutes, but also apples of different varieties, grades and packs produced in Michigan. Indeed, in most cases measures of alternative areas of production were found to be significant and relatively large factors affecting the price of apples under investigation. No measures were calculated for the substitution effects among Michigan varieties and packs, although there must be some substitution effects.

The price elasticities generated for each variety in each period are summarized in Table 13.

Table 13. Own-Price Elasticity for Jonathan, MacIntosh, and Red Delicious by Period

	Period I	Period II (Regular Storage)	Period III (Controlled Atmos.)
Jonathans	-15.50*	-1.93	-2.67
MacIntosh	- 2.07	-1.21	-2.04
Red Delicious	- 3.59*	-2.45	-3.01

*Both of these variables were insignificant at the 20 percent level in these price-forecasting equations.

A quick observation from Table 13 is that the elasticities calculated are higher than most commonly published. However, these seem to be well in line with estimates obtained by Pasour and O'Rourke who used similar model specifications.[10] A possible explanation for the "high" elasticities is that the elasticities are calculated for a specific variety and pack, thereby increasing the number of substitutes, i.e., other apple varieties and packs. It should be mentioned that the elasticities estimated for Red Delicious are not directly comparable since different definitions of own quantity were used in each period.

Pasour found a similar pattern in the change of elasticities from period to period and used it to suggest a possible marketing policy.[11] If demand is more elastic in the first and third periods than in the second, this would suggest diverting sales from the second period to the first or third period.

This is the classic price discrimination model where supplies are diverted from the more inelastic market to the more elastic market. For price discrimination to work, three conditions must be met. A seller must have market power, i.e., ability to control supply. The markets must be able to be segregated either spatially or temporally and the opportunities for arbitrage must be small. Obviously, these conditions are not fully met. And to price discriminate would probably entail industry-wide organization of producers. However, the demand exlasticities might be used to improve the allocation of apples over the season, i.e., to improve returns.

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[10] Pasour, An Analysis of Intraseasonal Apple Price Movement; O'Rourke, Factors Affecting Major Marketing Decisions for the Washington Apple Crop.

[11] Ibid.

For optimal allocation over the three periods the economic principle is that returns are maximized by allocating the apple supplies so that the marginal revenues in each period are equal--assuming equal marginal costs. When marginal costs vary, as they will because storage costs vary, net returns are maximized by equating the marginal net revenues in each period. Marginal net revenue is defined as the difference between marginal revenue and marginal cost in any period.

For this model, shippers' net revenues would be maximized by equating the discounted marginal net revenues in the three periods. To do a thorough job would require a demand equation for the processing market. It would also require information regarding storage costs. The price-forecasting equations may be used to establish fresh demand.

There are practical problems with implementing such a policy. It may not be possible to increase marketings in the first period because of harvest conditions or the maturation process of the fruit. Or there may be a physical constraint on storage facilities. Most likely the price forecasts themselves will be used as a basis of allocating apple supplies regardless of the demand elasticities. Packer-shippers making storage decisions at the beginning of the season would look at the price forecast for each period, project their storage and marketing costs, and divert the majority of their supplies to the period with the highest per unit net return. There will be some constraints on their decision. For instance, besides storage capacity constraints, packer-shippers might place more in regular storage than net per unit return might merit in order to maintain access to the retail market. Allocating supplies between periods might also be a form of risk aversion.

AN EX-POST TEST OF THE MODEL

The ultimate test of any price-forecasting model is to forecast beyond the period of the original sample. There are two ways of doing this. One is to make actual forecasts. This entails obtaining ancillary forecasts (estimates) of the independent variables and substituting these into the price-forecasting equation and calculating the forecasted price. Due to the timing of this research and subsequent publications, this test is not possible.

The second method is commonly referred to as an ex-post forecast. This method involves saving the last one or two year's data from the original fit of the model and see how the equation forecast using the observed but not included observation. This test was done and the results are shown below. Several points should be made. First, although the equations given previously were estimated with data covering the period from 1968 to 1979, for the purposes of this test the equations were estimated omitting the last year's observation (1979). This means that although the specifications of the equations are identical, the coefficients are slightly changed. Second, since the data for 1979 was available it was not necessary to make ancillary forecasts of the independent variables. This, of course, enhances the ability of the equation to provide reasonable estimates.

Table 14 below gives the forecasted prices for 1979 derived for the ex-post test versus the actual prices associated with the mini price-forecasting equations.

The results of the ex post forecast indicates that the model's performance is reasonable. Although the differences between the forecasted prices and the actual prices are larger than the standard error

Table 14. Ex-Post Price Forecasts versus Actual Prices, Red Delicious, Jonathans, and MacIntosh for Three Storage Periods

Equation	Forecasted Price ($/12-3 lb)	Actual Price ($/12-3 lb)	Difference ($/12-3 lb)	Percent Difference
D_1	2.823	3.335	.512	15.4
D_2	2.680	3.036	.356	11.7
D_3	3.477	2.626	-.149	5.7
J_1	2.873	2.973	.100	3.4
J_2	2.311	2.442	.131	5.4
J_3	2.845	2.921	.076	2.6
M_1	2.750	3.105	.355	11.4
M_2	2.647	3.043	.396	13.0
M_3	3.300	3.396	.096	2.8

of regression, this was expected since the estimation procedure used to fit the original model employs all the available information and is designed to minimize the error. It was also expected that, unless conditions change, the model's performance in the future (updated each year) should improve as there will be additional information to incorporate into the model.

It is interesting to note that, for the most part, the accuracy of the price forecasts improve as the marketing season progresses. This is to be expected. The beginning of the marketing season is marked by a high degree of uncertainty with respect to Michigan's production, alternative regions' production, and other key market variables. However, as the season progresses more information becomes available and market conditions can be assessed more accurately.

SUMMARY

Price-forecasting equations were developed for three varieties of Michigan apples--Jonathan, MacIntosh and Red Delicious. The equations were estimated for three periods corresponding to an early period, a regular storage period, and a controlled atmosphere period. All relationships were estimated in real terms.

The first period equations showed the most variation in the estimated price. This was expected due to the softness of market conditions early in the marketing season. The regular storage and controlled atmosphere equations suffered from less variance in the estimated price. Throughout the analysis no suitable measure for a substitute fruit was found.

Chapter V will present the conclusions and implications drawn from these results. It will also offer some uses for this research. It will conclude with some needs for future research.

CHAPTER V

CONCLUSIONS AND IMPLICATIONS

Chapter V is the concluding chapter in this research report. The conclusions and implications derived from the research results are presented in the section to follow. Potential uses of this research will also be presented. Suggestions will be made on how this research may be furthered and what gaps need to be filled. In closing, a brief overview of the project will be provided.

ALTERNATE AREAS OF PRODUCTION

At the outset of this research hypotheses were formulated regarding the significance of other producing areas' production. The Midwest was the most significant alternative producing area in all the price-forecasting equations for the first two periods. Usually this area is not considered a major apple producing region. Nonetheless, that this region should be a significant factor in the price of Michigan apples is not surprising. Midwestern apple marketers, particularly Illinois, Indiana and Ohio, compete in the same markets as Michigan apple marketers. They are especially competitive early in the season and become less so as the season progresses. According to Dr. Donald Dewey of Michigan State University, while the apple marketers in the states surrounding Michigan are not highly organized, they are extremely aggressive.[1] Many

[1]Interview with Dr. Donald Dewey, Michigan State University, Department of Horticulture, August 4, 1980.

sales made to retailers are consummated straight off the shipper's truck. These shippers seem willing to reduce prices in order to make a sale.

By the time the controlled atmosphere period arrives, Midwestern apples are no longer as much of a competitive influence on the prices of Red Delicious. As hypothesized, by then Washington production has become a significant influence on the price of Red Delicious. Washington not only produces more apples than any other state, but also produces more Red Delicious than any other state. The greater price CA apples command may enable them to absorb a greater transportation charge. Thus, as the CA season is reached, Washington becomes more competitive with Michigan apples.

For Jonathans and MacIntosh, Midwestern production was a significant factor influencing prices in all three periods. It may be that the varietal composition of the Midwest is such that Midwest apples are closer substitutes for Michigan Jonathans and MacIntosh than any other region's. It may also be that Jonathans and MacIntosh cannot support the cost of long transportation hauls.

It is obvious from these results that the competitive climate facing Michigan apple marketers changes as the season progresses. This may be important knowledge in terms of developing a marketing strategy. For example, early in the marketing season the Midwest is Michigan's most significant competitor. Midwest marketers are unorganized but highly aggressive. Marketers from Michigan may want to develop special marketing strategies to meet Midwest competitors. Perhaps they may want to offer special deals or stress better supply and quality assurance. As the season progresses though, Michigan marketers may want to alter their strategy as Washington and Eastern states become more dominant forces in

the market. Washington apples appear to be effectively promoted. Given the results obtained it may be good strategy for Michigan marketers to concentrate their promotional efforts later in the season.[2]

These examples are merely meant to be illustrative and not an advocation for a particular marketing policy. The important point is, as the competitive forces impinging on Michigan apple marketers change, there may be a need to change the marketing strategy to meet these new challenges.

SUBSTITUTE FRUITS

A major effort was put into developing a measure of substitute fruits for Michigan apple varieties. This effort was singularly unsuccessful. Three definitions of substitute fruits were experimented with: 1) a quantity index of selected non-citrus fruits other than apples; 2) sales of oranges; and 3) imports of bananas. All three variables proved to be insignificant in most cases and where significant, they possessed the wrong sign.

To some degree these results were not surprising as other researchers have reported similar results.[3] One explanation previously mentioned is that the cross elasticities between any particular variety of Michigan apples and some other fruit or groups of fruits are very small. The

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[2]The converse of this strategy may also be plausible. That is, promote most heavily when Washington is less of a factor in the market and increase Michigan sales at the expense of Midwest producers--i.e., take the money and run.

[3]O'Rourke, Factors Affecting Major Marketing Decisions for the Washington Apple Crop; Pasour, An Analysis of Intraseasonal Apple Price Movement; Tomek, An Analysis of Changes in the Utilization of Apples in the United States.

price-quantity relationship between Michigan apple varieties and other fruits are probably too small to be captured in the data and measured.

It is recognized that the closest substitute for a commodity grown in a state is that same commodity grown in other regions. Various measures were tested and the results were discussed in the previous section. However, a corollary of this statement is the closest substitute for any particular variety grown in a state is another variety grown in the state. Both varieties would, of course, have to be sold in the same market. Consider Red Delicious -- Red Delicious are primarily a fresh variety. Although MacIntosh and Jonathan are dual purpose varieties, they constitute an important source of fresh apples. In essence, the biggest competition for the varieties investigated under this research is among the varieties themselves. No attempt was made to measure the degree of substitution between varieties.

Due to the lack of substantive results concerning substitute fruits, few conclusions can be drawn. It does appear, though, that in terms of substitutes Michigan marketers should devote the majority of their attention to apples from competing regions rather than with other fruits. Marketers should also be cognizant of the fact that for any specific variety the closest substitute may be another variety grown in Michigan. It is unclear to say how this might affect marketing strategies. But perhaps shippers should view their roles as that of a line manager. Analogous to a line manager for a grocery manufacturer, apple shippers might be concerned with the overall profitability of the apple varieties they carry. Such a view might lead to strategies of market segmentation or cross subsidization in order to garner a broader market or shelf space.

A final note on substitutes is in order. In some cases the substitute variable was found to be significant, but it had the "wrong" sign. In other words, the sign of the coefficient was positive which would indicate the substitute variable is actually a complement. This is certainly a possibility, although in terms of standard economic theory it doesn't seem likely. It may be possible that apples and substitutes are subject to the same trends, for example, a change in consumer tastes and preferences. If so, in those cases where the substitute variable exhibits a positive sign it may be acting as a proxy for some unincluded-trended variables.

USE OF PRICE-FORECASTING EQUATIONS

Many of the uses of price-forecasting equations have already been alluded to. Points made earlier will not be belabored. Price analysis is a systematic way of looking at the past behavior of market relationships. It also identifies the factors which seem to be most important in the determination of price. Price analysis uses statistical relationships derived from historical behavior to estimate future prices. While this may be a weakness if the market relationships in the future vary dramatically from those in the past, in most cases historical relationships are a good barometer for future outcomes.

At the beginning of the season, packers and shippers must begin to make decisions concerning the marketing pattern and storage levels they will follow, Presently, these decisions are made with a great deal of uncertainty concerning prices likely to be received, but shippers do use historical relationships at least in an informal manner. The burden of decision making would be lessened if marketers had reliable estimates of what the prices will be.

The price-forecasting equations developed in this research can be used to obtain estimates of prices that shippers can expect to receive--given current market conditions. Presently, any price expectations formed by shippers are probably done so on an informal basis. These equations can provide a systematic and quantified method for shippers to arrive at their price estimates.

To use the model is a fairly simple matter. It does require the use of ancillary forecasts. Ancillary forecasts are estimates of the values of the independent variables for the upcoming time period. The accuracy of the price forecasts are dependent on accurate estimates of the independent variables. An example may help illustrate the use of a price-forecasting equation. Suppose a shipper is interested in knowing the average price he/she would receive for a carton of 12-3 lb. bags of MacIntosh sold in the first period. The price-forecasting equation for this period is:

$$P_{M1} = -11.2455 - .512690X_1 - .544579X_{39} + 7.29595X_{10} - .403930T$$

The shipper uses the August 1 crop estimates for ancillary forecasts of the production variables. The August 1 crop estimate for Michigan (X_1) is 700 million pounds, while the estimate for Midwest (X_{39}) production is 490 million pounds. As ancillary forecasts for disposable income, CPI, and population the shipper uses the July 1 figures for that year. These values are $1600 billion, 207.4 and 218.1 million respectively. All the quantity variables are put on a per capita basis and the price and income variables are convereted to a real basis by dividing by the CPI. The shipper then substitutes these values into the equation and multiplies them by their respective coefficients. This calculation would give a

price forecast for the average values of MacIntosh sold during the first period of $3.68 per carton of 12-3 lb. bags, in real terms.

This method is not infallible and it would be extremely improbable that the forecast was absolutely accurate. As previously mentioned, price analysis is based on historical relationships with the assumption that these relationships will continue. In most instances, this will be the case. However, in any particular year there may be unusual circumstances that may invalidate the price forecast. Under these circumstances the price forecast may require some modification based on knowledgeable evaluation of the extenuating circumstances not accounted for by the model. For example, the crop may be of average size, but of abnormally poor quality. A shipper would then discount the price forecast by a factor deemed appropriate to account for the poor quality.

In summary, the primary purpose of price forecasts is to reduce uncertainty in decisions where expected price is an important decision parameter.

FURTHER RESEARCH

During the course of this research several areas for future work came to the attention of the author. One area of future work which would be especially useful for the Michigan apple market is the incorporation of the processing market into the model. Although it has been worked on separately, the processing market is a major market alternative for many of Michigan's apples. Including the processing market would probably entail the use of simultaneous estimation procedures.

More work needs to be done to develop a suitable measure for substitute fruits of Michigan apples. In terms of economic theory and

opinions of knowledgeable apple marketers, this appears to be an important variable absent from the research. This task will probably require the construction of a "grand" quantity index representing the major hypothesized substitute fruits. The composition of the index might be varied among periods to reflect changes in market conditions.

The extension of this model to other varities, grades, and packs also is appropriate.

SUMMARY

This chapter was intended to draw together some of the major conclusions and implications derived from the results presented in Chapter IV. It also suggested how the results of this research may be used. The conclusions and uses put forth were not intended to be all inclusive. Finally, needs for further research were described, and suggestions were provided concerning how this research might be a valuable input for further work in this area.

APPENDICES

APPENDIX A
DATA

Appendix Table A-1. Period's Average F.O.B. Apple Prices[1]

Year	First Period Dollars per 12-3 lb film bags			Regular Storage Period Dollars per 12-3 lb film bags			Controlled Atmosphere Period Dollars per 12-3 lb film bags		
	Jonathan	MacIntosh	Red Delicious	Jonathan	MacIntosh	Red Delicious	Jonathan	MacIntosh	Red Delicious
1968	3.66	3.688	4.503	3.653	3.65	4.684	4.25	4.00	5.357
1969	2.612	2.719	3.436	2.654	2.589	2.925	3.243	3.269	3.822
1970	2.684	2.775	3.982	2.623	2.654	3.716	3.40	3.417	4.528
1971	2.92	2.958	3.27	2.68	2.775	3.103	3.491	3.518	4.007
1972	3.524	3.25	3.745	3.243	3.013	3.367	4.024	3.396	5.125
1973	6.023	6.071	6.339	6.014	6.454	5.714	6.40	6.656	6.337
1974	5.222	4.75	5.714	4.37	4.277	4.583	4.773	4.813	5.425
1975	3.613	3.828	4.141	3.062	3.729	3.977	4.232	4.334	5.422
1976	6.36	6.078	6.429	6.091	6.341	5.625	6.461	6.721	6.287
1977	5 .364	5.903	6.713	5.462	5.773	6.76	6.277	6.491	7.92
1978	7.50	6.094	6.625	5.266	5.25	5.42	6.454	6.423	7.228
1979	6.464	6.75	7.25	5.308	6.615	6.60	6.35	7.383	7.884

[1]Michigan Department of Agriculture, Marketing Division, Marketing Michigan Apples (h.p.) various issues.

Appendix Table A-2. Utilized Production in Michigan and Competing Regions[1]

	Michigan (million lbs)	Washington (million lbs)	Eastern[2] (million lbs)	Midwest[3] (million lbs)	New England[4] (million lbs)	Non-Michigan[5] (million lbs)
1968	555	1025	2513	497	1120	4887
1969	675	1695	2900	533	1145	6032
1970	690	1392	3008	510	1269	5599
11971	730	1206	3138	561	1277	5641
1972	730	1393	2557	510	1007	5157
1973	470	1860	2493	414	957	5623
1974	670	1806	2815	457	1331	5863
1975	700	2200	3124	603	1227	6807
1976	480	2308	2358	392	1132	5741
11977	570	2083	2697	442	1244	6103
1978	870	2300	3078	482	1375	6687
1979	680	2450	3161	511		

[1]U.S. Department of Agriculture, Noncitrus Fruits and Nuts Annual Summary (Washington, D.C.: Government Printing Office) various issues.

[2]Includes the states of Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, Connecticut, New York, New Jersey, Pennsylvania, Delaware, Maryland, Virginia, West Virginia, North Carolina and South Carolina.

[3]Includes the states of Ohio, Indiana, Illinois, Wisconsin, Minnesota, Iowa, Missouri, Kansas, Kentucky, Tennessee, and Arkansas.

[4]Includes the states of Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, Connecticut, and New York.

[5]Total U.S. production excluding Michigan.

Appendix Table A-3. Quantities of Competing Fruits

	Index of Noncitrus* Fruits[1] (1000 tons)	Sales of Fresh Oranges[2] (1000 boxes)	Banana Imports[3] (1000 tons)
1968	1503	44243	1928
1969	1591	43696	1894
1970	1244	44145	1991
1971	1348	43435	2071
1972	1119	42397	2085
1973	1267	44887	2095
1974	1323	54353	2189
1975	1488	50240	2106
1976	1511	47168	2318
1977	1525	44571	2333
1978	1474	40041	2464

*Pears, peaches, grapes, and nectarines.

[1]Includes fresh utilization of pears, peaches, grapes and nectarines. U.S. Department of Agriculture, U.S. Agricultural Statistics, 1979. (Washington, D.C.: Government Printing Office) p. 231-241.

[2]Ibid., p. 219.

[3]U.S. Department of Agriculture, Economics, Statistics and Cooperative Services, U.S. Foreign Agricultural Trade Statistics Report, Fiscal Year, (Washington, D.C.: Government Printing Office) various issues.

Appendix Table A-4. Michigan Regular Storage and Controlled Atmosphere[1] Storage Holdings, by Variety, as of November 1

Year	Regular Storage			Controlled Atmosphere Storage		
	Jonathan (1000 bu)	MacIntosh (1000 bu)	Red Delicious (1000 bu)	Jonathan (1000 bu)	MacIntosh (1000 bu)	Red Delicious (1000 bu)
1968	1322	537	596	1127	679	313
1969	1559	551	1201	1033	610	633
1970	1521	735	883	1290	626	550
1971	1355	599	1226	1040	508	1094
1972	1160	738	941	1054	666	956
1973	1165	370	602	738	326	624
1974	1233	699	824	967	581	909
1975	1398	420	816	985	503	1009
1976	532	265	545	722	328	834
1977	740	233	303	622	372	539
1978	952	356	1092	693	324	1107
1979	1155	287	603	878	352	1002

[1]Michigan Department of Agriculture, Marketing Michigan Apples (Np) various issues.

Appendix Table A-5. Disposable Income, Consumer Price Index, and Population, 1968-1979

	U.S. Disposable Personal Income[1] Current Prices (billions)	Consumer Price Index[2] (1967 = 100)	U.S. Civilian Population[3] (millions)
1968	588.1	104.2	197.1
1969	630.4	109.8	199.1
1970	685.9	116.3	201.7
1971	742.8	121.3	204.3
1972	801.3	125.3	206.5
1973	901.7	133.1	208.1
1974	984.1	147.7	209.7
1975	1086.7	161.2	211.4
1976	1134.5	170.5	213.0
1977	1305.1	181.5	214.7
1978	1458.4	195.4	216.1
1979	1624.31	217.4	218.5

[1]Department of Commerce, Survey of Current Business. (Washington, D.C.: Government Printing Office) various issues.

[2]Department of Labor, Bureau of Labor Statistics: Monthly Labor Review. (Washington, D.C.: Government Printing Office) various issues.

[3]Department of Commerce, Bureau of the Census Series P-25. (Washington, D.C.: Government Printing Office) September 1979.

APPENDIX B

ALTERNATIVE EQUATIONS FOR THE FIRST, REGULAR STORAGE AND CONTROLLED ATMOSPHERE PERIODS

APPENDIX B

B-1 First Period

1. Jonathan

$$P_{J1} = -20.1900 - .519765X_1 - .00407685X_6 + 10.0832X_{10} - .4951001T$$
$$(8.65517)^{***} \quad (.284264)^{**} \quad (.0080909) \quad (3.05752)^{***} \quad (.171702)^{***}$$

$R^2 = .8278$ D.W. = 2.7323

Standard error of regression = .407518

Where:

P_{J1} = average F.O.B. price at the packer per carton of 12-3 lb. film bag of Jonathans sold during the first period, expressed in real terms (1967 dollars)

X_1 = total utilized Michigan production (pounds per capita)

X_6 = fresh orange sales (boxes/1000 people)

X_{10} = per capita disposable income, expressed in real terms (1967 dollars)

T = trend variables

2. MacIntosh

$$P_{M1} = -14.2495 - .779341X_1 + .0813093X_{33} + 8.04636X_{10} - .431008T$$
$$(4.49059)^{***} \quad (.150880)^{***} \quad (.107379) \quad (1.64699)^{***} \quad (.0934447)^{***}$$

$R^2 = .9376$ D.W. = 2.7956

Standard error of regression = .220289

Where:

P_{M1} = average F.O.B. price at the packer per carton of 12-3 lb. film bag of MacIntosh sold during the first period, expressed in real terms (1967 dollars)

X_1 = total utilized Michigan production (pounds per capita)

X_{33} = quantity index of non-citrus fruits for fresh utilization (tons/1000 people)

X_{10} = per capita disposable income, expressed in real terms (1967 dollars)

T = trend variable

3. Red Delicious

$$P_{D1} = \underset{(8.61584)^*}{-11.8429} - \underset{(.282972)^{***}}{.73152X_1} + \underset{(.00797269)}{.0000525074X_6} + \underset{(3.04393)^{***}}{7.19218X_{10}} - \underset{(.170921)^{**}}{.431834T}$$

$R^2 = .7827$ D.W. = 2.0911

Standard error of regression = .405666

Where:

P_{D1} = average F.O.B. price at the packer per carton of 12-3 lb. film bag

X_1 = total utilized Michigan production (pounds per capita)

X_6 = fresh sales of oranges (boxes/1000 people)

X_{10} = per capita disposable income, expressed in real terms (1967 dollars)

T = trend variables

B-2 Regular Storage Equation

1. MacIntosh

$$P_{M2} = \underset{(7.57147)}{-8.70388} - \underset{(.208636)^{***}}{.426201X_{37}} - \underset{(.109044)^{***}}{.257639X_{13}} + \underset{(2.87778)^{***}}{7.37099X_{10}} - \underset{(.166642)^{***}}{.494853T}$$

$R^2 = .8471$ D.W. = 2.0685

Standard error of regression = .409043

Where:

P_{M2} = average F.O.B. price at the packer per carton of 12-3 lb. film bags of MacIntosh apples sold from regular storage, expressed in real terms (1967 dollars)

X_{37} = total regular storage holdings of MacIntosh as of November 1 (1000s bushels)

X_{13} = total utilized production of Eastern apples (pounds per capita)

X_{10} = per capita disposable income, expressed in real terms (1967 dollars)

T = trend variables

2. Jonathans

$$P_{J2} = \underset{(5.29873)***}{-24.1731} - \underset{(.0928913)***}{.427719X_{36}} + \underset{(.00536042)***}{.0152321X_2} + \underset{(1.97150)***}{12.0108X_{10}} - \underset{(.116632)***}{.818329T}$$

R^2 = .9138 D.W. = 2.1173

Standard error of regression = .289449

Where:

P_{J2} = average F.O.B. price at the packer per carton of 12-3 lb. film bags of Jonathan apples sold from regular storage, expressed in real terms (1967 dollars)

X_{36} = total regular storage holdings of Jonathan as of November 1 (bushels/1000 people)

X_6 = total fresh orange sales (boxes/1000 people)

X_{10} = per capita disposable income, expressed in real terms (1967 dollars)

T = trend variable

3. Red Delicious

$$P_{D3} = \underset{(4.73435)**}{-7.66657} - \underset{(.0730172)***}{.399583X_{38}} - \underset{(.0903015)}{.00282955X_2} + \underset{(1.97121)***}{5.95642X_{10}} - \underset{(.128814)***}{.440765T}$$

R^2 = .8880 D.W. = 1.8012

Standard error of regression = .300821

Where:

P_{D3} = average F.O.B. price at the packer per carton of 12-3 lb. film bags of Red Delicious sold from regular storage, expressed in real terms (1967 dollars)

X_{38} = total regular storage holdings of Red Delicious as of November 1 (bushels/1000 people)

X_2 = total utilized production of Washington apples (pounds per capita)

X_{10} = per capita disposable income, expressed in real terms (1967 dollars)

T = trend variable

B-3 Controlled Atmosphere Equation

1. MacIntosh

$$P_{M3} = \underset{(6.41833)}{-1.19220} - \underset{(.247481)***}{.593566X_{31}} - \underset{(.0724638)***}{.218690X_{13}} + \underset{(2.25223)***}{4.40060X_{10}} - \underset{(.112041)***}{.339139T}$$

R^2 = .8669 D.W. = 1.8950

Standard error of regression = .287434

Where:

P_{M3} = average F.O.B. price at the packer per carton 12-3 lb. film bags of MacIntosh apples sold from CA storage, expressed in real terms (1967 dollars)

X_{31} = controlled atmosphere holdings of MacIntosh as of November 1 (bushels/1000 people)

X_{13} = total utilized production of Eastern apples (pounds per capita)

X_{10} = per capita disposable income, expressed in real terms (1967 dollars)

T = trend variables

2. Jonathan

$$P_{J3} = \underset{(4.52067)***}{-13.2575} - \underset{(.153267)***}{.37751X_1} - \underset{(.367318)}{.597914X_{39}} + \underset{(.0978878)}{.126331X_{33}} + \underset{(1.61363)***}{8.04861X_{10}} - \underset{(.0865853)***}{.486193T}$$

$R^2 = .9467$ D.W. = 2.5886

Standard error of regression = .205804

Where:

P_{J3} = average F.O.B. price at the packer per carton of 12-3 lb. film bag of Jonathans sold from CA storage, expressed in real terms (1967 dollars)

X_1 = total utilized production of Michigan apples (pounds per capita)

X_{39} = total utilized production of Midwestern apples (pounds per capita)

X_{33} = quantity index of non-citrus fruits for fresh utilization (tons/1000 people)

X_{10} = per capita disposable income, expressed in real terms (1967 dollars)

T = trend variable

3. Red Delicious

$$P_{D3} = \underset{(4.24605)}{-4.29812} - \underset{(.0705640)***}{.307433X_{32}} - \underset{(.0392506)***}{.0831700X_4} + \underset{(1.63613)***}{4.84267X_{10}} - \underset{(.101835)***}{.245160T}$$

$R^2 = .4032$ D.W. = 2.4043

Standard error of regression = .236345

Where:

P_{D3} = average F.O.B. price at the packer per carton of 12-3 lb. film bags of Red Delicious sold from CA storage, expressed in real terms (1967 dollars)

X_{32} = CA storage holdings of Red Delicious as of November 1 (bushels/1000 people)

X_4 = total utilized production all other states (pounds per capita)

X_{10} = per capita disposable income, expressed in real terms (1967 dollars)

T = trend variable

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