INTRASEASONAL DEMAND FOR ARIZONA LETTUCE

by

Daniel W. Mathews

A Thesis Submitted to the Faculty of the

DEPARTMENT OF AGRICULTURAL ECONOMICS

In Partial Fulfillment of the Requirements
For the Degree of

MASTER OF SCIENCE

In the Graduate College

THE UNIVERSITY OF ARIZONA

1 9 6 9

STATEMENT BY AUTHOR

This thesis has been submitted in partial fulfillment of requirements for an advanced degree at The University of Arizona and is deposited in the University Library to be made available to borrowers under rules of the Library.

Brief quotations from this thesis are allowable without special permission, provided that accurate acknowledgment of source is made. Requests for permission for extended quotation from or reproduction of this manuscript in whole or in part may be granted by the head of the major department or the Dean of the Graduate College when in his judgment the proposed use of the material is in the interests of scholarship. In all other instances, however, permission must be obtained from the author.

SIGNED: Daniel W. Mathews

APPROVAL BY THESIS DIRECTOR

This thesis has been approved on the date shown below:

Robert S. Firch — November 1, 1968

Robert S. Firch
Associate Professor,
Agricultural Economics

Date

ACKNOWLEDGMENTS

The author wishes to express his appreciation to Dr. Robert S. Firch for his assistance and guidance during the thesis program.

Gratitude is also expressed to Dr. Roger W. Fox and Dr. Robert A. Young for their time and suggestions in the final stages of preparation.

The author is also indebted to Mr. J. C. Keller, Market Reporter of the Federal-State Market News Service in Phoenix, and to Mr. David M. Vaughn, Market Reporter of the Federal-State Market News Service in Yuma, for their time and assistance in providing historical data on lettuce shipments and prices.

Acknowledgment is due, also, to the typing and clerical staff of the Agricultural Economics Department of The University of Arizona for the assistance and time they have provided in preparation of this thesis.

And finally, I am grateful to my wife, Janice, for the many hours spent in editing and typing the early drafts of this thesis.

TABLE OF CONTENTS

TABLE OF CONTENTS--Continued

LIST OF TABLES

<u>Appendix Tables</u>

LIST OF TABLES--Continued

LIST OF ILLUSTRATIONS

LIST OF ILLUSTRATIONS--Continued

ABSTRACT

The western lettuce industry is the major supplier of commercial lettuce in the United States. Lettuce is shipped from this area throughout the calendar year. The western lettuce industry's shipping season in total consists of a cyclical pattern of shipping districts entering and exiting from production. Over time, the various competing districts have had shifts in their individual shipping seasons. A descriptive graphic analysis is made of the shipping patterns of the major districts to determine the extent of these shifts.

Regression analysis of the demand for Arizona lettuce was based on weekly observations of average shipping point prices and total weekly shipments. Due to the nature of the commodity, single equation models are felt to be appropriate. The resulting statistical equations have significant regression coefficients for quantity and income variables. These are, however, of little value as predicting equations because of high values of the standard error of estimate and low values for the multiple coefficients of determination.

An excess demand model has been formulated to analyze the intraseasonal demand for Arizona lettuce. This model represents a comparative static analysis of the excess demand facing a district as it moves through a shipping season. Regression analysis in sets of four-week and two-week time periods was made of the intraseasonal excess demand for Arizona lettuce. The statistical results support the formulated model.

A variance analysis of weekly Arizona lettuce price indicates a high weekly price variance. A high proportion of the weekly price variance cannot be explained by the variance and/or covariance of weekly lettuce shipments.

CHAPTER I

INTRODUCTION

Organization and Objectives

The majority of the commercial lettuce production in the United States takes place in a four-state area consisting of California, Arizona, Texas and New Mexico. This four-state area (hereafter referred to as the western lettuce industry) has consistently accounted for over 85 percent of the total yearly United States commercially produced lettuce (Table 1).

This thesis presents the work and the findings of an analysis of the western lettuce industry. Specific emphasis is placed on the Arizona lettuce producing districts. The analysis consists of descriptive and graphic analyses of shifts in the seasonal shipping patterns of the major districts in the western lettuce industry. The demand for Arizona district lettuce is analyzed for the period 1948 through 1967, with the two major districts, central Arizona and Yuma, Arizona, being analyzed separately. Weekly average prices and weekly quantity data are analyzed for each district.

Shifts in the seasonal shipping patterns of the major districts in the western lettuce industry have been previously investigated by Hillman (1955). The analysis of shifts in this report will be similar to the work by Hillman, but will use thousands of cartons rather than rail carloads as the unit of measure for quantity of shipments. The use of carloads as a measure of quantity of lettuce shipped does not allow

Table 1. Percentage of United States Lettuce Production by Major Producing States.

Year	California	Arizona	Texas	New Mexico	Total Four States	Other Districts
1948	63.4	21.0	1.3	.1	85.9	14.1
1949	63.9	20.7	1.6	.2	86.4	13.6
1950	63.4	19.3	3.7	.2	86.6	13.4
1951	60.4	21.7	3.5	.2	85.8	14.2
1952	62.9	17.9	4.4	.4	85.6	14.4
1953	63.3	17.3	4.6	.5	85.7	14.3
1954	62.3	16.4	6.6	.3	85.7	14.3
1955	64.3	18.0	5.6	.4	88.4	11.6
1956	61.1	20.0	6.7	.4	88.2	11.8
1957	61.1	21.4	4.2	.8	87.5	12.5
1958	54.3	28.3	2.9	1.8	87.4	12.6
1959	57.8	26.8	2.2	1.1	88.0	12.0
1960	58.4	25.0	4.0	.8	88.2	11.8
1961	57.8	26.6	3.1	.6	88.1	11.9
1962	58.8	25.6	1.9	.6	86.9	13.1
1963	59.1	24.8	2.6	.8	87.4	12.6
1964	58.9	24.6	3.0	1.0	87.5	12.5
1965	58.3	24.5	2.8	1.9	87.6	12.4
1966	62.5	21.9	2.0	2.7	89.1	10.9
Low	54.3	16.4	1.3	.1	85.6	10.9
High	64.3	28.3	6.7	2.7	89.1	14.4
Average	60.6	22.2	3.5	.8	87.2	12.8

Source: Percentage computed from yearly shipment data taken from the Federal-State Market News Service, United States Department of Agriculture, Marketing Central and Eastern Arizona Lettuce, Brief Summary of Fall and Spring Season, Annual issues 1948-67, Phoenix, Arizona.

for the increased load capacity of trucks and railcars that has occurred over time. The use of thousands of cartons as a measure of quantity gives a more accurate picture of changes that have occurred over the period since 1948. Miklius (1966) used weekly quantity and average price data with quantity data in terms of carloads per week. Thus, he does not account for the change in per unit capacity of the carriers.

This thesis is organized in the following manner. The remainder of this chapter presents an outline of the objectives of the study and a description of the western lettuce industry. In the next chapter, the conceptual model used in the analysis of demand for lettuce is formulated. An analysis of the shifts in the shipping patterns of the major districts in the western lettuce industry is presented in the third chapter. An analysis of demand for the central Arizona district lettuce and for the Yuma district lettuce is presented in Chapter IV. Price variations for the central Arizona district and for the Yuma district are analyzed in Chapter V. A discussion of the total analysis and the resulting conclusions are presented in the final chapter.

The objectives of this thesis are:

1. To analyze the shifts in the seasonal shipping patterns of the major districts in the western lettuce industry.
2. To develop an economic model for analyzing the structure of demand for Arizona lettuce based on weekly average price and weekly shipment data.
3. To analyze the demand structure for Arizona lettuce for annual, seasonal and intraseasonal periods.

4. To examine the relationship between variations in Arizona price and variations in quantity of lettuce shipped.

The Western Lettuce Industry

Table 1 shows, by state, the portion of the United States lettuce shipments originating from the western lettuce industry for the period of the analysis. As can be seen, California is the largest shipper of lettuce in the western lettuce industry, followed by Arizona, Texas and New Mexico.

The California Districts

California has three major lettuce producing districts, the Salinas-Watsonville district, the Imperial Valley district, and the southern California district. (See Figure 1 for the locations.) For the period 1948-66, an average of 60 percent of the lettuce shipments in the United States originated in California.

The Salinas-Watsonville district is the dominant shipper of lettuce in the United States during the summer season. Lettuce is shipped from this district for the months of April through November. During the summer season, shipments of lettuce from states other than those of the western lettuce industry are the main competition to lettuce shipments from the Salinas-Watsonville district. At the start and at the end of the shipping season for the Salinas-Watsonville district, shipments from the central Arizona district and the southern California district represent the main competition.

The Imperial Valley district is the major shipper of lettuce during the winter season. The shipping season for the Imperial Valley

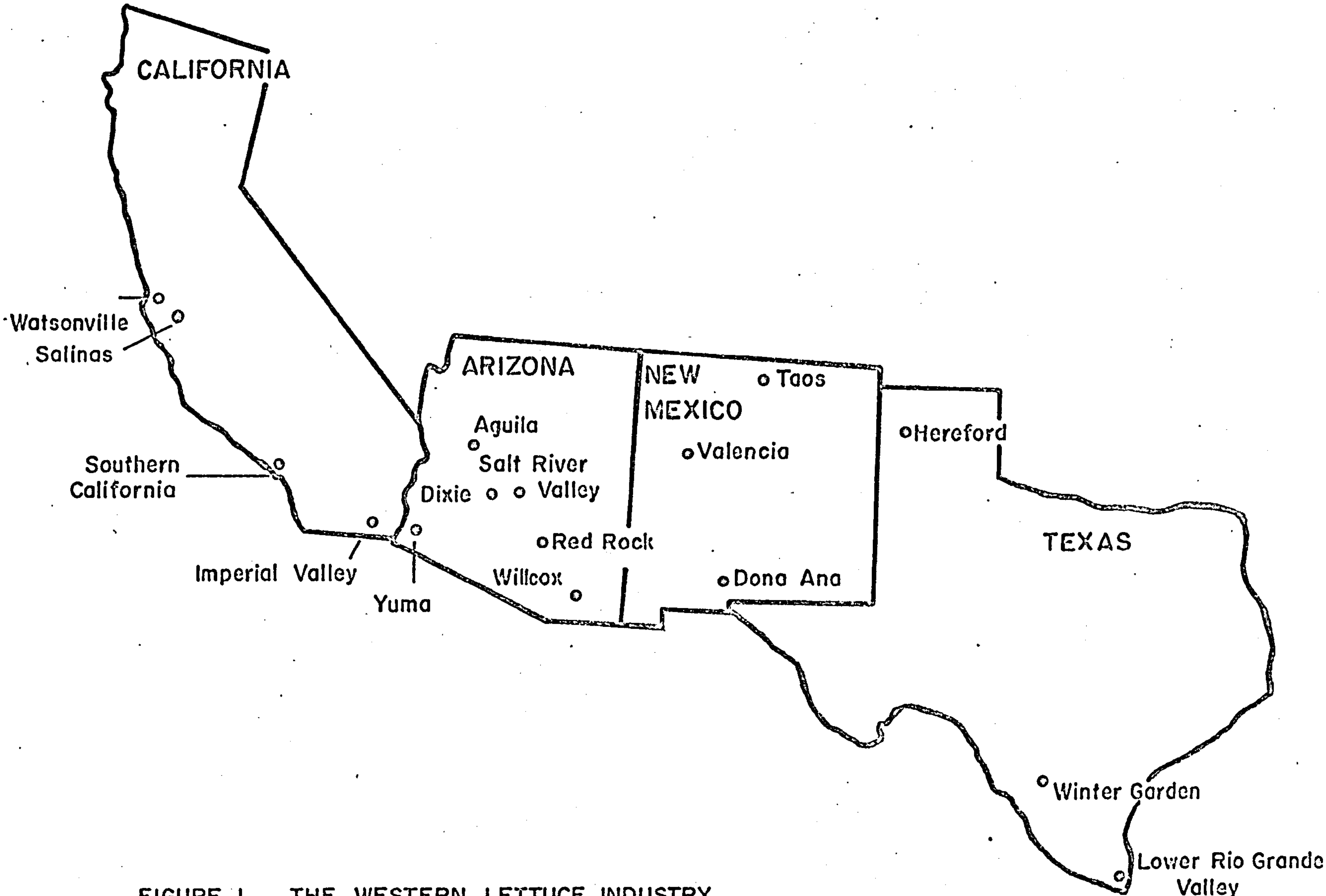


FIGURE I THE WESTERN LETTUCE INDUSTRY

district starts in the early weeks of December and extends into the month of April. Lettuce from the Imperial Valley district is in competition with that of the Yuma district and the Texas district during the middle of the winter season. At the start and at the end of the shipping season for the Imperial Valley district, lettuce shipments from the southern California district and the central Arizona district compete with lettuce shipments from the Imperial Valley district.

The southern California district has two distinct shipping periods, late fall season (November through December) and early spring season (March through May). The main competition is from shipments from the central Arizona district, the Imperial Valley district and the Yuma district.

The Arizona Districts

Arizona is second to California in the total amount of lettuce shipped for the period of the analysis. Arizona lettuce shipments account for an average of 22 percent of the lettuce shipments in the United States for the years 1948 through 1966 (Table 1). Arizona is divided into two major shipping districts, the central Arizona district and the Yuma district. (See Figure 1 for the locations.)

The central Arizona district encompasses all the lettuce shipping areas in Arizona excluding the Yuma district, but it contains several fairly distinct subdistricts. Lettuce is shipped from the central Arizona district in two distinct seasons. The fall season starts in September and extends through the month of December. The spring season starts in the first week of March and extends into July.

The fall shipping season starts in the Willcox subdistrict and then moves into the Aguila, Salt River Valley, Dixie and Red Rock subdistricts. During the spring season, this sequence is reversed. The Salt River Valley subdistrict is the oldest lettuce shipping subdistrict in Arizona and accounts for the largest amount of lettuce shipped each year. Table 2 shows the relative proportions of lettuce shipped from Arizona by each subdistrict for the years 1958 through 1967.

In the middle of its shipping season, lettuce shipments from the central Arizona district are in direct competition with those of the New Mexico, southern California and Texas districts. Lettuce shipped from the Yuma district and the Imperial Valley district competes with the shipments from the central Arizona district at the end of the fall season and at the start of the spring season. Lettuce shipments from the Salinas-Watsonville district compete with those of the central Arizona district at the start of the fall season and at the end of the spring season.

The Yuma district is second only to the Imperial Valley district as a shipper of lettuce during the winter season. The shipping season for the Yuma district starts in the first week of November and extends through the month of April. Lettuce shipped from the Yuma district is in direct competition with shipments from the Imperial Valley district and the Texas district. At the start and at the end of the shipping season for the Yuma district, lettuce shipments from the central Arizona district and the southern California district compete with those of the Yuma district.

Table 2. Seasonal Shipments of Central Arizona District Lettuce, in Thousands of Cartons, by Each Major Production Area (1958-67).

	Aguila		Salt River Valley		Dixie[a]		Red Rock		Willcox	
Year	Fall	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall	Spring
1958	718	1,832	5,218	7,914					298	1,104
1959	1,104	1,948	5,523	7,135					1,462	1,020
1960	2,009	2,222	4,870	7,026					1,356	1,260
1961	1,696	2,100	5,332	7,289					1,215	1,052
1962	1,697	1,313	4,186	4,788	990	1,254	654	966	1,289	1,089
1963	1,218	1,475	3,937	5,130	1,000	1,472	501	863	588	998
1964	1,058	739	3,574	4,580	631	1,248	628	776	968	814
1965	812	909	3,630	4,143	674	1,261	353	1,143	997	1,070
1966	531	218	4,330	3,800	802	836	1,054	1,081	887	775
1967	423	584	3,674	4,022	700	755	1,218	2,064	572	508

a. Shipments from Dixie and Red Rock were included in the Salt River Valley shipments prior to the 1962 season.

Source: Federal-State Market News Service, United States Department of Agriculture, Marketing Central and Eastern Arizona Lettuce, Brief Summary of Fall and Spring Season, annual issues 1948-67, Phoenix, Arizona.

The Texas Districts

Texas lettuce shipments originate from three relatively small subdistricts: the Hereford subdistrict, shipping during the late fall and early spring season; the Winter Garden subdistrict, shipping during the early weeks of the winter season; and the lower Rio Grande Valley subdistrict, shipping throughout the winter season. (See Figure 1 for the location of districts.) Total Texas shipments are quite small when compared to those of Arizona and California. For the years 1948 through 1966, lettuce shipments from the Texas districts averaged slightly more than three percent of shipments in the United States (Table 1).

The New Mexico Districts

New Mexico accounts for only a small portion of the total shipments in the United States. The average is less than one percent of the total shipments (Table 1). Production of lettuce is scattered through New Mexico with 91 percent (James, 1963) being produced in the three counties of Dona Ana, Valencia and Taos. (See Figure 1 for locations.) Shipments originate from the New Mexico district in the fall season during the months of October and November and in the spring season during the months of May and June.

Other Districts

In the 1966-67 season, 18 states, other than those of the western lettuce industry, reported commercial lettuce shipments. Colorado, Florida and New York are the three largest shippers of this group. Lettuce is shipped from at least 1 of the 18 states throughout the year except during the winter season. Table 1 shows that this category, on the average, accounts for over 12 percent of total lettuce shipments in the United States for the years 1948 through 1966.

CHAPTER II

CONCEPTUAL MODELS AND DATA PREPARATION

Farm Level Demand

The farm level demand should be thought of as being derived from the demand at the consumer level. This relationship, as stated by Thomsen (1951), is "The demand for products at the farm end of the marketing system consists of consumer demand (i.e., prices which consumers will pay for different quantities) minus a schedule of marketing charges (i.e., per unit marketing margins associated with different quantities marketed)." These marketing margins can affect the relationship between the farm level demand and consumer demand in different ways.

If the market charge is a fixed per unit rate, independent of the price paid by consumers or the quantity demanded, then the derived farm demand curve would be parallel to and below that of the consumer demand curve. This is illustrated in Figure 2. The consumer demand (D_c) and the farm level demand (D_f) are in the upper diagram, and marketing charge is represented by the horizontal line in the lower diagram. A movement from the consumer demand curve to that of the farm level demand curve (point a to point b) would result in a lower price ($P_c > P_f$) for given quantity (Q_1). Thus, as is illustrated by the following equations, the price elasticity for the farm level demand curve would be less than that of the consumer level demand curve.

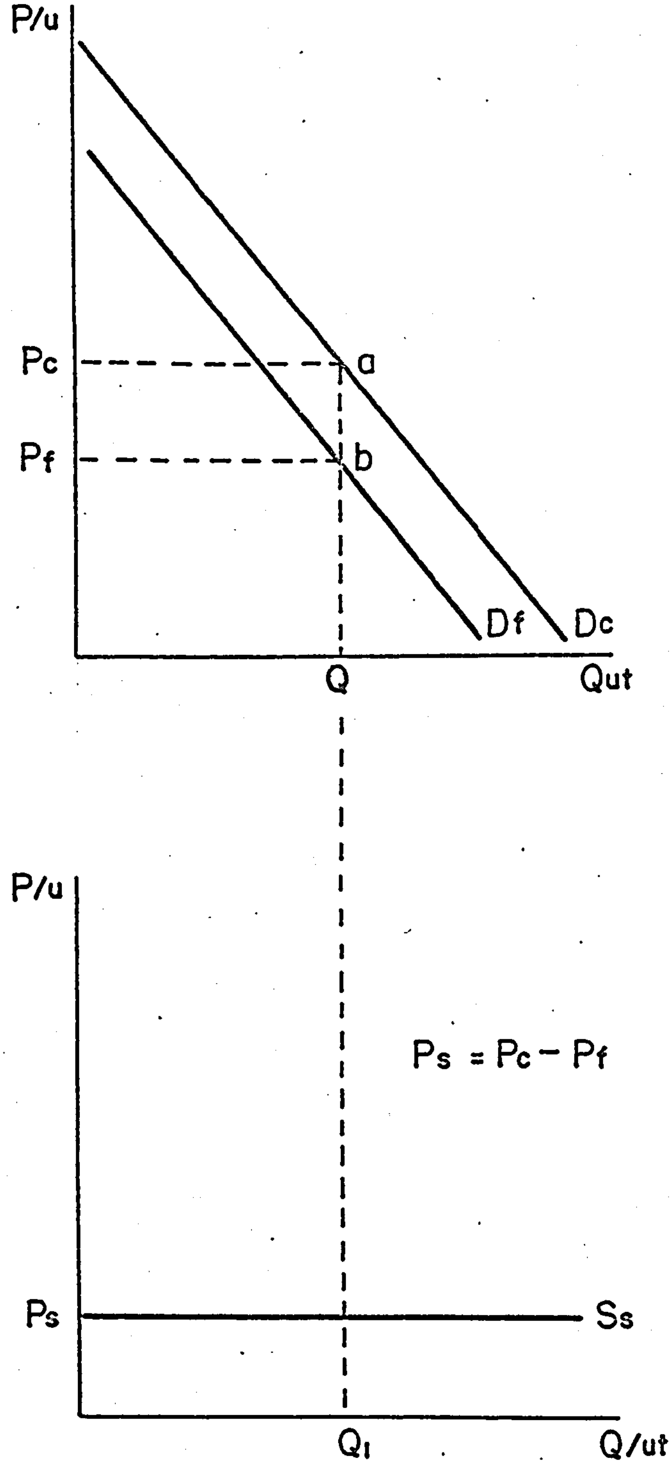


FIGURE 2 DERIVED DEMAND —CONSTANT MARKUP MARKET CHARGE

$$\text{Price } P_c > \text{Price } P_f$$

$$\Delta Q/\Delta P \text{ of } D_c = \Delta Q/\Delta P \text{ of } D_f$$

$$\text{Quantity } Q_1 \text{ is constant}$$

$$\text{Price Elasticity } (E_D) = \Delta Q/\Delta P \cdot P/Q$$

$$\therefore \left|E_{D_c}\right| > \left|E_{D_f}\right|$$

In the case of an increasing per unit markup, the farm level demand curve would be related to the consumer level demand curve as is illustrated in Figure 3. A movement from the consumer demand curve to the farm level demand curve (point a to point b) would result in a lower price ($P_c > P_f$) for the given quantity (Q_1) and a decrease in the slope ($\Delta Q/\Delta P$). Thus, as illustrated by the following equations, the price elasticity of the farm level demand curve would be less than that of the consumer level demand curve.

$$\text{Price } P_c > \text{Price } P_f$$

$$\Delta Q/\Delta P \text{ of } D_c > \Delta Q/\Delta P \text{ of } D_f$$

$$\text{Quantity } Q_1 \text{ is constant}$$

$$\text{Price Elasticity } (E_D) = \Delta Q/\Delta P \cdot P/Q$$

$$\therefore \left|E_{D_c}\right| > \left|E_{D_f}\right|$$

In the case of percentage markup, either of the elasticities may be larger than the other. If the market charge per unit is a constant percentage of the retail price, the farm level demand curve would have a slope more nearly horizontal than the consumer demand curve. The relative elasticities at points such as point (a) and point (b) in Figure 4 depend upon whether the proportionate change in the slope is greater or less than the proportionate change in the ratio (P/Q).

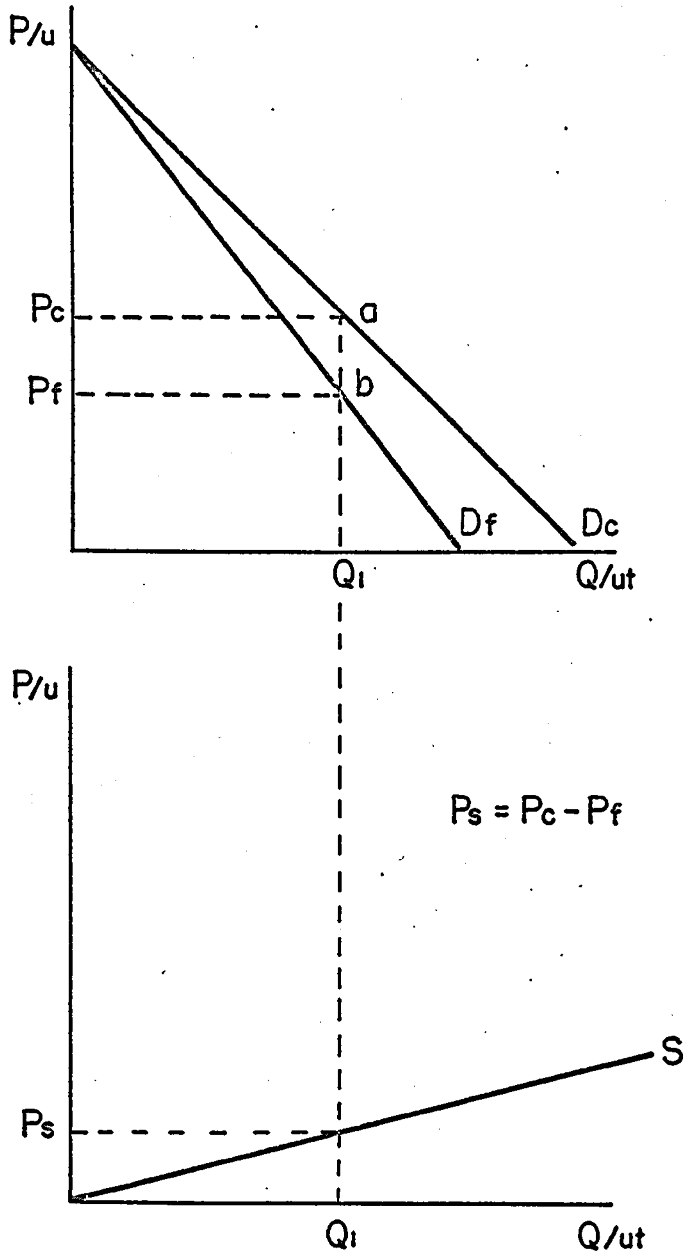


FIGURE 3 DERIVED DEMAND—INCREASING MARKUP MARKET CHARGE

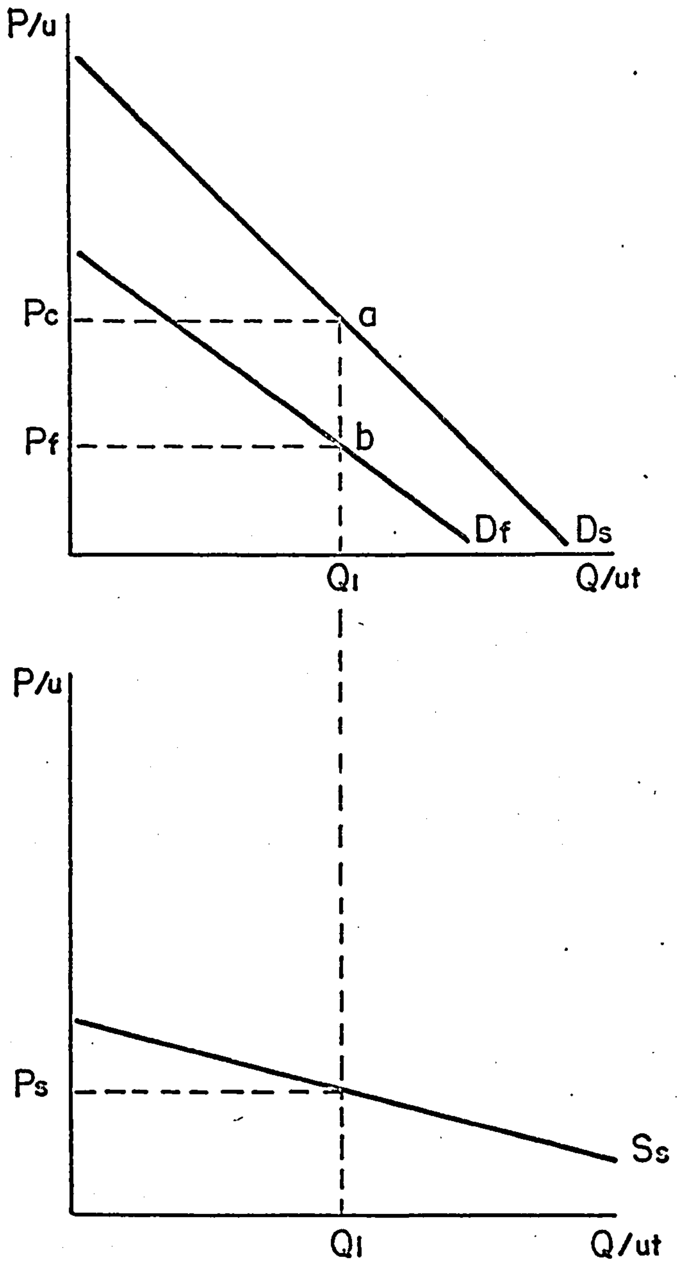


FIGURE 4 DERIVED DEMAND — PERCENTAGE MARKUP MARKET CHARGE

These relationships between the demand elasticities at farm level and consumer level are valid only under the assumptions of linear demand at farm and consumer levels.

Waugh (1964) indicates that many studies on farm products show that the market charge is not of any one type but a combination. This would seem to be consistent with the types of charges for various marketing services performed on lettuce as it moves from the farm to the final consumer. The total market charge separating farm level demand from that of consumer level demand for lettuce is a combination of harvesting, packaging, transportation, brokerage, wholesaling and retailing costs.

The harvesting cost can be considered an increasing cost function. This is dependent upon the available supply of lettuce. If marketable lettuce is in short supply, the available fields of lettuce will receive several cuttings. This will involve higher per unit cost as the field density decreases.

Transportation and packaging cost for the shipper of lettuce is usually considered to be fixed per unit. In the case of large volume shipments, certain economies can be gained by the use of the extra large refrigerator car. Railroads offer per unit price reduction as inducements to use the large volume refrigerator cars.

Costs resulting from brokerage and wholesaling activities can be a combination of different types of market charges, depending upon the policy of the particular firm. Constant percentage markups are common for fresh produce at the retail level.

Shifts in Demand

In the use of time series data for estimation of demand for a commodity, shifts can occur in the demand function. To arrive at a good estimate of demand, these shifts have to be taken into account. In this analysis, two types of shift variables are considered.

Zero-One Variable

It is implicit in regression analysis that the structure generating the data is constant over the period of time covered by the data. In the use of time series data, a zero-one variable can be included in a regression analysis to allow for discrete changes in the structure. A significant regression coefficient for the zero-one variable implies a significant change in the structure from one period to another, but it is of little predictive value as it does not indicate the exact nature of the change.

Per Capita Disposable Income

The use of income as a demand shifter implies that a change in the level of per capita disposable income would result in a change in the quantity consumed, everything else remaining unchanged. The income effect upon consumption of a commodity can be classified as a positive relationship, a negative relationship or no relationship. The demand for fresh vegetables is generally considered to exhibit a positive relationship between changes in disposable income and changes in consumption. This relationship between income and consumption is illustrated in Figure 5. Demand curve (D_{I_1}) represents the demand for lettuce at income level (I_1). The income consumption curve (I_{P_1}) represents the consumption of lettuce

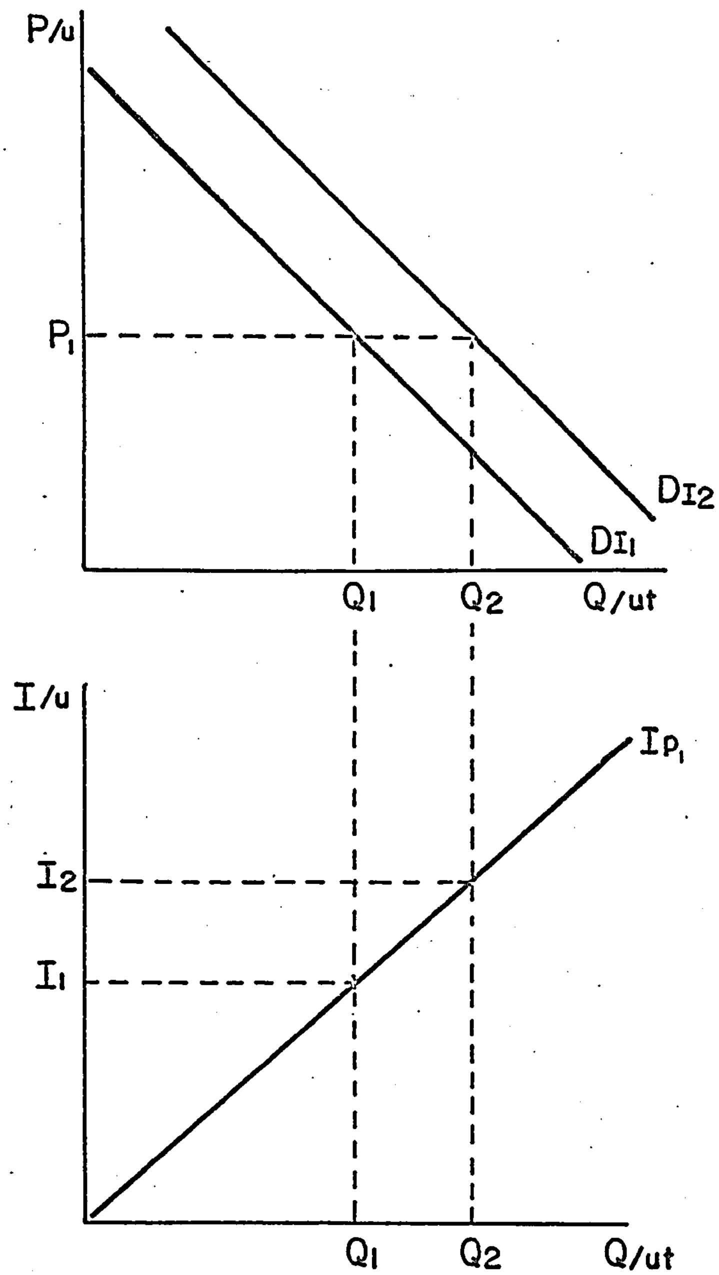


FIGURE 5 DEMAND — INCOME RELATIONSHIP

at price (P_1). Holding price at (P_1), an increase in the level of income to (I_2), would result in a shift in the demand curve to (D_{I_2}). Thus, a larger quantity is consumed at price (P_1). The income elasticity of demand is defined by the following equation:

$$E_I = \Delta Q/\Delta I \cdot I/Q$$

In Figure 5, a movement from income level (I_1) to (I_2) holding price at (P_1) results in:

$$\uparrow\Delta Q \uparrow\Delta I$$

$$I_2 > I_1$$

$$Q_2 > Q_1$$

$$\therefore E_I > 0$$

In this analysis, the demand equation is of the following general form:

$$P = bo + bqQ + biI + e$$

The income regression coefficient (bi) is the change in price as a result of a change in income. In order to estimate the income elasticity coefficient, the following equation is used:

$$\hat{E}_I = (-)\ bi/bq \cdot \overline{I}/\overline{Q}$$

This relationship is illustrated in Figure 6. Demand curve (D_{I_1}) represents the relationship between the price of lettuce and the quantity of lettuce. The price-income curve (PI) represents the relationship between the price of lettuce and per capita income. The regression technique with price as the dependent variable holds quantity consumed constant at (Q_1) and an increase in the level of income from (I_1) to (I_2) results in a shift outward of the demand curve (D_{I_1}) to curve (D_{I_2}) and

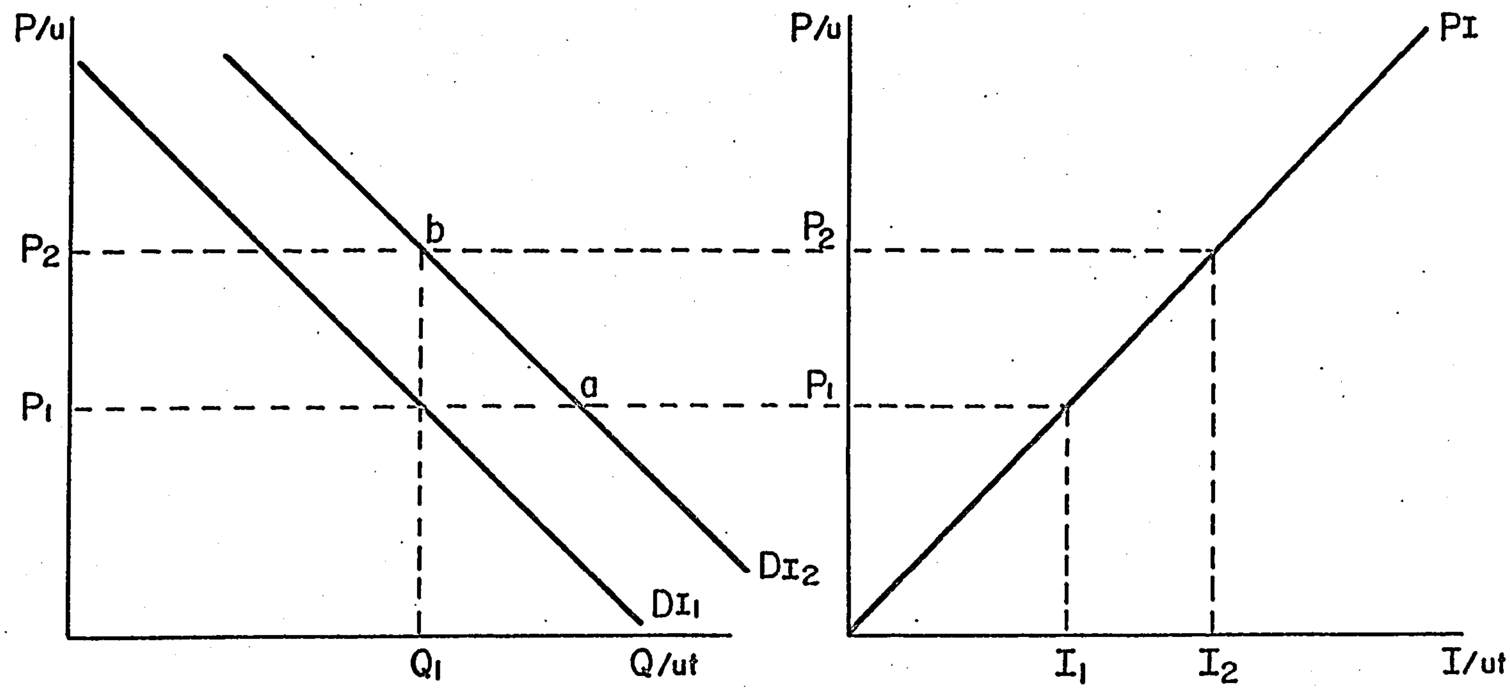


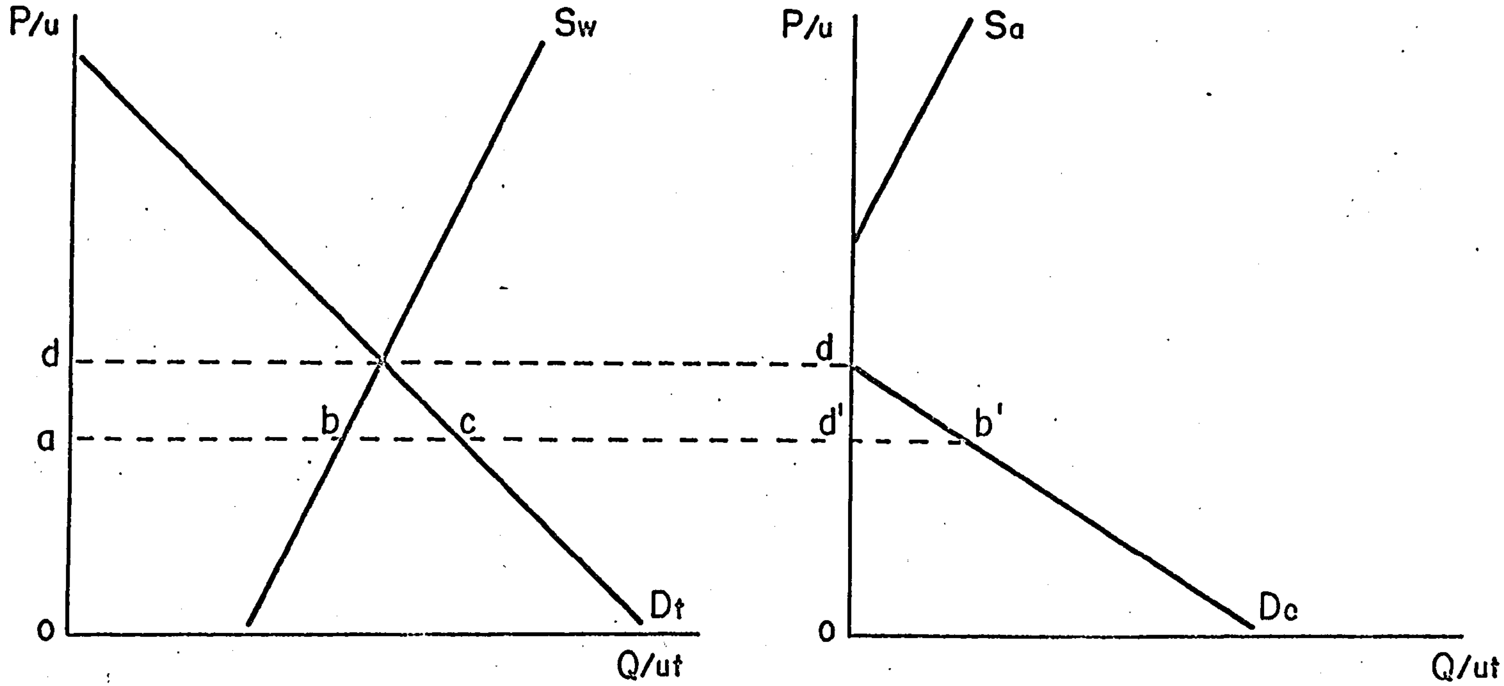
FIGURE 6 INCOME - PRICE EQUATION RELATIONSHIP

a price increase from (P_1) to (P_2). But, the income elasticity of demand concerns the change in quantity taken in relation to a change in income while holding price constant. The necessary transformation is equivalent to a movement from point (b) to point (a) in Figure 6. The mathematical equivalent of this transformation is the ratio (bi/bq).

Excess Demand

The total market demand for lettuce is a concept showing the aggregate demands of all buyers in the entire market. This is the demand that faces the entire lettuce production industry. The relevant demand facing any one district is the total market demand less the quantity supplied by other districts at each price. This concept is known as excess demand.

The derivation of excess demand may be illustrated through the use of Figure 7. Total market demand is represented by (D_t), while (S_w) represents the quantity of lettuce supplied at each price by the Salinas-Watsonville district. Demand curve (D_e) is the excess demand curve facing the central Arizona district and (S_a) represents the lettuce supplied at each price by the central Arizona district. The horizontal difference between (D_t) and (S_w) at each price gives the excess demand at that price. The following example illustrates the derivation of excess demand. At price (oa), the total quantity demanded is (ac); the quantity supplied by the Salinas-Watsonville district is (ab); resulting in a horizontal difference of line (bc). Horizontal line (bc) is equal to line (a'b'); thus, the horizontal difference between (S_w) and (D_t) is equal to excess demand.



Salinas - Watsonville District

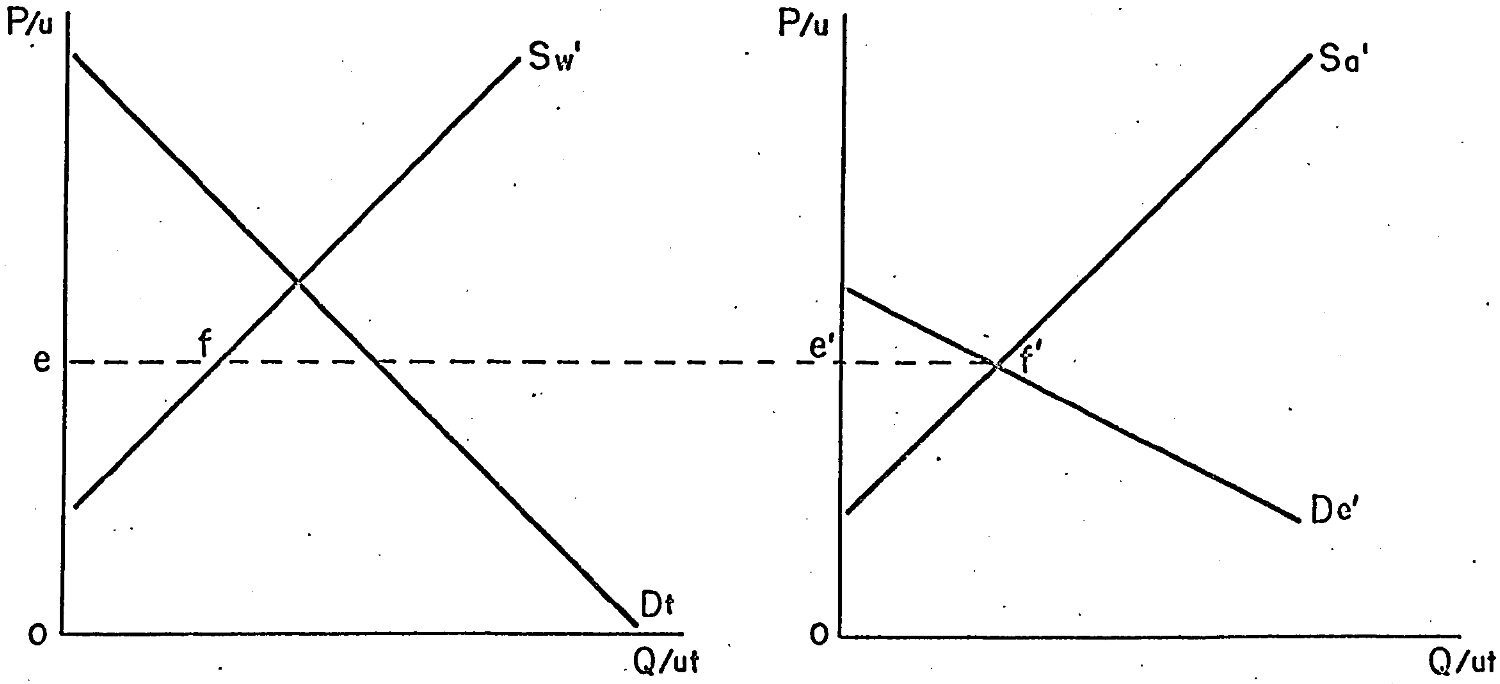
Central Arizona District

FIGURE 7 EXCESS DEMAND FOR SEPTEMBER

In the western lettuce industry, over a period of time, each district has established a definite shipping season. As has been indicated in Chapter I, a crop year, in total, consists of a cyclical pattern of districts entering and exiting from production. Figures 7, 8 and 9 illustrate the entering and exiting of districts and show how the model of excess demand can be used to understand this behavior. To expedite the analysis, the following assumptions are made:.

1. The total market demand for lettuce is linear and unchanged over time.
2. The supply of lettuce by all districts is assumed to be linear and predetermined (that is, the quantity of lettuce supplied for any one period is determined prior to that period).
3. The lettuce supplied is of homogeneous size and quality.
4. The total market demand curve (D_t) and the supply curves (S_w and S_a) are assumed to be predetermined.

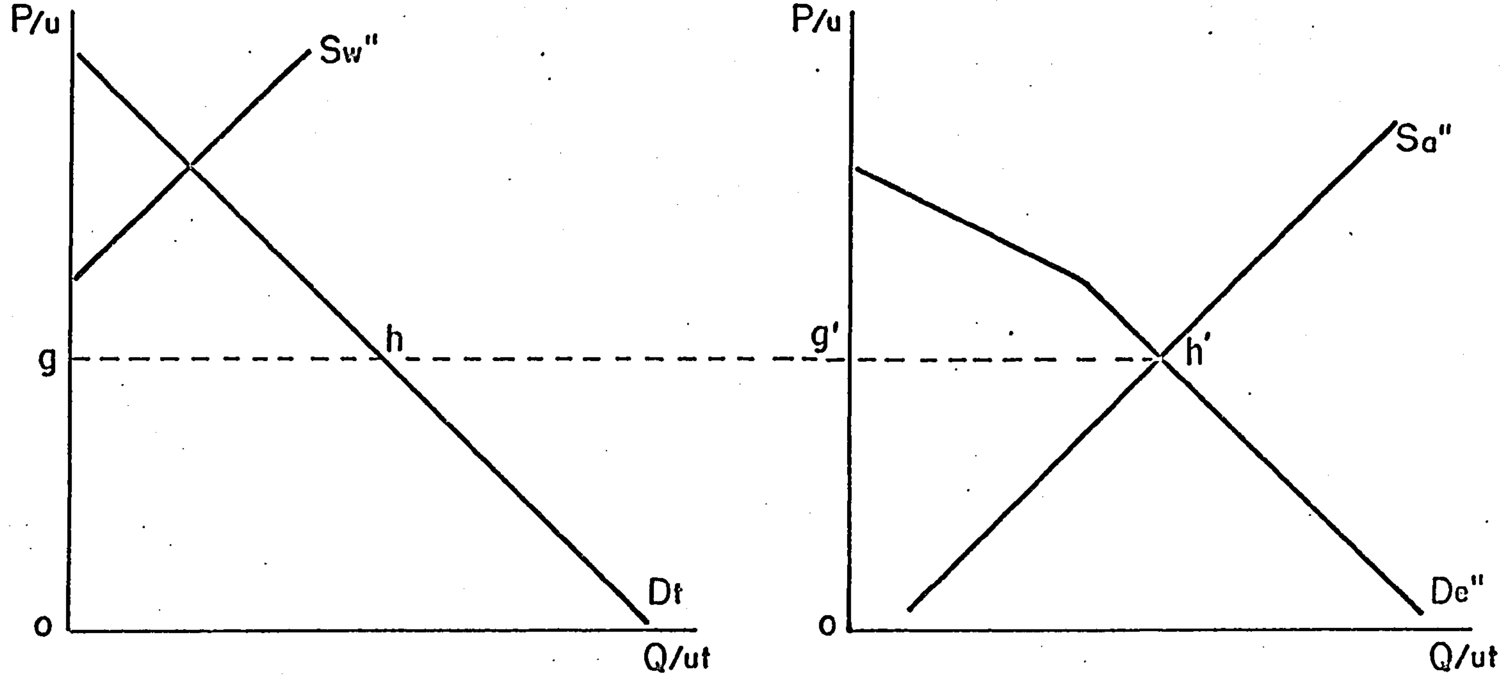
Figure 7 illustrates the situation in the western lettuce industry as found in the month of September. The Salinas-Watsonville district is the major shipper of lettuce during this month. Supply curve (S_w) represents the September supply of lettuce by the Salinas-Watsonville district and all other districts excluding the central Arizona district. The position of curve (S_a) indicates that because of environmental factors, producers in the central Arizona district cannot produce any lettuce that will be ready for market in September at a cost per unit that is lower than the price at which the Salinas-Watsonville district will produce the entire market equilibrium quantity. The excess demand curve (D_e) does not intersect the supply (S_a) at any positive quantity.



Salinas-Watsonville District

Central Arizona District

FIGURE 8 EXCESS DEMAND FOR OCTOBER



Salinas-Watsonville District

Central Arizona District

FIGURE 9 EXCESS DEMAND FOR NOVEMBER

Figure 8 illustrates the transitional period in which the central Arizona district is entering production and the Salinas-Watsonville district is exiting. Changes in the environmental condition of the two districts from September to October have caused the supply curve (S_w') to shift up and the supply curve (S_a') to shift down. For the central Arizona district, the shift of (S_w') causes the September excess demand curve (D_e) to shift to the right to a new position (D_e') in October. The new equilibrium finds both districts supplying lettuce at the equilibrium price.

Figure 9 represents the situation in the month of November. Changes in the environment of the two districts from October to November have caused the supply curve (S_w") to shift farther up and the supply curve (S_a") to shift farther down. For the central Arizona district, the shift of curve (S_w) causes the excess demand curve (D_e) to continue to shift to the right to position (D_e"). The new equilibrium finds the central Arizona district supplying the entire equilibrium quantity in November.

The sequence of shifts in the supply curve and excess demand curves outlined in the previous discussion is repeated as the various districts enter and exit during the complete cycle of a calendar year. As a district exits from production, a reverse of the sequence, starting with Figure 9, occurs.

The price elasticity of the excess demand curve will usually exceed that of the total demand curve for any specific price as long as more than one region is shipping lettuce at that price. Referring to Figure 7, the relationship between the price elasticity of the total demand curve (D_t) and that of the excess demand curve (D_e) can be compared at price (oa). A movement from point (b') on curve (D_e) to point (c) on curve (D_t) results in the following relationship:

$$\text{Price oa} = \text{Price oa}'$$

$$\Delta Q/\Delta P \text{ of } D_t < \Delta Q/\Delta P \text{ of } D_e$$

$$\text{Quantity a'b'} < \text{Quantity ac}$$

$$\text{Price elasticity } (E_D) = \Delta Q/\Delta P \cdot P/Q$$

$$\therefore \left|E_{D_t}\right| < \left|E_{D_e}\right|$$

The relative price elasticities of the excess demand curve derived in Figures 8 and 9 may be shown through the following example. At price (oe') and (og') on Figures 8 and 9, respectively, a movement from point (f') on curve (D_e') to point (h') on curve (D_e") results in the following relationship:

$$\text{Price oe}' = \text{Price og}'$$

$$\Delta Q/\Delta P \text{ of } D_e' > \Delta Q/\Delta P \text{ of } D_e''$$

$$\text{Quantity g'h'} > \text{Quantity e'f'}$$

$$\text{Price elasticity } (E_D) = \Delta Q/\Delta P \cdot P/Q$$

$$\therefore \left|E_{D_e}'\right| > \left|E_{D_e}''\right|$$

The price elasticity of demand for lettuce from any particular district, as measured on the excess demand curve, would exceed that of the total demand curve for lettuce at each price while other areas are supplying significant quantities of lettuce to the market. Therefore, it is to be expected that the effective price elasticity of demand for a particular district will decline as its share of the market increases, and the price elasticity of demand would increase as its share of the market declined near the end of its season.

Applicability of Single Equation Least-Squares Analysis to Demand for Lettuce

Unbiased estimates of the structural coefficients of demand may be obtained through the use of the single equation least-squares analysis if the commodity satisfies certain conditions. Fox (1953) set forth these conditions as:

1. The supply of the crop must not be affected by current price.
2. The consumption of the crop must be determined by current production.
3. A change in the price and/or consumption of the commodity must not have a significant effect upon consumer income.
4. The price of the commodity must not have a significant effect upon the supply of any other commodity.
5. The commodity must not have more than one major outlet.

If the commodity does not conform to these conditions, the simultaneous multi-equation technique should be used.

Lettuce has a basic demand and price structure as illustrated in Figure 10. The components of this diagram and their compatibility with the conditions previously outlined are discussed in the following paragraphs.

Supply

Supply of lettuce is determined by harvested acreage and yield per acre. Yields vary from year to year because of weather during the growing season, damage from disease and insects, and other noneconomic factors. Favorable price expectations may induce improved cultural practices that would limit the effects of these factors, thus limiting

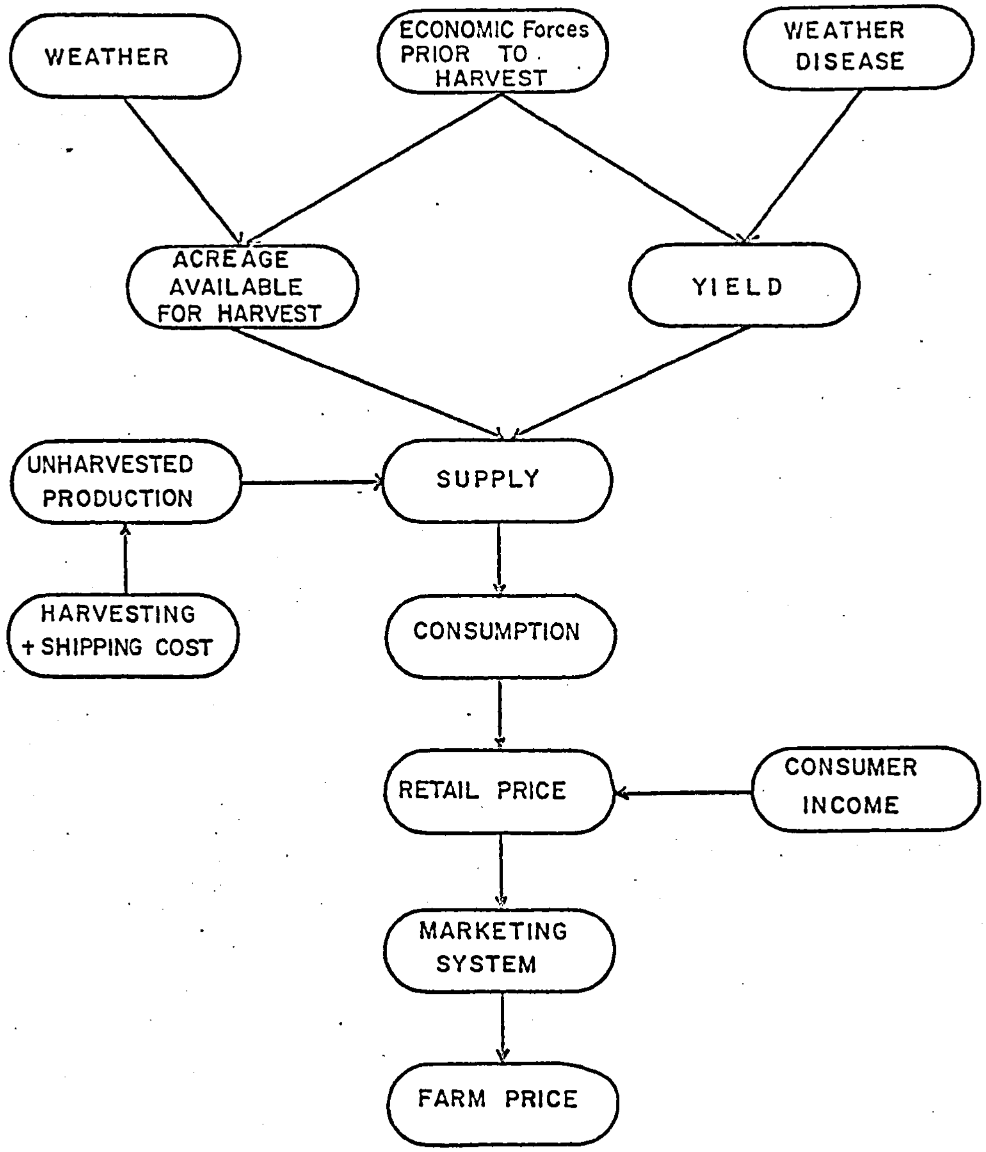


FIGURE 10 DEMAND AND PRICE STRUCTURE FOR COMMERCIAL LETTUCE

SOURCE — U.S.D.A. TECHNICAL BULLETIN NO. 1105, p.18

their effect upon supply. Acreage planted to lettuce is influenced by past and anticipated prices, weather during the planting season, past and anticipated prices of alternative crops, and yield of lettuce in recent years. The decision on the amount to plant is made by producers prior to the production season.

In this analysis, production has been treated as predetermined and as a variable that influences other variables in the lettuce demanded structure but is not influenced by them. This is compatible with Fox's (1953) first condition for the unbiased estimate of the structural coefficients through the use of the single equation least-squares regression analysis.

Because the basic data for the analysis are weekly prices and shipments, it can be safely assumed that quantity is more nearly predetermined and price a function of quantity. The dependent variable in this analysis is the farm level price for a carton containing two dozen heads of lettuce.

Consumption

The consumption of lettuce is equal to shipments except for a small percent that is lost through spoilage. Shuffett (1954) states that the amount lost, due to spoilage, tends to be fairly stable from year to year as a percent of the crop. Once lettuce is harvested, it must be moved rapidly to the final consumer to prevent spoilage. The quantity consumed is, in fact, closely determined by harvested production; therefore, the second condition for the use of the single equation least-squares regression analysis is satisfied.

Disposable Income

Disposable consumer income is treated as predetermined in this analysis. Disposable income influences the price of lettuce as it measures the purchasing power of consumers at the retail level. Other things equal, the price of a specific quantity of lettuce would be expected to vary directly with the level of consumer income. Fox (1953) states in his article that changes in the supply and/or price of major farm commodities, such as grain and meat products, have only a two to three percent effect upon consumer disposable income. Since total farm income received from lettuce is much smaller than the total income from grain and meat products, it has been assumed that changes in the supply of lettuce would have no significant effect on disposable income. Therefore, the third condition for unbiased estimates of structural coefficients through the single equation least-squares regression analysis seems to be satisfied in the case of lettuce.

Other Commodities and Number of Market Outlets

The last two conditions for an unbiased estimate of the structural coefficients by single equation least-squares regression analysis are met because of the nature of lettuce and the time units in which price-quantity data are collected. Because of its very nature, lettuce is a product that is delivered to the consumer in only one form and is not adaptable to storage or transportation involving long periods of time; thus, there is only one significant outlet. Lettuce is considered to be a unique salad item that has only poor substitutes; thus, the price of lettuce would have little effect upon the supply of competing items.

A change in the weekly price of lettuce would have a very limited effect upon the supply of competing or complementary commodities. Other vegetable items, competing or complementary, have a supply response time that is determined by the length of their biological growth processes. Processed items, such as spices and salad dressings, have a supply response time limited by such things as the size of inventory stock and capacity of production and distribution facilities. A price change would have to cover a longer period than a week before it would have an effect on the decision of suppliers of related commodities.

Data

Price and shipment data are taken from the annual lettuce marketing summaries published by the Federal-State Market News Service offices at Phoenix (1948-67) and Yuma (1948-67). In order to facilitate the analysis, each week in each season is given a number. The numbering system is constructed so that December 25 always falls in the twentieth week of a season. These data are discussed in the following pages. Supplemental data dealing with per capita income, gross national product (GNP), implicit price index and population are presented in Appendix Table 1 with their sources.

Lettuce Price

Price data are taken from summary tables showing daily f.o.b. shipping point prices. Two price series are used, one showing central Arizona district prices and the other showing Yuma district prices. A simple average of daily quoted "mostly" prices has been computed for weekly prices. When a "mostly" price is not quoted, the average of the high-low range of prices is used. The price series used are those quoted for a crate containing four dozen heads of lettuce for the season 1947-48 through 1953-54, and for a carton containing two dozen heads of lettuce for the season 1954-55 through 1966-67. In order to make the price series comparable for the entire period from 1947-48 season through 1966-67 season, all weekly average prices for the season 1947-48 through 1953-54 are reduced by 50 percent. The rationale for this reduction is the relationship between the number of heads of lettuce per carton and the number of heads of lettuce per crate, 24 and 48, respectively.

Lettuce Shipments

Shipment data are in thousands of cartons per week. These data are computed from summary tables showing the number of railcars and trucks shipped per day, and tables showing seasonal production data for each district in crates or cartons shipped by each mode of transportation. Prior to the 1958-59 season, the shipment reports cover only railcar movements of lettuce.

As with the price data, production data prior to the 1953-54 season have to be adjusted to a carton basis. This is accomplished by increasing the quantity in crates 100 percent for the seasons 1947-48 through 1953-54.

Estimates of seasonal average cartons per rail carload and cartons per truck are computed by dividing seasonal production in cartons moved by each mode of shipment by the total seasonal shipments made in that mode. Estimates of the seasonal average cartons per rail carload and of cartons per truck have been computed for both of the major Arizona districts. For districts outside of Arizona, the estimates made for the central Arizona district are assumed to be representative. Appendix Table 2 presents the estimated average cartons per rail carload and cartons per truck for each year of the analysis.

To arrive at a figure showing weekly shipments of lettuce in cartons, the number of rail carloads and trucks shipped for each district are multiplied by each of their respective estimated seasonal average cartons per load.

Data Adjustments

Over time, the value of the dollar with respect to its purchasing power over goods and services has changed. To adjust for these changes, price data are deflated by the GNP implicit price index. The GNP implicit price index has been chosen as the appropriate deflator because it reflects changes in the purchasing power of the dollar with respect to all goods and services produced in the United States.

To allow for the changes in demand due to changes in population, weekly shipments of lettuce for the years 1948-67 are deflated by a yearly population index (1958 = 100).

Income data are on a per capita basis and were deflated by the consumer price index.

Data Limitations

Historical information on quality or size differences of lettuce shipped is not available. During a season, several classes[1] may be

1. During the 1966-67 season, different prices were quoted for size class 1½, 2 and 3 lettuce packs. These size classes represent 18, 24, and 36 heads of lettuce, respectively, packed in a standard nonbulge carton; dimensions are 10 3/4 x 16½ x 21½ inches.

shipped and quality can vary depending upon environmental and supply conditions. If the available and harvestable lettuce is in short supply, quality restrictions tend to be relaxed. The price series for size class 2, 24 heads of lettuce per carton, has been chosen because it has been the predominant pack.[2]

The lack of data on truck shipments prior to the 1958-59 season and the computational process through which weekly shipments in thousands of cartons are derived have resulted in a discrepancy between the annual total of the adjusted weekly shipment data and annual production. Appendix Table 3 shows the computed annual adjusted shipments and the actual annual production of lettuce for the central Arizona district and the Yuma district. A comparison of these series will give an idea of the discrepancy introduced in the computed data.

2. During the 1966-67 season, approximately 95.6 percent of the lettuce shipped from the central Arizona district was size class 2.

CHAPTER III

INTERREGIONAL AND INTERTEMPORAL SHIFTS IN THE PRODUCTION OF LETTUCE

Over a period of time, shifts in the seasonal shipping patterns of districts in the western lettuce industry have occurred. These shifts become apparent as one district begins shipping earlier or extends its season later while a competing district ends its season earlier or begins its shipping season later.

A succession of five-year periods are defined, starting with the 1937-38 season. The war years have been omitted, and the second period starts with the 1949-50 season. The last period, starting with the 1964-65 season, consists of only three years. Shifts are analyzed as to the date each incoming district surpasses a competing, outgoing district in weekly shipments. Hereafter, this will be termed a crossing date. Comparisons are drawn between periods to illustrate the shifts that have taken place in the western lettuce industry since the 1937-38 season. The average weekly shipments during each period for each district are expressed as a percent of the average annual shipments during the period, and are plotted by weeks and periods in Figures 11 to 14. Annual crossing dates between the major districts are presented in Table 3 along with the average crossing date for each period. The annual crossing dates are also plotted in Figure 15.

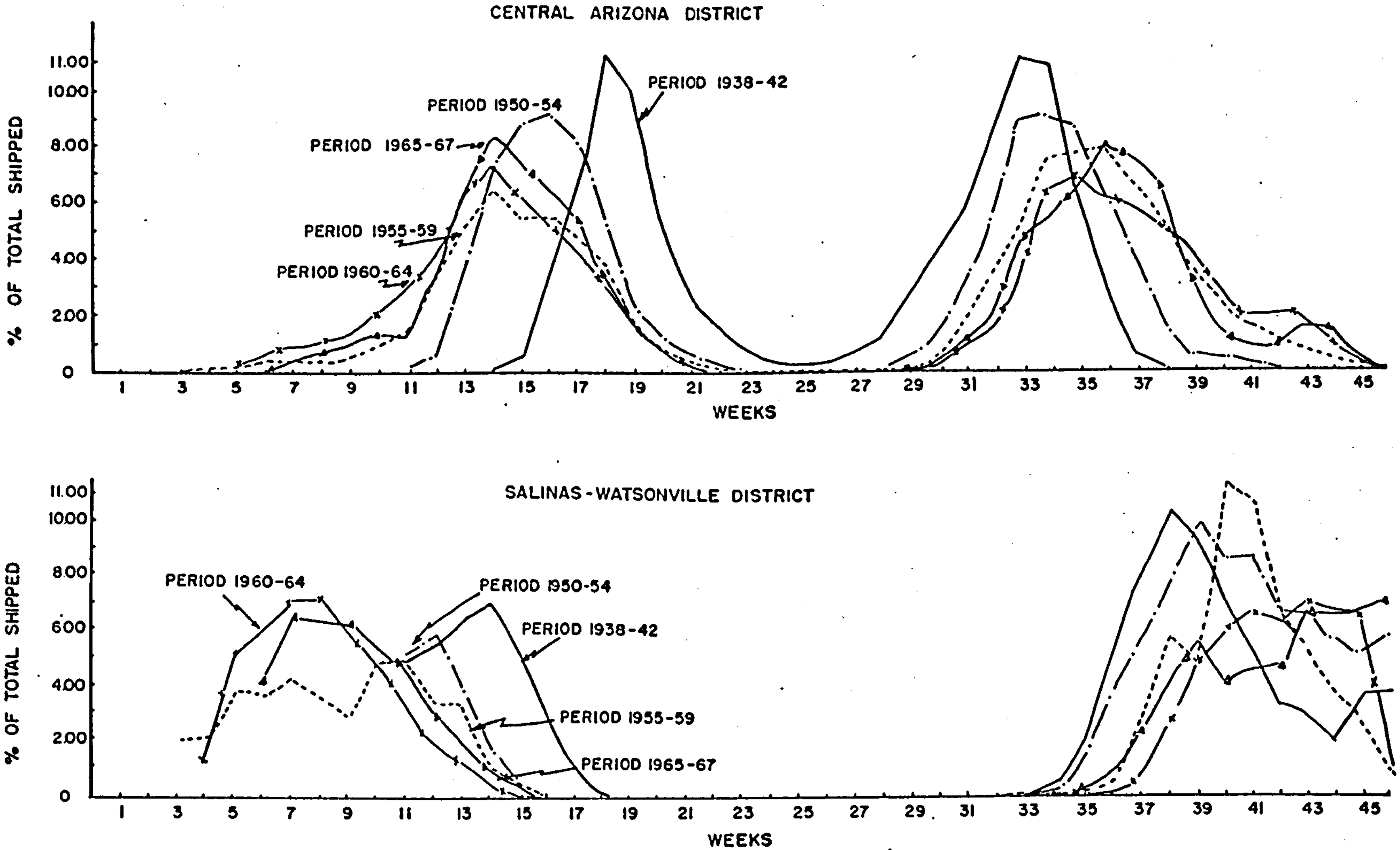


FIGURE 11 AVERAGE WEEKLY SHIPMENTS OF LETTUCE FOR FIVE CONSECUTIVE PERIODS—CENTRAL ARIZONA AND SALINAS-WATSONVILLE DISTRICTS
SOURCE: APPENDIX TABLES 4 THROUGH 8

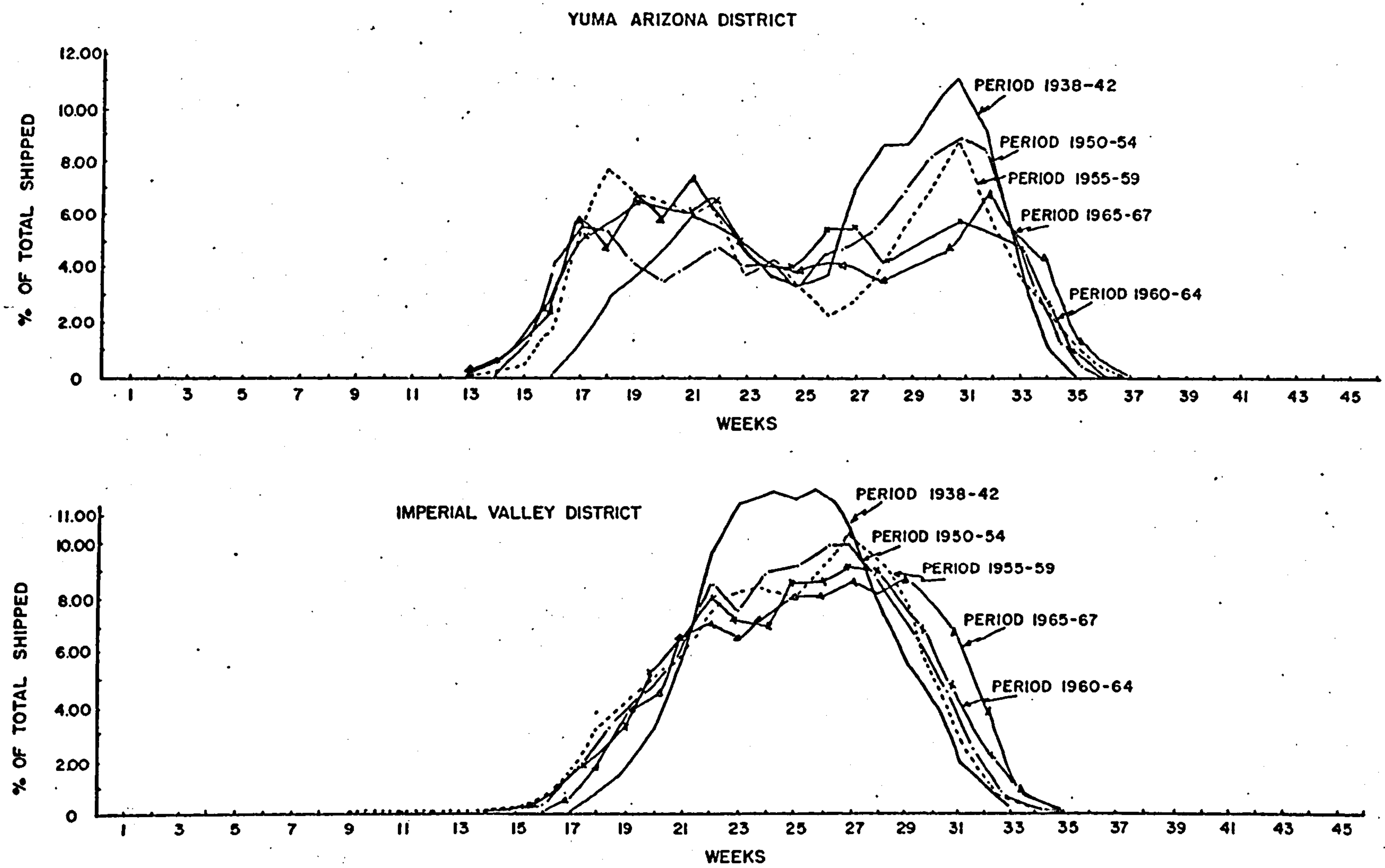


FIGURE 12 AVERAGE WEEKLY SHIPMENTS OF LETTUCE FOR FIVE CONSECUTIVE PERIODS—YUMA ARIZONA AND IMPERIAL VALLEY DISTRICT
SOURCE: APPENDIX TABLES 4 THROUGH 8

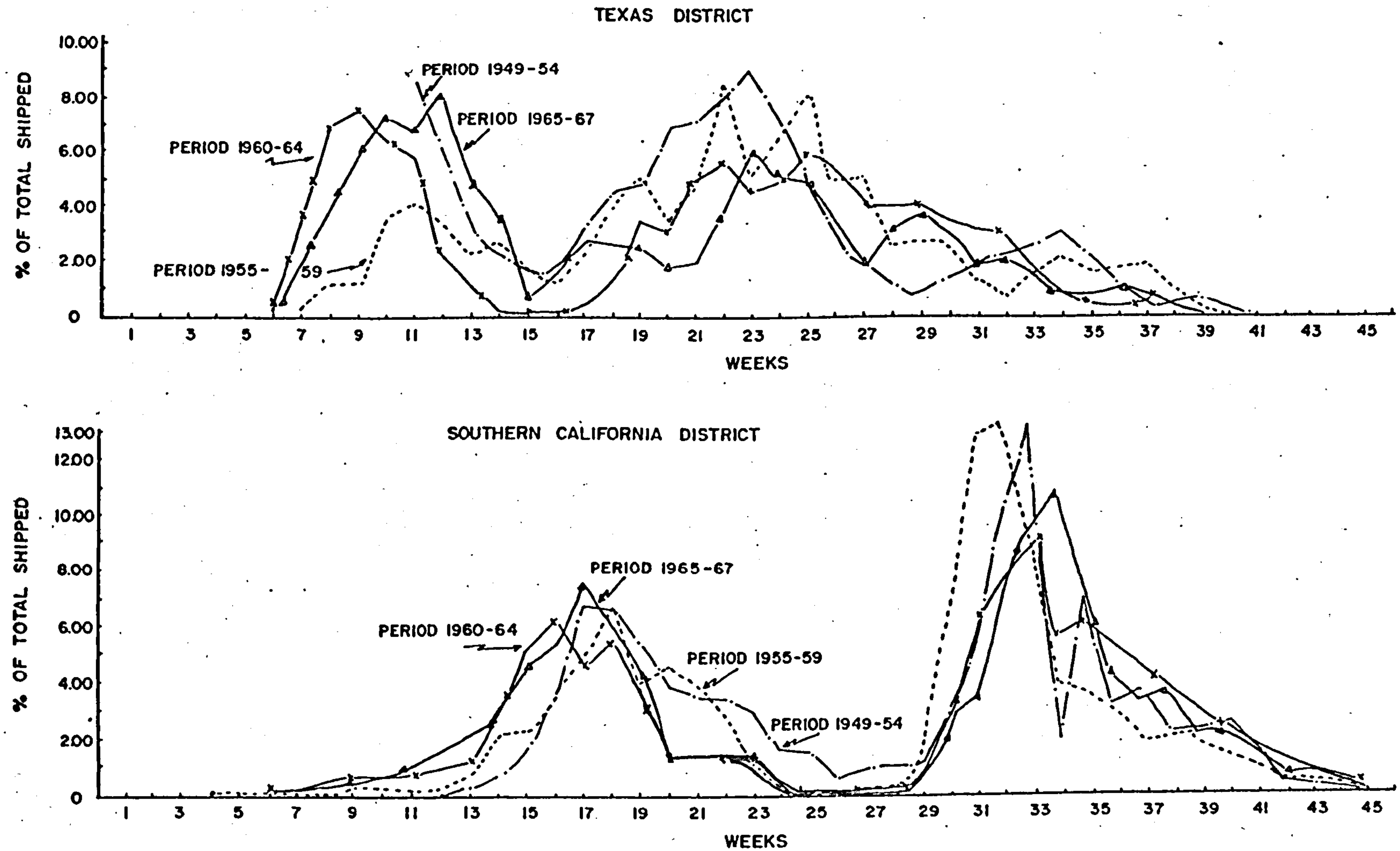


FIGURE 13 AVERAGE WEEKLY SHIPMENTS OF LETTUCE FOR FIVE CONSECUTIVE PERIODS—TEXAS AND SOUTHERN CALIFORNIA DISTRICTS
SOURCE: APPENDIX TABLES 4 THROUGH 8

NEW MEXICO DISTRICT

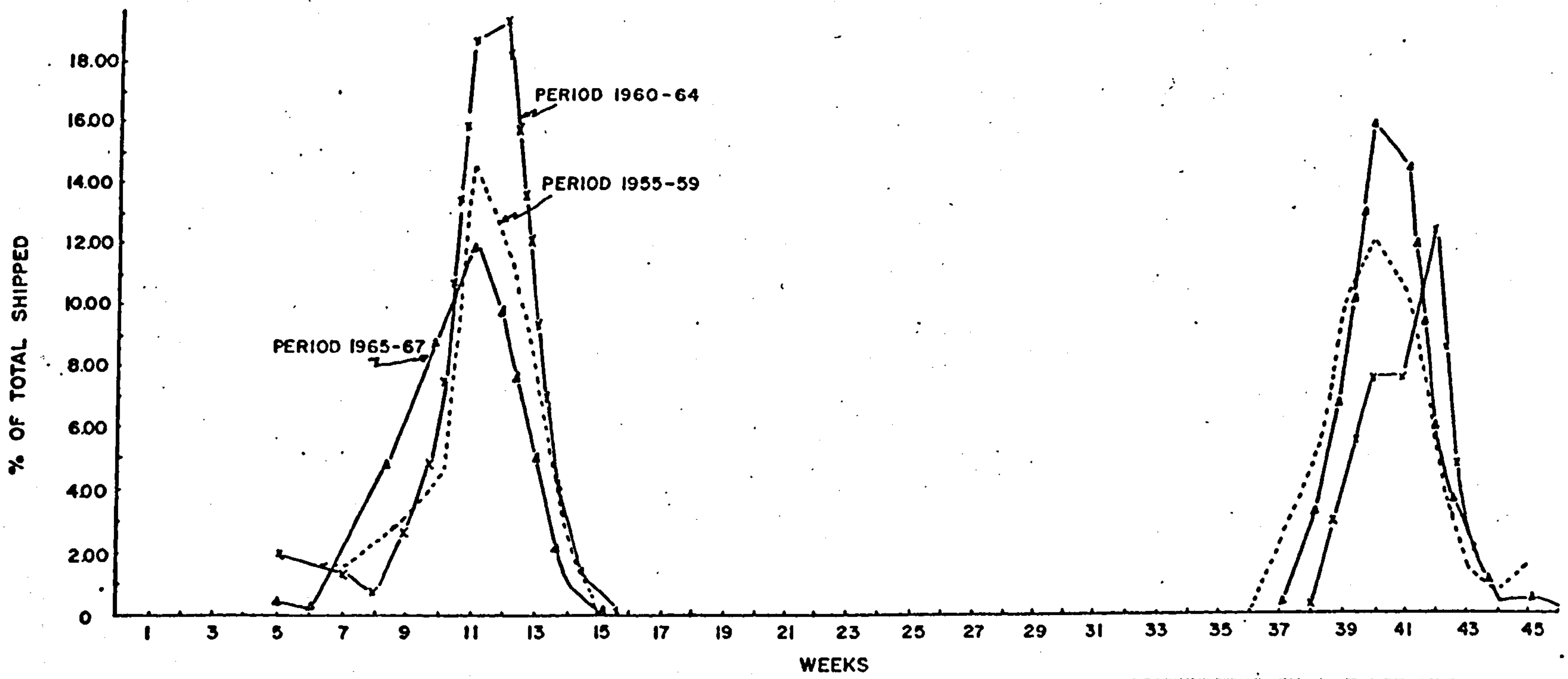


FIGURE 14 AVERAGE WEEKLY SHIPMENTS OF LETTUCE FOR FIVE CONSECUTIVE PERIODS-- NEW MEXICO DISTRICT
SOURCE: APPENDIX TABLES 4 THROUGH 8

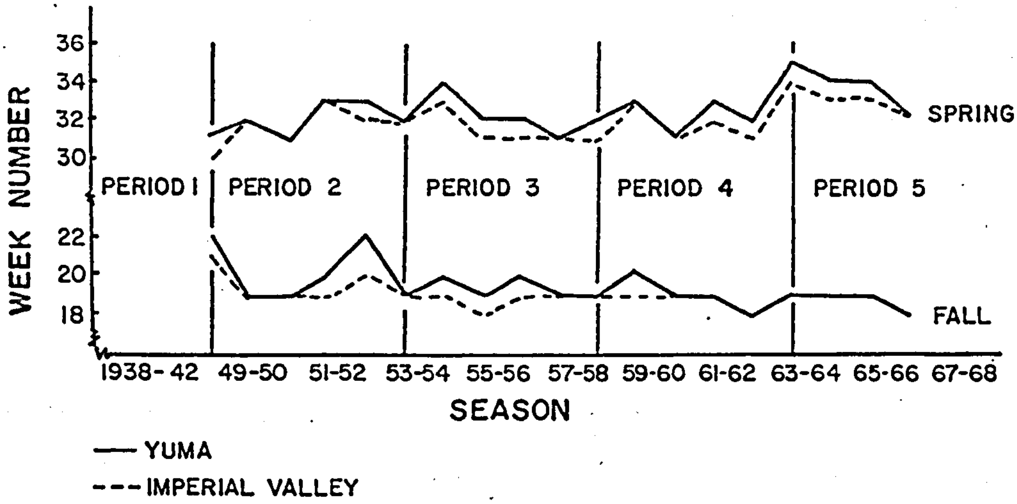
Table 3. Crossing Dates Between the Major Districts.

Season or Period	Salinas-Watsonville Crossing				Central Arizona Crossing			
	Central Arizona		Southern California[a]		Imperial Valley		Yuma	
	Entering	Exiting	Entering	Exiting	Entering	Exiting	Entering	Exiting
	(Crossing Week)							
Period One								
1938-48 Average	17	36			21	30	22	31
Period Two								
1949-50	15		18	33	19	32	19	32
1950-51	14	36	16	33	19	31	19	31
1951-52	14	37	17	35	19	33	20	33
1952-53	15	36	17	35	20	32	22	33
1953-54	14	38	16	36	19	32	19	32
1949-54 Average	14	37	18	34	19	32	20	32
Period Three								
1954-55	14	39	16	37	19	33	20	34
1955-56	12	38	14	35	18	31	19	32
1956-57	12	38	15	35	19	31	20	32
1957-58	12	40	15	37	19	31	19	31
1958-59	11	39	14	35	19	31	19	32
1954-59 Average	12	40	15	37	19	32	19	32
Period Four								
1959-60	10	40	14	37	19	33	20	33
1960-61	11	39	15	37	19	31	19	31
1961-62	11	39	15	36	19	32	19	33
1962-63	12	38	14	38	18	31	18	32
1963-64	12	40	15	38	19	34	19	35
1959-64 Average	11	39	14	37	19	33	19	33
Period Five								
1964-65	13	39	16	37	19	33	19	34
1965-66	13	39	15	37	19	33	19	34
1966-67	12	38	14	36	18	32	18	32
1964-67 Average	13	39	15	37	19	33	19	33

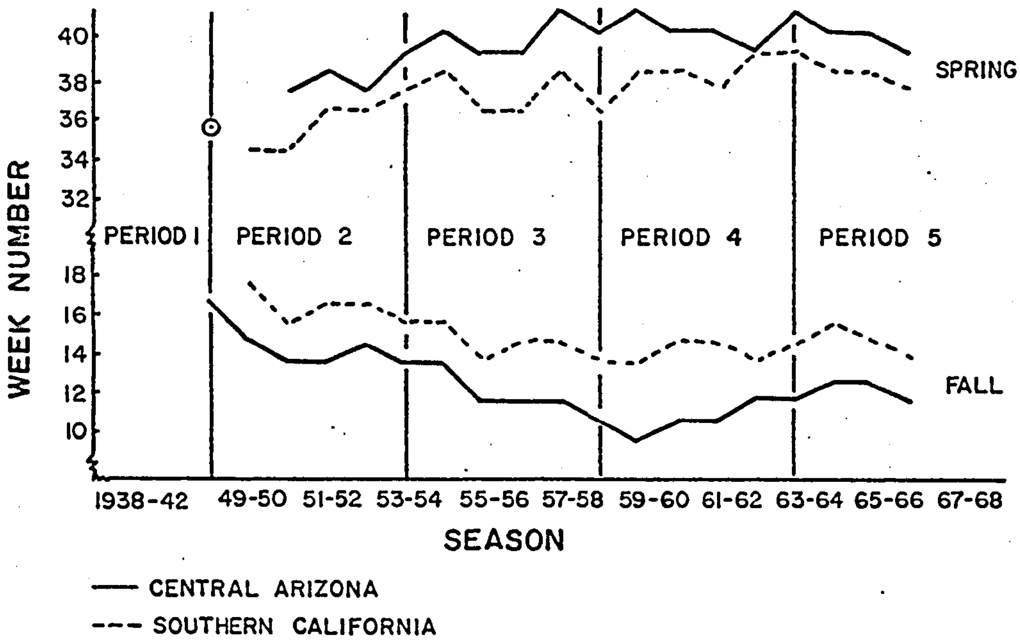
Table 3. (Continued).

a. Shipments were not reported from southern California prior to the 1941-42 season.

Source: Appendix Tables 4 through 8.



CENTRAL ARIZONA, IMPERIAL VALLEY AND YUMA



SALINAS-WATSONVILLE, CENTRAL ARIZONA AND SOUTHERN CALIFORNIA

FIGURE 15 CROSSING DATES BETWEEN THE MAJOR DISTRICTS

Period One

This period consists of the combined annual averages of shipments for the seasons 1937-38 through 1941-42. Shipments originating from the Salinas-Watsonville district, the Imperial Valley district, the central Arizona district and the Yuma district were reported during this period. Figures 11 to 14 show the shipping pattern established by each district during Period One.

The Salinas-Watsonville district is the major shipper of lettuce during the summer season. The crossing dates between the Salinas-Watsonville district and the central Arizona district are week 17 in the fall and week 36 in the spring. Peak shipment weeks are week 18 and week 33. The Imperial Valley district and the Yuma district dominate the winter season during Period One. The crossing dates between the central Arizona district and the Imperial Valley district are week 21 in the late fall season and week 30 in the early spring season. The crossing dates between the Yuma district and the central Arizona district are week 22 in the fall and week 31 in the spring.

Period Two

The second period consists of the combined annual averages of the shipments for the seasons 1949-50 through 1953-54. A comparison of the shipping patterns established by each district in Period Two to those of the previous period indicates that shifts between districts have occurred (Figures 11 to 14). Figure 15 shows a general shift to an earlier crossing date in the fall season and a later date in the spring season between the Salinas-Watsonville district and the central Arizona district for each season during Period Two. Table 3 shows that, as compared to Period One, the average crossing date between these two districts is three weeks earlier in the fall, week 14, and one week later in the spring, week 37. The peak shipping weeks for the central Arizona district are week 16 in the fall season and week 34 in the spring season. The shifts in the peak weeks in the fall and the spring shipping seasons coincide with the shifts in the crossing dates.

In Period Two, the shipping seasons for the Imperial Valley district and the Yuma district have extended into the shipping period previously dominated by the central Arizona district. Figure 15 shows a general trend to an earlier crossing date in the early winter season and a later crossing date in the late winter season between the central Arizona district and the Imperial Valley district and between the central Arizona district and the Yuma district. Table 3 shows that the average crossing dates between the central Arizona district and the Imperial Valley district have extended to an earlier week, week 22, in the early winter season and a later week, week 32, in the late winter season. The average crossing dates between the central Arizona district and the Yuma district have followed a similar pattern, week 20 and week 32 in the early and late winter weeks, respectively.

In addition to the shifts among districts, the Texas district and the southern California district have begun shipments of some consequence. Their entrance may be responsible for the shifts in the shipping seasons for the Salinas-Watsonville and the central Arizona districts. The southern California district has a shipping season of 32 weeks. The season starts in Period Two at week 13 and extends through week 44, reaching a peak at week 17 and again at week 33. The southern California district has moved into the weeks left vacant by the shifts of the shipping season of the central Arizona district. Figure 15 indicates an annual shift to an earlier crossing date in the fall and a later crossing date in the spring between the Salinas-Watsonville district and the southern California district throughout Period Two. Figure 13 shows that the shipments for the Texas district for Period Two are heaviest during the winter season.

Period Three

The third period consists of the combined annual averages of the shipments for the seasons 1954-55 through 1958-59. Figures 11 to 14 indicate a continuation of some of the shifts found in the second period. Figure 15 indicates a seasonal trend toward an earlier crossing date in the fall season and a later crossing date in the spring season between the Salinas-Watsonville district and the central Arizona district. Table 3 shows that the average crossing dates in Period Three between these two districts are week 12 in the fall and week 40 in the spring. This represents a shift of two weeks earlier in the fall season and three weeks later in the spring season as compared to Period Two.

There are no significant shifts by either the Imperial Valley district or the Yuma district during Period Three. Table 3 indicates that the average crossing dates between the central Arizona district and the Imperial Valley district are the same as in Period Two. As compared to Period Two, the early winter crossing date for the central Arizona district and the Yuma district is one week earlier, week 20, but the late winter crossing date is the same, week 32. Figure 15 indicates a considerable fluctuation of the seasonal crossing dates between these two districts and the central Arizona district.

As compared with Period Two, Table 3 shows that the average crossing dates between the Salinas-Watsonville district and the southern California district are at an earlier week in the fall, week 15, and at a later week in the spring, week 36. Figure 15 indicates the Salinas-Watsonville-southern California districts' annual crossing dates tend toward a later week in the spring throughout Period Three. The movement to an earlier crossing date in the fall is not quite as evident. A comparison of the shipping patterns of various districts in Period Three (Figures 11 to 14) shows that the shipping season of the southern California district tends to fill the periods between the crossing of the shipping seasons of the central Arizona district and the Imperial Valley and Yuma districts.

Shipments from the Texas district exhibit a pattern in Period Three that is essentially unchanged from Period Two.

During the third period, the New Mexico district becomes a shipping district of consequence. The shipping season of the New Mexico district is divided into two district subseasons, a fall season and a spring season (Figure 14). The fall season starts at week 6 and ends by week 15. The spring season begins at week 36 and extends through week 45. The peak week in the fall season is week number 11, and the peak week in the spring season is week 40.

Period Four

Period Four consists of the combined annual averages of the shipments for the seasons 1959-60 through 1963-64. Figure 11 shows a slight shift in the shipping season of the central Arizona district to an earlier week in the fall season. Table 3 shows that the average crossing date between the Salinas-Watsonville district and the central Arizona district for Period Four is one week earlier in the fall season than in Period Three. The shift of the central Arizona spring season into weeks previously dominated by the Salinas-Watsonville district throughout the first three periods is reversed during the fourth period. Table 3 indicates that the average spring crossing date between these two districts is week 39 in Period Four and week 40 in Period Three. Figure 15 indicates that the annual crossing dates between these two districts have reversed their previous trend toward an earlier week in the fall season and a later week in the spring season.

Figures 11 and 12 indicate that, as compared to Period Three, there are no significant shifts between the shipping season of the central Arizona district and the shipping seasons of the Imperial Valley and Yuma districts during the early winter weeks of Period Four. Figure 15 indicates a trend toward a later crossing date between the central Arizona district and the Imperial Valley and Yuma districts. The average crossing date between the central Arizona district and each of these districts is week 33. This represents a one-week shift by the Imperial Valley and Yuma districts into the spring season of the central Arizona district.

As compared to Period Three, the average fall crossing date between the Salinas-Watsonville district and the southern California district is a week later, week 14, but the average spring crossing date is unchanged. Figure 15 indicates no real trends in the seasonal crossing dates between these two districts.

The Texas and New Mexico districts do not exhibit any significant shifts in Period Four relative to Period Three. Figure 14 indicates that each of the shipping seasons of the New Mexico district tends to cover more weeks than in the previous period.

Period Five

Period Five consists of the combined annual averages of the shipments for the seasons 1964-65 through 1966-67. Figure 11 indicates that the previous shifts between the Salinas-Watsonville district and the central Arizona district to an earlier week are reversed in the fall season. The average crossing date for these two districts in Period Five is week 13 as compared to week 11 in Period Four. The average crossing date between the Salinas-Watsonville district and the central Arizona district in the spring is unchanged in Period Five. Figures 11 and 12 indicate that the relationships among shipping seasons for the central Arizona district and those of the Imperial Valley and Yuma districts have not changed.

The fall shipping season for the southern California district has also been shortened by the Salinas-Watsonville district. Table 3 indicates a fall crossing date between these two districts one week later in Period Five, week 15, than in the previous period. The spring crossing date between the Salinas-Watsonville district and the southern California district is unchanged.

The Texas and New Mexico districts do not exhibit any shifts relative to Period Four. Figure 14 indicates that the shipping season of the New Mexico district is longer in both the fall and spring seasons.

CHAPTER IV

ANALYSIS OF THE DEMAND FOR ARIZONA LETTUCE

The analysis of demand for commercially produced Arizona lettuce was performed separately for the central Arizona district and the Yuma district. The basic data for the analysis are shipments per week and average prices per week. The derivation of the data is explained in Chapter II. For separate analyses, the data are partitioned by years, by the subperiods 1948-58 and 1959-67, by sets of four weeks and by sets of two weeks. The central Arizona district data are also partitioned by fall and spring seasons for some analyses.

The basic statistical technique used in this analysis of the demand for lettuce has been single equation least-squares multiple regression. Logarithmic, semilog and linear equation forms were imposed on the data on an experimental basis, and with few minor exceptions, the linear function yielded the best fit to the data as evidenced by the multiple $\overline{R}^2$ values. All the results reported in this chapter are from linear regression equations.

The possibility of a consistent seasonal pattern in the residuals was explored. The weeks were analyzed separately by years and the residuals of regression were plotted against the week numbers. No consistent pattern appeared in the plotted data. This suggests that the demand curve has no consistent seasonal pattern of movement as might result from regular effects of seasonal changes in weather and the prices of substitute or complementary commodities.

Analysis of Demand for the Central Arizona District Lettuce

The variables included in the demand analysis of central Arizona district lettuce are as follows:

- P - deflated average f.o.b. central Arizona district price for a carton containing two dozen heads of lettuce
- Q_1 - total weekly quantity of lettuce, in thousands of cartons, shipped from the central Arizona district
- Q_2 - total weekly quantity of lettuce, in thousands of cartons, shipped from the Yuma district
- Q_3 - total weekly quantity of lettuce, in thousands of cartons, shipped by all districts other than the central Arizona and Yuma districts
- Q_4 - total weekly quantity of lettuce, in thousands of cartons, shipped by all districts other than the central Arizona district
- I - deflated United States per capita disposable income
- T - zero-one shift variables for each of various years
- e - error term representing the net influences on the dependent variables of other variables not explicitly included in the analysis

For judging the significance of the resulting coefficients, the following statistical tests were used:

1. To determine if the estimated regression coefficients are significantly different from zero, the "t" test was applied to each regression coefficient. The computed "t" values appear

in parentheses directly below each regression coefficient. The following designations indicate significance levels .05, .10 and .20; *, **, and ***, respectively.

2. The standard error of estimate is denoted by Sy.x. This measures the degree of dispersion about the regression line and indicates the value of the equation for predicting the dependent variable.
3. The adjusted coefficient of multiple determination, ($\bar{R}^2$), is presented to give a measure of the proportion of the variation in the dependent variable associated with or "explained" by the variations in the independent variables.

Combined Analysis of Demand

Lettuce is shipped from the central Arizona district in distinct fall and spring seasons. The combined analysis of demand is an attempt to determine the structural demand coefficients on the assumption that the structure generating the data is the same in both seasons.

The least-squares regression equation (hereafter abbreviated as LSR equation), $P = b_o + b_1Q_1 + b_2Q_2 + b_3Q_3 + b_6I + e$, has been used to analyze the period 1948-67. The following results were obtained:

$$P = 2.59 - \underset{(6.02)^*}{.000953}Q_1 - \underset{(5.60)^*}{.001631}Q_2 - \underset{(3.71)^*}{.000594}Q_3 + \underset{(1.18)}{.002688}I$$

$$Sy.x = .82 \qquad \bar{R}^2 = .10 \qquad d.f. = 412$$

All regression coefficients have the expected sign and all are significant at the five percent level except income (b_6).

The 1948-67 period is broken into two subperiods, 1948-58 and 1959-67, and then each is analyzed separately using the previously described equation form. The reason for the break is that prior to the 1958-59 season, weekly data were not reported for truck shipments. The resulting statistical equations for the 1948-58 period and the 1959-67 period are:

$$1948\text{-}58 \qquad P = 8.39 - \underset{(5.42)^{*}}{.001327Q_1} - \underset{(6.34)^{*}}{.002824Q_2} - \underset{(4.43)^{*}}{.001226Q_3} - \underset{(5.27)^{*}}{.002745I}$$

$$Sy.x = .70 \qquad \overline{R}^2 = .21 \qquad d.f. = 176$$

$$1959\text{-}67 \qquad P = -1.01 - \underset{(5.67)^{*}}{.002104Q_1} - \underset{(5.29)^{*}}{.002085Q_2} - \underset{(4.18)^{*}}{.000904Q_3} + \underset{(5.63)^{*}}{.002208I}$$

$$Sy.x = .79 \qquad \overline{R}^2 = .18 \qquad d.f. = 231$$

All resulting coefficients are significantly different from zero at the five percent level and have the expected sign except for the 1948-58 income coefficient. The income elasticity coefficients implied from these equations are -6.65 for the 1948-58 period and +7.20 for the 1959-67 period.

Seasonal Analysis of Demand

A seasonal analysis, fall and spring, was made of each of the previously described subperiods. The rationale for this is the belief that the demand structure being analyzed for each of the seasons differs significantly. The LSR equation previously described was used to analyze each subperiod season, and the following results were obtained:

1948-58

$$\text{FALL} \qquad P = 8.34 - \underset{(2.91)^{*}}{.001381Q_1} - \underset{(5.34)^{*}}{.004588Q_2} - \underset{(2.18)^{*}}{.001340Q_3} - \underset{(3.16)^{*}}{.002571I}$$

$$Sy.x = .76 \qquad \overline{R}^2 = .26 \qquad d.f. = 81$$

SPRING $P = 8.56 - \underset{(4.09)^{*1}}{.001213Q_1} - \underset{(4.10)^{*2}}{.002122Q_2} - \underset{(3.26)^{*3}}{.001013Q_3} - \underset{(4.35)^{*}}{.002966I}$

$Sy.x = .61 \quad \bar{R}^2 = .18 \quad d.f. = 90$

1959-67

FALL $P = -.16 - \underset{(5.45)^{*1}}{.001708Q_1} - \underset{(5.50)^{*2}}{.002695Q_2} - \underset{(4.90)^{*3}}{.001730Q_3} + \underset{(4.49)^{*}}{.002180I}$

$Sy.x = .59 \quad \bar{R}^2 = .24 \quad d.f. = 103$

SPRING $P = -2.69 - \underset{(3.92)^{*1}}{.001220Q_1} - \underset{(3.58)^{*2}}{.002189Q_2} - \underset{(2.63)^{*3}}{.000801Q_3} + \underset{(4.90)^{*}}{.003041I}$

$Sy.x = .94 \quad \bar{R}^2 = .22 \quad d.f. = 123$

All estimated coefficients except for income in the 1948-58 period have the expected sign. The computed "t" values indicate that all coefficients are significant at the five percent level. The seasonal analysis has resulted in the improvement in the $\bar{R}^2$ for all periods except for the spring 1948-58 period. There was no consistent improvement in the standard error of the estimate. The implied income elasticity coefficients are as follows:

1948-58	FALL:	-6.29
	SPRING:	-7.53
1959-67	FALL:	+5.07
	SPRING:	+9.76

To determine if changes in the demand relationship have occurred over time, subperiod seasonal analyses are made with the inclusion of zero-one variables to represent yearly shifts. The LSR equation of the following form is used to analyze each season in each subperiod:

$$P = b_o + b_1Q_1 + b_2Q_2 + b_3Q_3 + b_nT_n + e$$

The results are presented in Appendix Table 9. The 1959-67 subperiod is again analyzed on a seasonal basis using the income variable and zero-one variable for years for which significant shifts are judged to have occurred. This judgment is made on the basis of the computed "t" values of each of the years 1959-67. The LSR equation of the following form is to analyze the fall and spring season for the subperiod 1959-67:

$$P = b_o + b_1Q_1 + b_2Q_2 + b_3Q_3 + b_6I + b_nT_n + e$$

The resulting statistical equations are as follows:

FALL
$$P = .14 - \underset{(5.32)^{*}}{.001580Q_1} - \underset{(5.92)^{*}}{.002743Q_2} - \underset{(4.60)^{*}}{.001556Q_3} + \underset{(2.99)^{*}}{.001907I} +$$

$$\underset{(3.67)^{*}}{.718388T_{64}} + \underset{(1.13)}{.232231T_{65}} - \underset{(.26)}{.073338T_{67}}$$

$$Sy.x = .54 \qquad \bar{R}^2 = .32 \qquad d.f. = 100$$

SPRING
$$P = 1.57 - \underset{(4.99)^{*}}{.001413Q_1} - \underset{(3.86)^{*}}{.002129Q_2} - \underset{(3.49)^{*}}{.00964Q_3} + \underset{(1.19)}{.000871I} +$$

$$\underset{(2.85)^{*}}{.680028T_{63}} + \underset{(4.84)^{*}}{1.316232T_{65}} + \underset{(4.16)^{*}}{1.458694T_{67}}$$

$$Sy.x = .84 \qquad \bar{R}^2 = .38 \qquad d.f. = 120$$

For each of the seasons, the regression coefficients for all of the quantity variables are highly significant. Income is significant at the five percent level for the fall season but is not significant for the spring season. Zero-one variables for all selected years are significant except for the years 1965 and 1967 in the fall season. The $\bar{R}^2$ represents an improvement over the analysis without zero-one variables, but there are no substantial reductions in the standard error of the estimates. The implied income elasticity coefficient for the fall season is +4.80.

Annual Analysis of Demand

A separate yearly analysis has been made for each of the years, 1948 through 1967. This analysis ignores any seasonal division in the demand structure for central Arizona district lettuce. The following LSR equation is used to analyze each year:

$$P = b_o + b_1Q_1 + b_2Q_2 + b_3Q_3 + e$$

The results are presented in Table 4.

The excess demand curves for the central Arizona district have been plotted in Figures 16 and 17 for each year in which the regression coefficient for the quantity of central Arizona district lettuce is at least significant at the 20 percent level. The equation for excess demand is:

$$P = b_o' + b_1Q_1$$

The value of the regression constant (b_o') is computed by the following formula with no restrictions placed on allowable significance levels of regression coefficients (b_2) and (b_3).

$$b_o' = b_o + b_2\bar{Q}_2 + b_3\bar{Q}_3$$

Figures 16 and 17 indicate that there has been a considerable yearly shift in the excess demand curve facing the central Arizona district. The various excess demand curves either have the general slope exhibited by year 1957 in Figure 16 or the type exhibited by year 1959 in Figure 17. Table 4 indicates that the equations for the steeper sloped curves consistently have a higher $\bar{R}^2$. This suggests the possibility of a consistent regression bias.

Four-Week Period Analysis of Demand

The demand analysis for four-week periods represents an attempt to analyze the intraseason shifts in the demand structure for the central Arizona district lettuce. The time periods 1948-67, 1948-58 and 1959-67

Table 4. Analysis of Demand of Central Arizona District Lettuce by Years (1948-67).

$P = b_o + b_1Q_1 + b_2Q_2 + b_3Q_3 + e$

Year	Regression Constant b_o	Net Regression Coefficients b_1	b_2	b_3	Adjusted R^2
1948	3.29	-.000725 (1.24)	-.002555 (2.86)*	.000052 (.09)	.398
1949	2.10	-.000270 (.61)	.003610 (4.61)*	-.000439 (.55)	.770
1950	2.44	-.000785 (.74)	-.001857 (.85)	.001435 (.74)	.413
1951	3.59	-.000660 (.97)	-.003587 (3.83)*	-.001072 (1.09)	.462
1952	5.74	-.002440 (2.85)*	-.003890 (2.30)*	-.002542 (2.89)*	.488
1953	1.82	-.000028 (.04)	-.001849 (2.41)*	.000659 (1.04)	.371
1954	3.99	-.002089 (2.02)**	-.003675 (2.22)*	-.001898 (1.59)***	.158
1955	4.33	-.001609 (2.00)**	-.003812 (2.87)*	-.001949 (3.08)*	.388
1956	3.73	-.002038 (2.06)**	-.003623 (2.77)*	-.000948 (1.24)	.252
1957	5.43	-.003270 (4.12)*	-.009715 (4.42)*	-.002974 (4.22)*	.539
1958	3.19	-.001438 (1.38)***	-.003263 (1.13)	-.001062 (.73)	-.010
1959	3.31	-.001355 (4.36)*	-.001701 (2.85)*	-.001713 (4.29)*	.378
1960	4.18	-.001626 (2.53)*	-.002202 (1.66)***	-.002236 (2.55)*	.169
1961	3.34	-.001604 (2.83)*	.002599 (2.38)*	-.000927 (1.85)**	.203
1962	4.53	-.002355 (4.36)*	-.001679 (1.68)***	-.002573 (3.59)*	.413
1963	4.30	-.001602 (2.78)*	-.002639 (2.12)*	-.001534 (2.27)*	.145
1964	6.14	-.003168 (6.02)*	-.003263 (3.74)*	-.002593 (5.93)*	.622
1965	3.78	-.000628 (.49)	-.003584 (1.89)**	-.000632 (.58)	.083

Table 4. (Continued).

Year	Regression Constant b_o	Net Regression Coefficients b_1	b_2	b_3	Adjusted R^2
1966	1.82	.000058 (.16)	.000164 (.25)	-.000249 (.66)	-.090
1967	6.57	-.002889 (1.81)**	-.006776 (2.74)*	-.001948 (1.04)	.407

*Regression coefficient significantly different from zero at the five percent level.

**Regression coefficient significantly different from zero at the 10 percent level.

***Regression coefficient significantly different from zero at the 20 percent level.

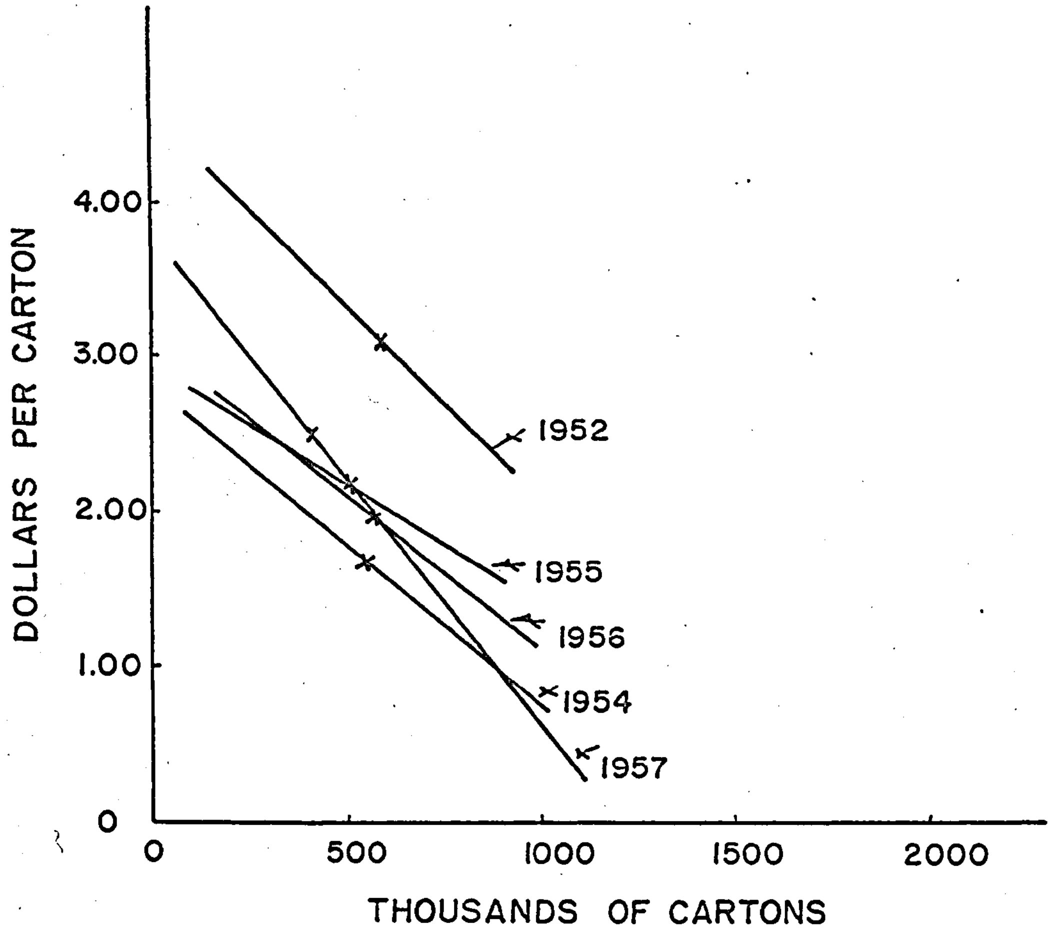


FIGURE 16 ANALYSIS OF DEMAND OF CENTRAL ARIZONA DISTRICT LETTUCE BY YEARS (1948-58)

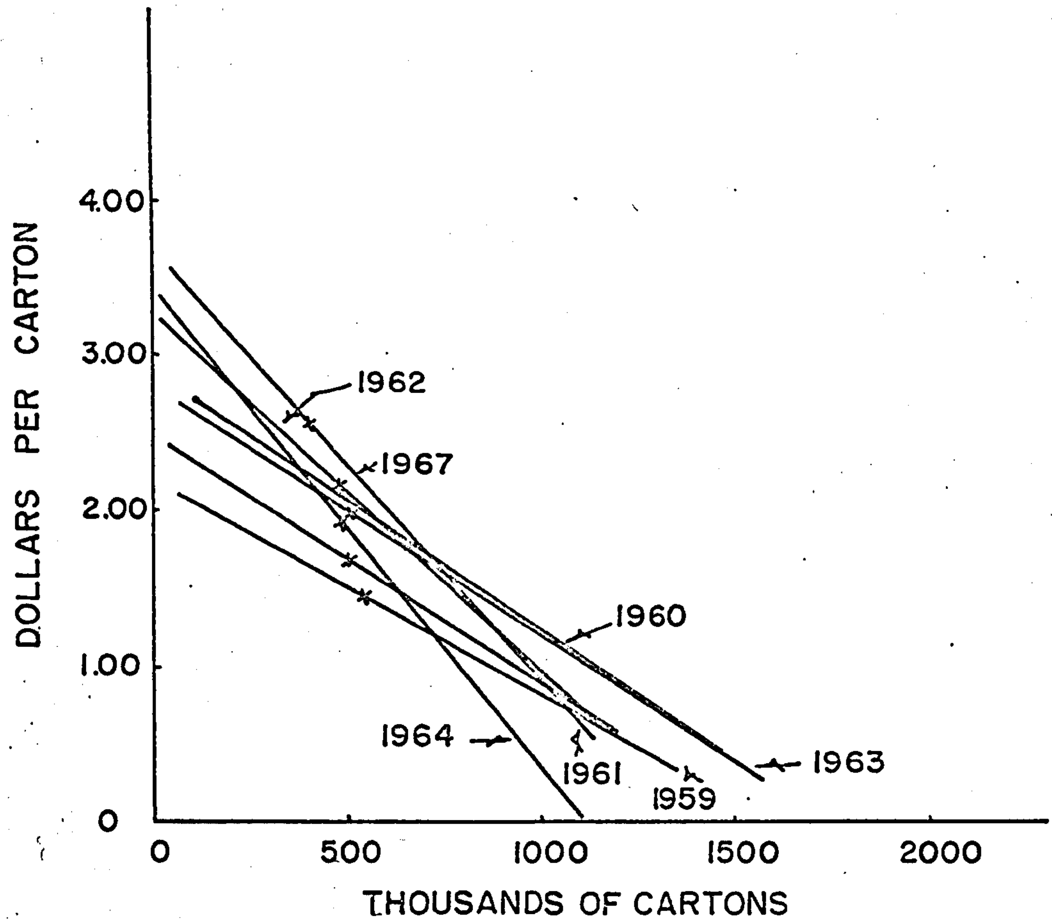


FIGURE 17 ANALYSIS OF DEMAND OF CENTRAL ARIZONA DISTRICT LETTUCE BY YEARS (1959-67)

are each analyzed separately. The LSR equation used to analyze each of the time periods is as follows:

$$P = b_o + b_1Q_1 + b_4Q_4 + e$$

The resulting regression coefficients are presented in Table 5. The price flexibility coefficient for lettuce shipments from the central Arizona district and lettuce shipments from all other districts is computed and presented in Table 5 when its respective regression coefficients are significant at least at the 20 percent level.

The excess demand curves for the central Arizona district lettuce have been plotted for each of the four-week periods in the 1948-58 and the 1959-67 periods in which the regression coefficient for central Arizona district lettuce is significant at least at the 20 percent level. The equation for the four-week period excess demand is:

$$P = b_o' + b_1Q_1$$

The value of the regression constant b_o' is computed by the following formula with no restriction on the allowable level significance on b_4:

$$b_o' = b_o + b_4\overline{Q}_4$$

The excess demand curves for the 1948-58 and 1959-67 periods are plotted in Figures 18 through 21. Table 5 indicates that in most cases the price flexibility coefficients follow a general pattern. As the mean value of the variable quantity of central Arizona lettuce shipped (Q_1) increases, the price flexibility coefficient, with respect to this variable, also increases. This is more explicitly indicated in the analysis of the 1959-67 subperiod than in the analysis of the other two time periods. Figures 18 and 19 also indicate that there is a relationship between the position of the excess demand curve and the mean value

Table 5. Regression of Central Arizona District Price for Four-Week Periods.

$P = b_o + b_1Q_1 + b_4Q_4 + e$

Weeks	Time Period	Net Regression Coefficients		Means			Price Flexibility	
		b_1	b_4	$\overline{P}$	$\overline{Q}_1$	$\overline{Q}_4$	Q_1	Q_4
12-15	1948-67	-.001860	-.000410	2.31	730.66	402.11	-.59	
		(5.72)*	(1.07)					
16-19	1948-67	-.000480	-.001057	1.94	556.26	588.44		-.32
		(1.26)	(2.98)*					
30-33	1948-67	-.001646	-.001132	1.93	370.31	812.81	-.32	-.48
		(4.05)*	(4.08)*					
34-37	1948-67	-.000911	-.000205	2.00	881.31	389.31	-.40	
		(2.97)*	(.65)					
38-41	1948-67	-.001391	-.000606	2.21	462.27	885.05	-.29	-.24
		(3.06)*	(1.61)***					
42-45	1948-67	-.003587	.001012	2.17	194.59	1,101.20	-.32	
		(1.64)***	(1.62)***					
12-15	1948-58	-.002777	-.001501	2.64	550.61	356.10	-.58	-.20
		(3.39)*	(1.85)**					
16-19	1948-58	-.000013	-.001481	2.05	563.58	460.70		-.33
		(.02)	(2.03)*					
30-33	1948-58	-.001590	-.001677	1.98	419.48	602.69	-.34	-.51
		(2.88)*	(3.38)*					

Table 5. (Continued).

Weeks	Time Period	Net Regression Coefficients b_1	b_4	Means $\bar{P}$	$\bar{Q}_1$	$\bar{Q}_4$	Price Flexibility Q_1	Q_4
34-37	1948-58	-.000412 (.95)	.000619 (1.39)***	2.16	791.73	371.80		
38-41	1948-58	-.001614 (2.40)*	-.001923 (3.78)*	2.41	381.65	725.10	-.26	-.58
12-15	1959-67	-.001445 (2.98)*	-.000228 (.49)	2.01	899.79	445.33	-.65	
16-19	1959-67	-.001784 (3.13)*	-.001442 (2.81)*	1.82	547.26	745.37	-.54	-.59
30-33	1959-67	-.002135 (3.44)*	-.001356 (3.00)*	1.89	321.14	1,022.93	-.36	-.74
34-37	1959-67	-.001085 (2.09)*	-.000698 (1.49)***	1.81	992.33	411.06	-.59	
38-41	1959-67	-.001293 (2.06)*	-.000099 (.18)	2.09	507.06	973.92	-.31	
42-45	1959-67	-.004419 (1.83)**	.001133 (1.43)***	2.23	197.80	1,176.07	-.39	

*See Table 4.

**See Table 4.

***See Table 4.

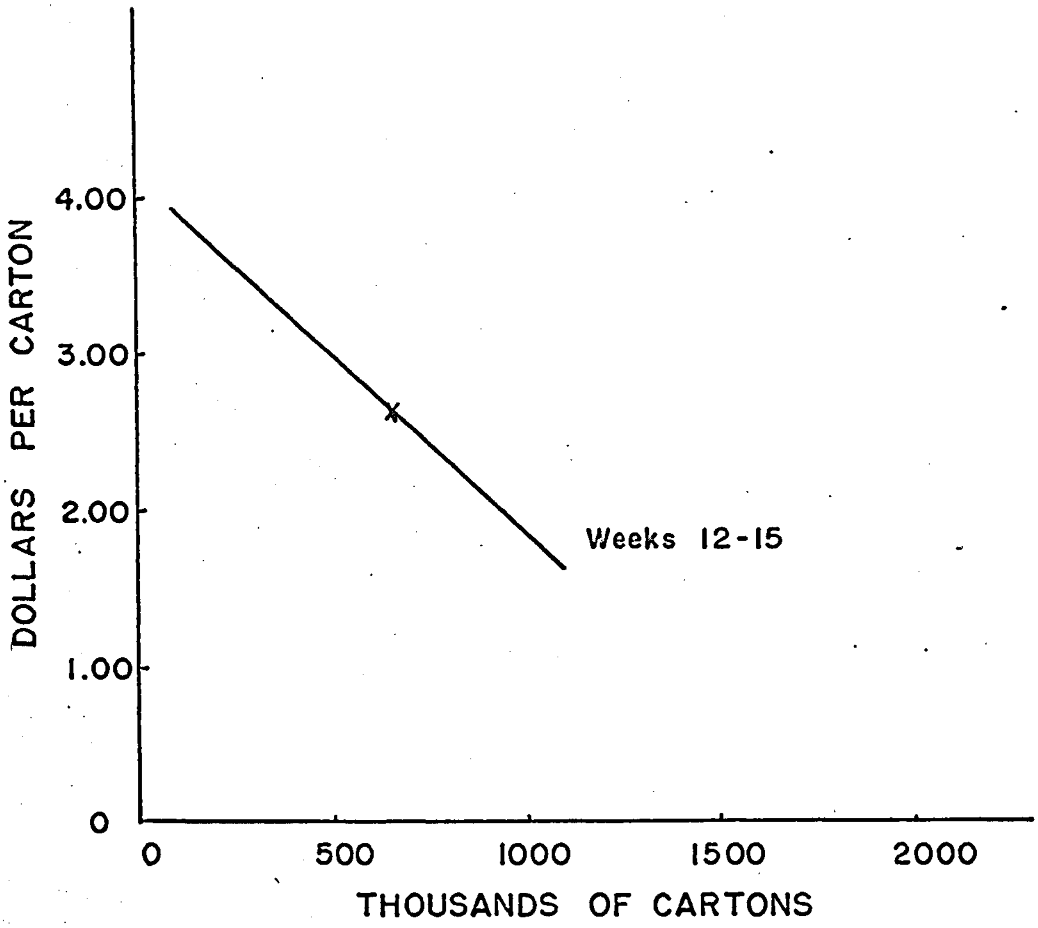


FIGURE 18 ANALYSIS OF DEMAND OF CENTRAL ARIZONA DISTRICT LETTUCE, FOUR WEEK PERIODS (FALL 1948-58)

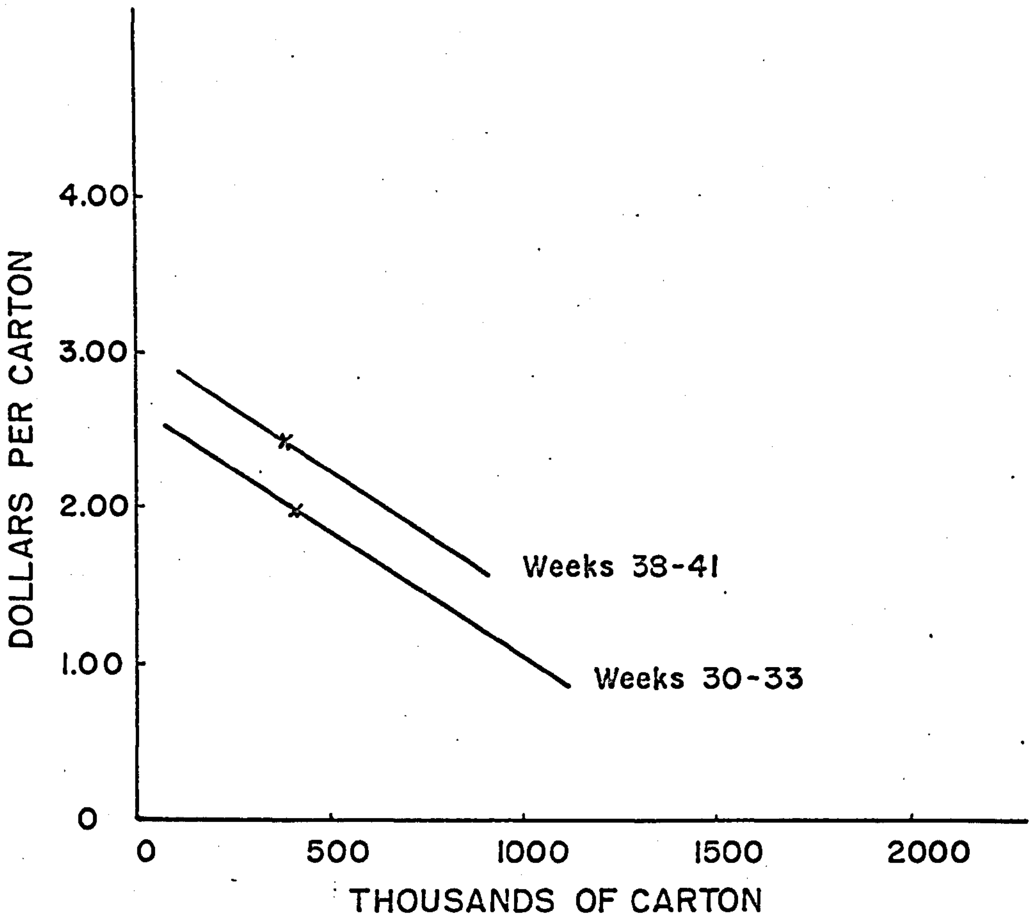


FIGURE 19 ANALYSIS OF DEMAND OF CENTRAL ARIZONA DISTRICT LETTUCE, FOUR WEEK PERIODS (SPRING 1948-58)

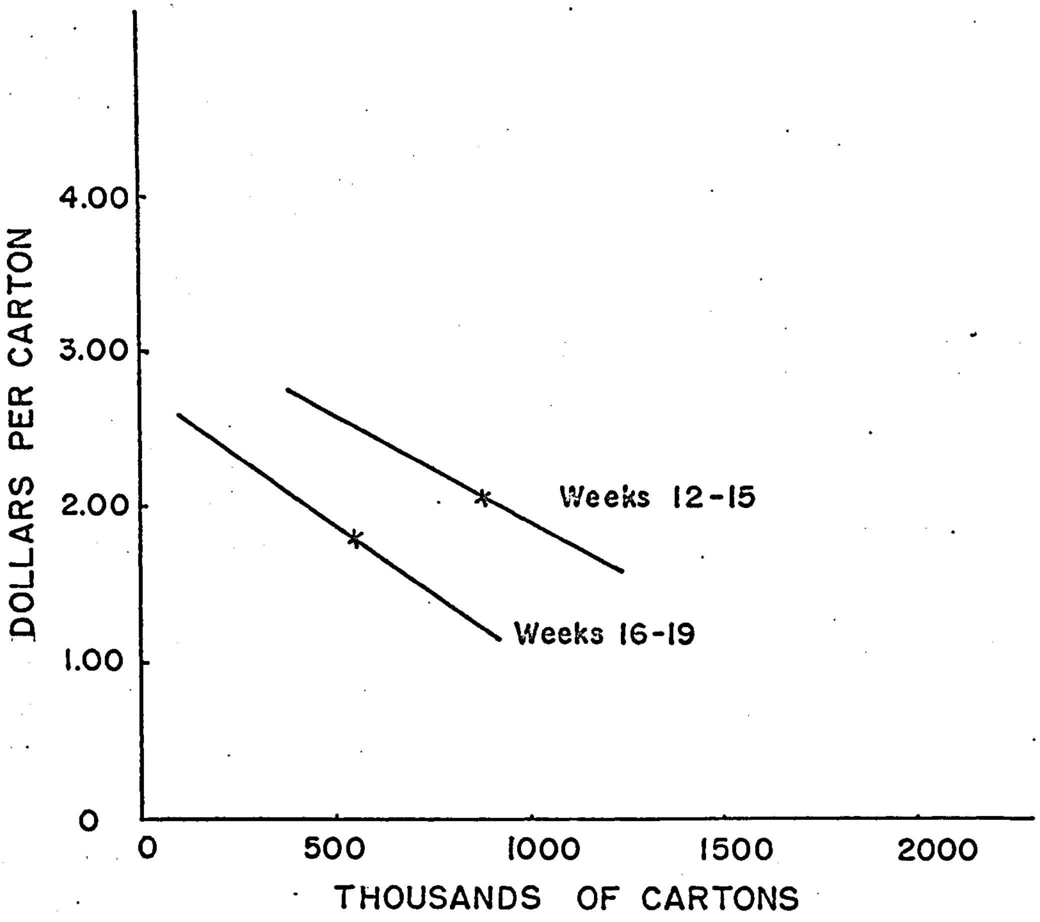


FIGURE 20 ANALYSIS OF DEMAND OF CENTRAL ARIZONA DISTRICT LETTUCE, FOUR WEEK PERIODS (FALL 1959-67)

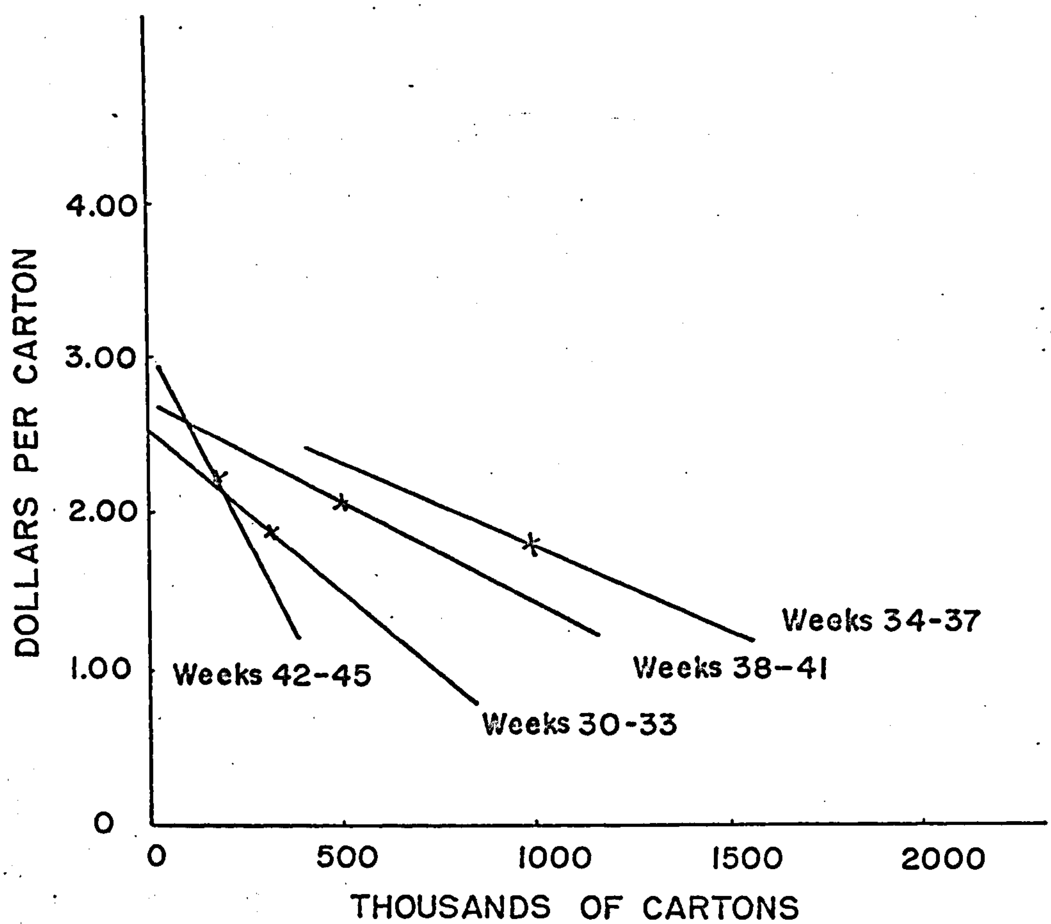


FIGURE 21 ANALYSIS OF DEMAND OF CENTRAL ARIZONA DISTRICT LETTUCE, FOUR WEEK PERIODS (SPRING 1959-67)

of variable Q_1. In general, as the mean value of Q_1 increases in size relative to its value in previous weeks, the excess demand curve shifts outward relative to its position in the previous weeks. This pattern is reversed for both the price flexibility coefficients and the excess demand curve in the case of a decreasing mean value for variable Q.

Two-Week Period Analysis of Demand

The time period 1959-67 has been analyzed in periods of two weeks each. The LSR equation previously described in the analysis of four-week periods was used to analyze each two-week period. The resulting regression coefficients and the price flexibility coefficients for significant variables are presented in Table 6. Excess demand curves have been plotted as before and are presented in Figures 22 and 23.

In the analysis of two-week time periods, the relationship between the computed excess demand curves and the price flexibility coefficients is more evident than in the analysis of four-week time periods. Table 6 indicates that as the mean value of variable quantity of central Arizona lettuce shipped (Q_1) increases, the price flexibility coefficient, with respect to this variable, also increases. Figures 22 and 23 indicate that the relationship between the position of the excess demand curve and the mean value of variable Q_1 found in the analysis of four-week periods is also exhibited in the analysis of two-week periods. As the mean value of Q_1 increases relative to its value in previous weeks, the excess demand curve shifts outward relative to its position in the previous two-week periods. Again, as has been found in the analysis of four-week periods, this pattern is reversed for both the price flexibility

Table 6. Regression of Central Arizona District Price for Two-Week Periods.

$P = b_o + b_1Q_1 + b_4Q_4 + e$

Weeks	Time Period	Net Regression Coefficients b_1	Net Regression Coefficients b_4	Means $\overline{P}$	Means $\overline{Q}_1$	Means $\overline{Q}_4$	Price Flexibility Q_1	Price Flexibility Q_4
12-13	1959-67	.000096 (.11)	.000785 (1.11)	2.27	762.47	556.87		
14-15	1959-67	-.002918 (5.28)*	.000475 (.95)	1.79	1,014.22	352.39	-1.65	
16-17	1959-67	-.002124 (2.40)*	-.001975 (4.28)*	1.66	736.78	590.11	-.94	-.70
18-19	1959-67	-.000504 (.37)	-.000513 (.47)	1.98	346.59	909.76		
31-32	1959-67	-.003097 (3.06)*	-.001353 (2.32)*	2.02	249.80	1,057.60	-.38	-.79
33-34	1959-67	-.001144 (1.94)**	-.000688 (1.38)***	1.51	752.41	689.06	-.57	
35-36	1959-67	-.001332 (1.54)***	-.000819 (.94)	1.94	1,023.25	335.12	-.70	
37-38	1959-67	-.001487 (2.27)*	-.000779 (1.42)*	1.99	891.17	587.39	-.67	
39-40	1959-67	-.001184 (1.15)	-.000065 (.08)	2.02	480.89	1,031.50		

Table 6. (Continued).

Weeks	Time Period	Net Regression Coefficients b_1	b_4	Means $\bar{P}$	$\bar{Q}_1$	$\bar{Q}_4$	Price Flexibility Q_1	Q_4
41-42	1959-67	-.005599 (2.25)*	.002340 (2.14)*	2.37	230.72	1,063.89	-.54	1.05
43-44	1959-67	-.005517 (1.62)***	.001419 (1.31)	2.30	210.17	1,223.33	-.50	

*See Table 4.

**See Table 4.

***See Table 4.

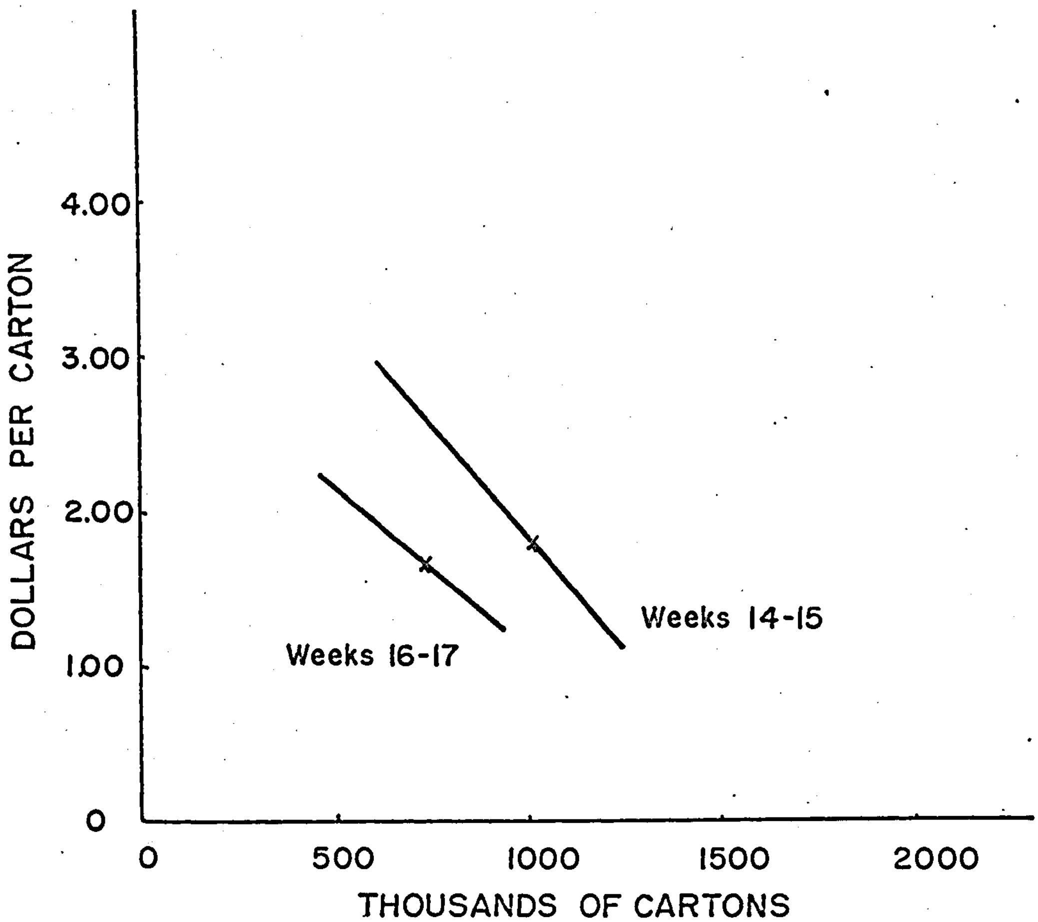


FIGURE 22 ANALYSIS OF DEMAND OF CENTRAL ARIZONA DISTRICT LETTUCE, TWO WEEK PERIODS (FALL 1959-67)

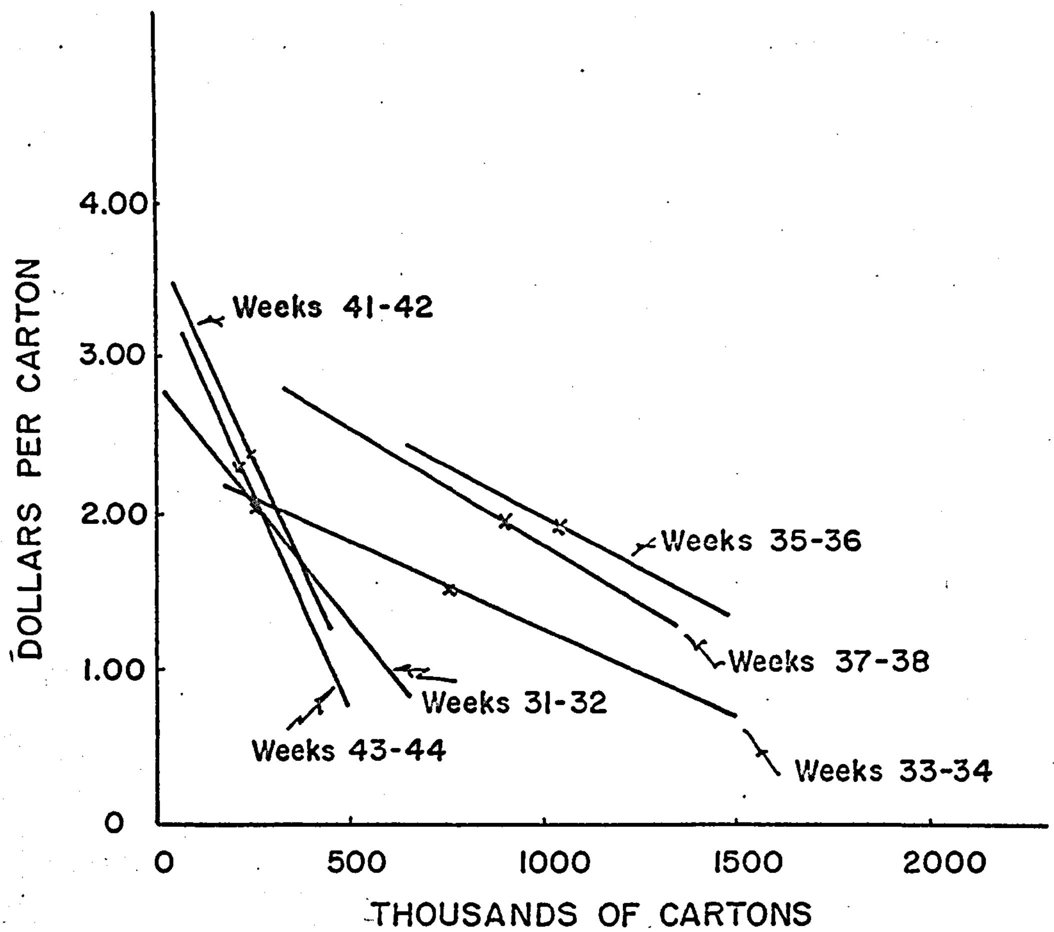


FIGURE 23 ANALYSIS OF DEMAND OF CENTRAL ARIZONA DISTRICT LETTUCE, TWO WEEK PERIODS (SPRING 1959-67)

coefficients and the excess demand curves in the case of a decreasing mean value for variable Q_1.

The 1959-67 subperiods are analyzed in four-week and two-week time periods with the inclusion of selected yearly zero-one variables for the year in which significant shifts were judged to have occurred. The LSR equation of the following form is used in the analysis of each time period:

$$P = b_o + b_1Q_1 + b_4Q_4 + b_nT_n + e$$

The results are presented in Appendix Table 10. The use of the shift variable results in a general increase in the significance level of the shipment variables (Q_1 and Q_3), higher $\bar{R}^2$, and smaller standard errors of the estimate as compared to the previous analysis when only shipment variables were used as independent variables.

Analysis of Demand for the Yuma, Arizona, District Lettuce

The demand relationships for the Yuma, Arizona, district lettuce are analyzed in a manner that parallels the study of central Arizona district lettuce. The Yuma district demand analysis differs from that of the central Arizona district in that shipments are made only during the winter season. The variables included in the demand analysis are the same as those used in the analysis of central Arizona district demand except for the following:

P - deflated f.o.b. Yuma district price for a carton containing two dozen heads of lettuce

Q_5 - total weekly quantity of lettuce, in thousands of cartons, shipped by all districts other than the Yuma district

The same statistical tests are applied to the Yuma district demand analysis as are applied to the central Arizona district demand analysis.

Combined Analysis of Demand

Lettuce is shipped from the Yuma district during the winter season. The LSR equation used to analyze the period 1948-67 is:

$$P = b_o + b_1Q_1 + b_2Q_2 + b_3Q_3 + b_6I + e$$

The following results have been obtained:

$$P = 3.35 - \underset{(4.78)*}{.00950Q_1} - \underset{(1.83)*}{.00655Q_2} - \underset{(4.11)*}{.000807Q_3} - \underset{(1.15)}{.000236I}$$

$$Sy.x = .76 \qquad \bar{R}^2 = .09 \qquad d.f. = 360$$

All quantity variables have the expected sign and their regression coefficients are significant at the five percent level except for the regression coefficient for the variable Q_2 which is significant at the 10 percent level. The income coefficient is not significant.

The 1948-67 period is broken into two subperiods, 1948-58 and 1959-67, and then each is analyzed separately, using the previously described equation form. The reason for the break is that prior to the 1958-59 season weekly data were not reported for truck shipments. The resulting statistical equations for the 1949-58 period and the 1959-67 period are:

1948-58 $$P = 10.88 - \underset{(3.49)*}{.001170Q_1} - \underset{(4.59)*}{.002341Q_2} - \underset{(4.43)*}{.001412Q_3} - \underset{(8.71)*}{.004286I}$$

$$Sy.x = .68 \qquad \bar{R}^2 = .30 \qquad d.f. = 181$$

1959-67 $$P = 1.74 - \underset{(8.50)*}{.002055Q_1} - \underset{(5.03)*}{.002495Q_2} - \underset{(6.72)*}{.001584Q_3} + \underset{(3.62)*}{.001289I}$$

$$Sy.x = .65 \qquad \bar{R}^2 = .29 \qquad d.f. = 173$$

All quantity variables have the expected sign and their regression coefficients are significant at the five percent level. The regression coefficients for income for both subperiods are significant at the five percent level. Again, as is found in the analysis of the central Arizona district, the sign for the income variable changes between the two subperiods. The estimated income elasticity coefficients for the two subperiods are:

1948-58: -31.53

1959-67: +4.96

The breaking of the 1947-67 period into two subperiods results in a considerable improvement in the $\overline{R}^2$, but only a slight improvement in the standard error of the estimate.

To determine if changes in the demand relationship have occurred over time, each subperiod is analyzed with zero-one variables included to represent yearly shifts. The LSR equation of the following form is used to analyze each subperiod:

$$P = b_o + b_1Q_1 + b_2Q_2 + b_3Q_3 + b_nT_n + e$$

The resulting statistical equations are presented in Appendix Table 11. The 1959-67 subperiod is analyzed using income as a variable and zero-one variables for years in which significant shifts are judged to have occurred. The LSR equation of the following form is used to analyze the subperiod 1959-67:

$$P = b_o + b_1Q_1 + b_2Q_2 + b_3Q_3 + b_6I + b_nT_n + e$$

The resulting statistical equation is as follows:

$$P = 3.05 - \underset{(10.15)*}{.002134Q_1} - \underset{(6.66)*}{.002874Q_2} - \underset{(7.68)*}{.001567Q_3} + \underset{(1.70)**}{.000585I}$$

$$+ \underset{(2.24)*}{.299451T} + \underset{(6.78)*}{.879318T_{64}} + \underset{(5.39)*}{.827746T_{66}}$$

$$Sy.x = .56 \quad \bar{R}^2 = .48 \quad d.f. = 270$$

All variables are highly significant at the five percent level, except for the income variable which is significant at the 10 percent level. The quantity and income variables have the expected signs. The estimated income elasticity coefficient is +2.16. There is an improvement in the $\bar{R}^2$ and a slight improvement in the standard error of the estimate.

Annual Analysis of Demand

A yearly analysis of the demand for Yuma district lettuce is made for each of the years 1948 through 1967. The LSR equation of the following form is used to analyze each year:

$$P = b_o + b_1Q_1 + b_2Q_2 + b_3Q_3 + e$$

The results are presented in Table 7. The excess demand curve is plotted in Figures 24 and 25 for each year in which the regression coefficient for quantity of lettuce shipped from the Yuma district is significant at least at the 20 percent level. The excess demand equation is:

$$P = b_o' + b_2Q_2$$

The value of b_o' is computed by the following formula:

$$b_o' + b_0 + b_1\bar{Q}_1 + b_3\bar{Q}_3$$

As is the case with the central Arizona district, there are considerable yearly shifts among the Yuma district excess demand curves. The various demand curves tend to fall into three general slope categories as typified by the curves for the years 1964, 1966 and 1967. As found in the analysis of the central Arizona district, the greater the slope of the curve, the higher the $\bar{R}^2$.

Table 7. Analysis of Demand of Yuma, Arizona, District Lettuce by Years (1948-67).

$$P = b_o + b_1Q_1 + b_2Q_2 + b_3Q_3 + e$$

Year	Regression Constant b_o	Net Regression Coefficients b_1	b_2	b_3	Adjusted R^2
1948	3.45	-.000266 (.24)	-.002314 (2.06)**	-.000554 (.56)	.134
1949	3.06	-.000905 (.47)	-.001520 (.30)	-.000911 (.40)	.097
1950	4.28	-.001778 (2.53)*	-.003426 (2.24)*	-.001240 (1.72)***	.342
1951	1.70	-.000501 (1.40)***	-.001956 (2.08)**	-.000710 (1.74)***	.443
1952	6.71	-.002945 (2.37)*	-.004606 (3.35)*	-.003733 (3.56)*	.551
1953	2.76	-.001210 (1.46)***	-.000074 (.08)	-.001123 (1.50)***	-.042
1954	2.82	-.000068 (.04)	-.000497 (.17)	-.001274 (.86)	-.011
1955	2.41	-.001033 (1.04)	.000354 (.14)	-.000277 (.21)	-.055
1956	2.78	-.000911 (1.09)	-.000013 (.01)	-.001841 (2.33)*	.371
1957	3.66	-.001276 (.59)	-.004679 (1.59)***	-.001919 (1.28)	.119
1958	3.54	-.001117 (.76)	-.003624 (.93)	-.002485 (1.51)***	.002
1959	1.22	.000129 (.21)	-.002125 (1.67)***	.001135 (1.77)**	.392
1960	4.25	-.002063 (1.91)**	-.003565 (1.67)***	-.001271 (1.22)	.177
1961	4.72	-.002700 (2.82)*	-.002256 (.82)	-.002279 (3.45)*	.335
1962	4.55	-.002598 (6.05)*	-.001249 (1.10)	-.002716 (5.31)*	.673
1963	4.33	-.001825 (2.66)*	-.003104 (1.71)***	-.001368 (1.75)**	.175
1964	6.62	-.003598 (7.81)*	-.005047 (4.90)*	-.002045 (4.78)*	.732
1965	2.80	.000163 (.18)	-.001615 (1.51)***	-.000827 (1.17)	.441

Table 7. (Continued).

Year	Regression Constant b_o	Net Regression Coefficients b_1	b_2	b_3	Adjusted R^2
1966	3.51	-.001576 (2.60)*	-.002190 (2.64)*	.000027 (.04)	.619
1967	4.18	-.001767 (2.51)*	-.002154 (1.46)***	-.001723 (2.42)*	.166

*See Table 4.

**See Table 4.

***See Table 4.

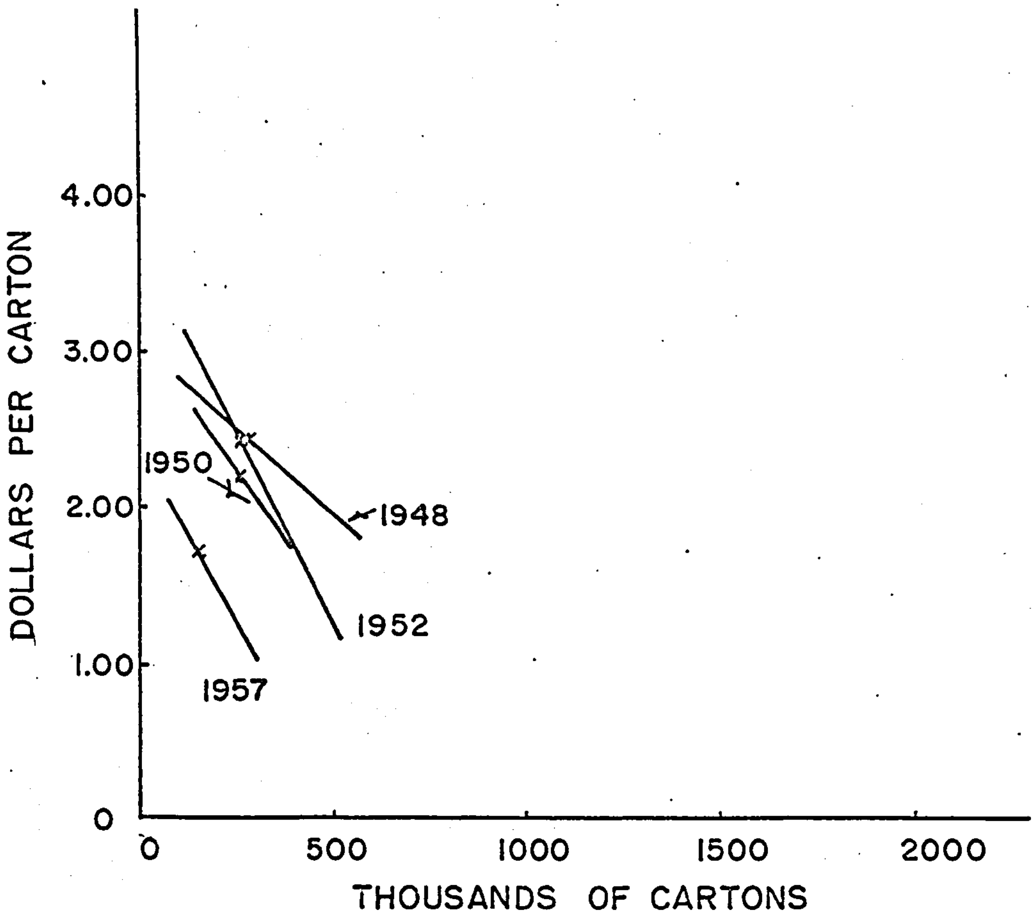


FIGURE 24 ANALYSIS OF DEMAND OF YUMA ARIZONA DISTRICT LETTUCE BY YEARS (1948-58)

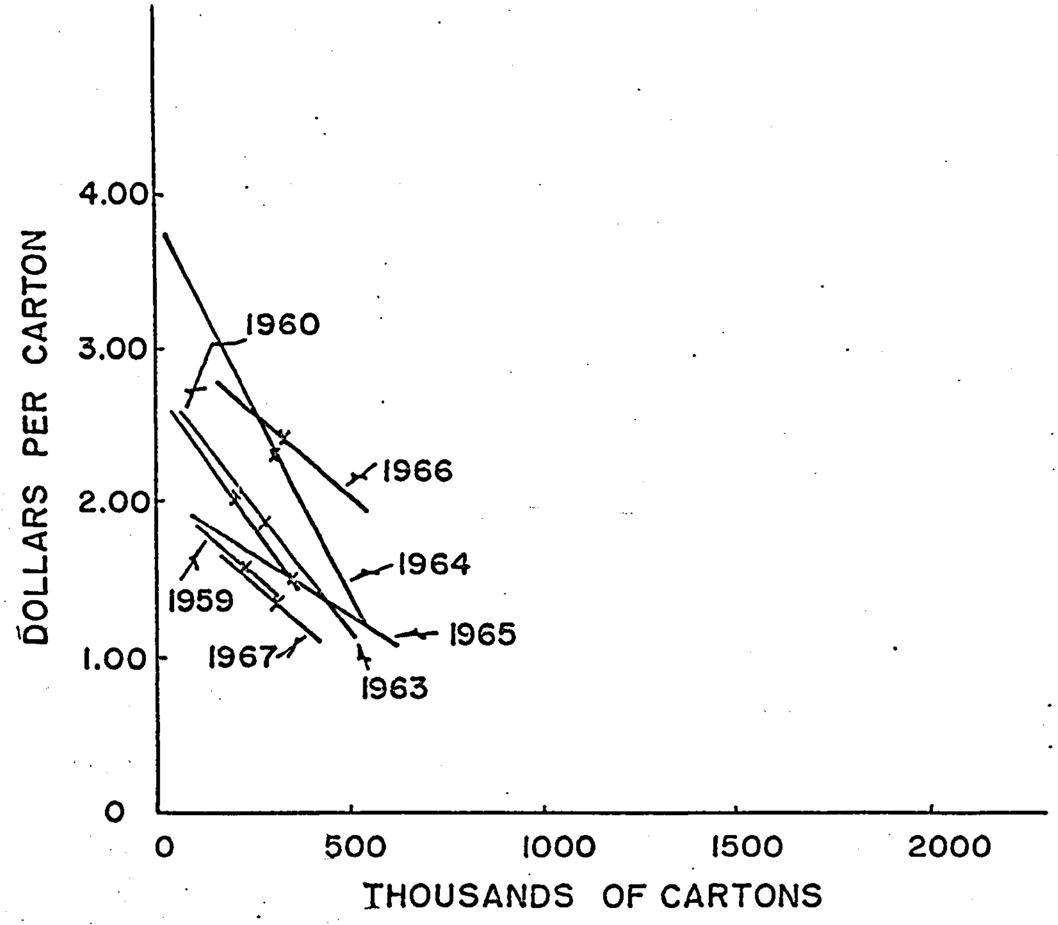


FIGURE 25 ANALYSIS OF DEMAND OF YUMA ARIZONA DISTRICT LETTUCE BY YEARS (1959-67)

Four-Week Period Analysis of Demand

Four-week periods are analyzed for the Yuma district as has been done for the central Arizona district. The LSR equation of the following form is used:

$$P = b_o + b_2Q_2 + b_5Q_5 + e$$

The resulting statistical equations are presented in Table 8. Price flexibility coefficients are computed for each variable when its regression coefficient is significant at least at the 20 percent level. In general, the price flexibility coefficient with respect to the quantity of lettuce shipped from the Yuma district (Q_2) increases as the mean value of variable Q_2 increases. Due to the lack of significant regression coefficients, this is not as evident as in the analysis of the central Arizona district. Excess demand curves are computed for each statistical equation for the 1948-58 and 1959-67 periods in which the variable Q_2 is significant at or above the 20 percent level. The equation for the four-week period excess demand is:

$$P = b_o' + b_1Q_1$$

The value of the regression constant b_o' is computed by the following formula with no restrictions on allowable level of significance on b_5:

$$b_o' = b_o + b_5\bar{Q}_5$$

The curves for the 1948-58 subperiod are presented in Figure 26 and those for the 1959-67 period are presented in Figure 27. Although the shift is not as evident as in the central Arizona district, the computed excess demand curves for the Yuma district tend to shift outward and as the mean value of the variable Q_2 increases relative to its value in the previous week.

Table 8. Regression of Yuma, Arizona, District Price for Four-Week Periods.

$P = b_0 + b_2Q_2 + b_5Q_5 + e$

Weeks	Time Period	Net Regression Coefficients		Means			Price Flexibility	
		b_2	b_5	$\bar{P}$	$\bar{Q}_2$	$\bar{Q}_5$	Q_2	Q_5
16-19	1948-67	-.002094	-.000532	1.99	246.68	921.00	-.26	
		(2.42)*	(1.12)					
21-24	1948-67	-.000425	-.000687	2.11	235.72	921.25		
		(.42)	(1.14)					
25-28	1948-67	.001457	-.001663	1.87	201.77	1,002.80		-.89
		(1.25)	(3.64)*					
29-32	1948-67	-.001338	-.000594	2.00	301.60	885.49	-.20	-.26
		(1.66)*	(1.69)*					
16-19	1948-58	-.004936	.001080	2.20	196.40	840.03	-.44	
		(2.58)*	(1.42)***					
21-24	1948-58	.005359	-.001174	2.11	176.34	842.30	-.45	-.47
		(2.18)*	(1.43)***					
25-28	1948-58	.002358	-.002911	1.83	155.63	899.79		-1.43
		(1.27)	(2.94)*					
29-32	1948-58	-.001763	.000792	2.05	294.76	751.57	-.25	
		(1.81)**	(.89)					
16-19	1959-67	-.000980	-.001660	1.76	299.83	1,006.60		-.95
		(1.05)	(2.66)*					

Table 8. (Continued).

Weeks	Time Period	Net Regression Coefficients b_2	b_5	Means $\bar{P}$	$\bar{Q}_2$	$\bar{Q}_5$	Price Flexibility Q_2	Q_5
21-24	1959-67	-.002677 (2.13)*	-.001932 (2.11)*	2.11	308.30	1,017.75	-.39	-.93
25-28	1959-67	-.001418 (.84)	-.001613 (3.26)*	1.91	250.47	1,111.53		-.94
29-32	1959-67	-.001308 (.84)	-.001265 (2.71)*	1.95	309.58	1,041.72		-.68
33-36	1959-67	-.001126 (1.56)***	-.001527 (3.20)*	1.51	271.11	1,219.56	-.20	-1.23

*See Table 4.

**See Table 4.

***See Table 4.

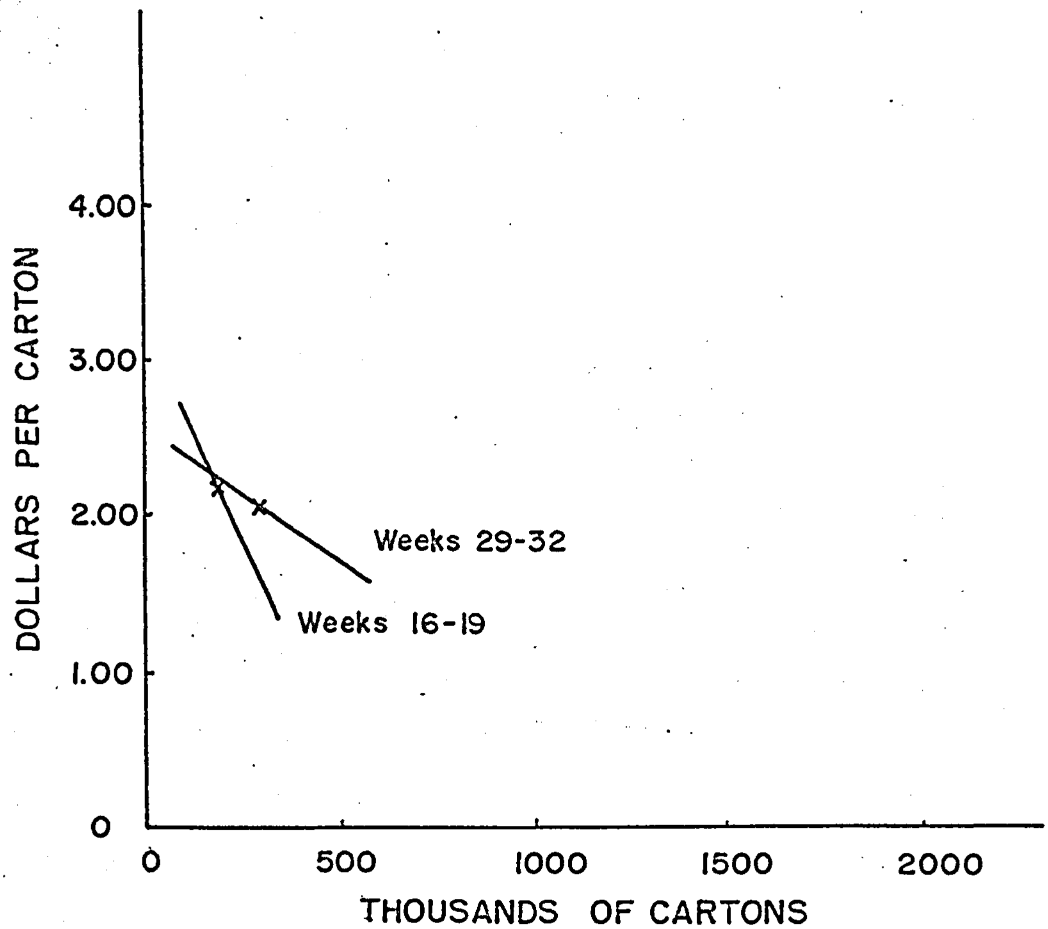


FIGURE 26 ANALYSIS OF DEMAND OF YUMA ARIZONA DISTRICT LETTUCE, FOUR WEEK PERIODS (1948-58)

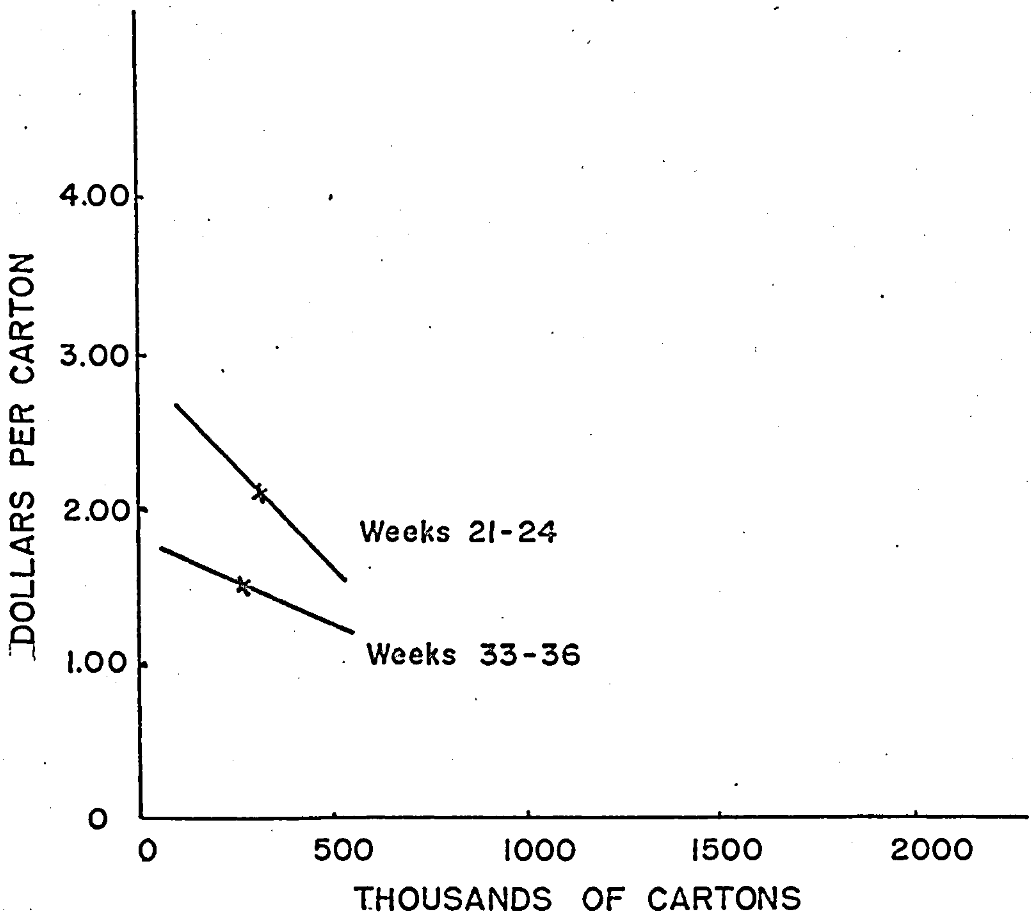


FIGURE 27 ANALYSIS OF DEMAND OF YUMA ARIZONA DISTRICT LETTUCE, FOUR WEEK PERIODS (1959-67)

Two-Week Period Analysis of Demand

The two-week period demand for the Yuma district lettuce is analyzed for the subperiod 1959-67. The LSR equation previously described in the four-week demand analysis is used. The resulting statistical equations are presented in Table 9. Price flexibility coefficients are computed for only the two variables for which the regression coefficient was significant at or above the 20 percent level. The excess demand curves for these equations are plotted in Figure 28. The computed excess demand curves and price flexibility coefficients concur with those of the four-week demand analysis.

The 1959-67 subperiod is analyzed in four-week and two-week time periods with the inclusion of selected yearly zero-one variables for the years in which significant shifts are judged to have occurred. The LSR equation of the following form is used in the analysis of each time period:

$$P = b_o + b_2Q_2 + b_5Q_5 + b_nT_n + e$$

The results are presented in Appendix Table 12. As in the similar analysis of the central Arizona district, the use of shift variables has resulted in a general increase in the significance level of the regression coefficient for the shipment variables (Q_2 and Q_5), a higher $\bar{R}^2$ and a reduction in the size of the standard error of the estimates.

Analysis from Data Adjusted for Lack of Weekly Truck Shipments

Prior to the 1958-59 season, lettuce shipments by truck were not reported. Appendix Table 13 shows the percentage of central Arizona and Yuma district production shipped by truck. This percentage varies from

Table 9. Regression of Yuma, Arizona, District Price for Two-Week Periods.

$$P = b_o + b_2Q_2 + b_5Q_5 + e$$

Weeks	Time Period	Net Regression Coefficients		Means			Price Flexibility	
		b_2	b_5	$\bar{P}$	$\bar{Q}_2$	$\bar{Q}_5$	Q_2	Q_5
16-17	1959-67	-.002014 (1.94)**	-.001451 (1.84)**	1.58	253.18	1,097.41	-.32	-1.01
18-19	1959-67	-.000621 (.33)	-.000899 (.71)	1.94	343.89	920.83		
21-22	1959-67	-.000059 (.03)	-.000408 (.34)	1.76	367.28	1,038.33		
23-24	1959-67	-.002731 (1.08)	-.002983 (2.10)*	2.45	249.33	997.17		-1.21
25-26	1959-67	-.003750 (1.67)***	-.001227 (2.07)**	2.05	250.00	1,089.44	-.46	-.65
27-28	1959-67	.000637 (.23)	-.001655 (1.76)**	1.77	250.94	1,133.61		-1.06
29-30	1959-67	-.002722 (.97)	-.001012 (1.45)***	1.90	278.33	1,095.11		
31-32	1959-67	-.000567 (.24)	-.001502 (2.09)**	1.99	340.83	988.33		-.74
33-34	1959-67	-.000939 (1.10)	-.001355 (2.33)*	1.53	303.21	1,176.78		-1.04

Table 9. (Continued).

*See Table 4.

**See Table 4.

***See Table 4.

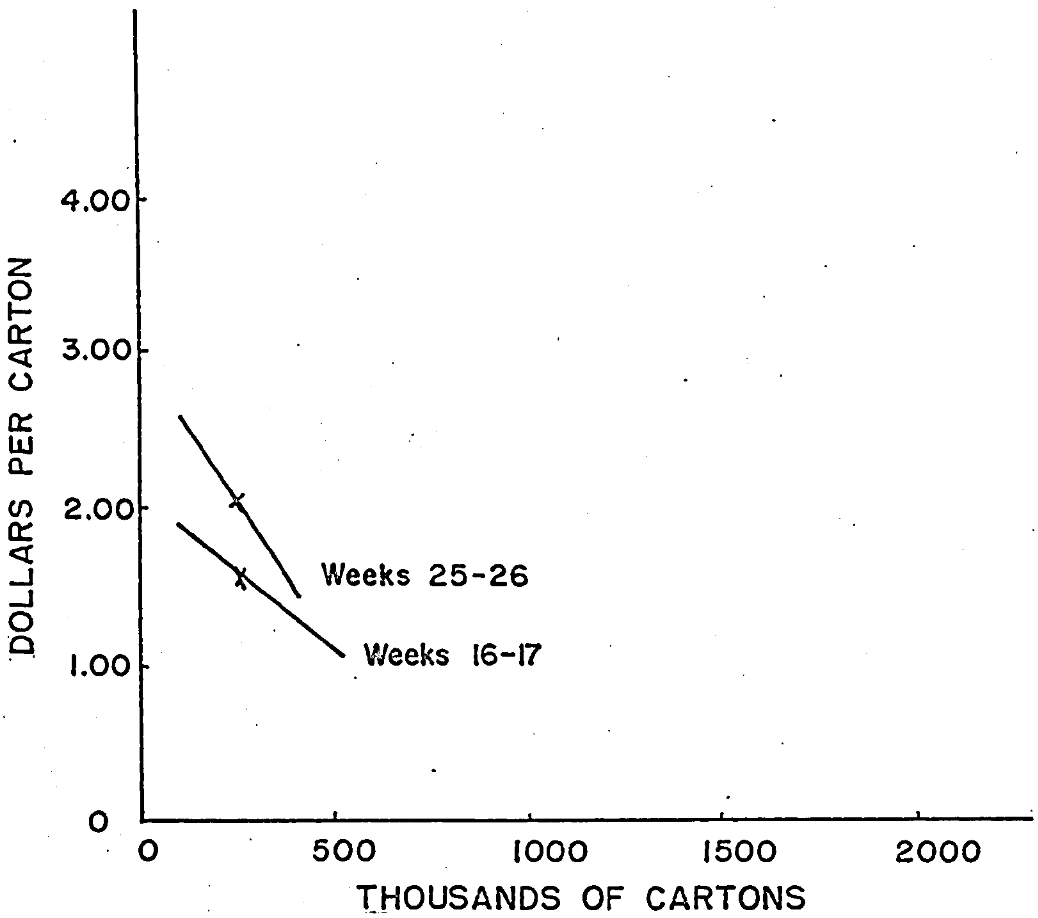


FIGURE 28 ANALYSIS OF DEMAND OF YUMA ARIZONA DISTRICT LETTUCE, TWO WEEK PERIODS (1959-67)

a low of 5.3 percent of the 1950 fall season central Arizona district production to a high of 45.5 percent of the 1958 Yuma district production. Some of the unexplained price variation for lettuce in the 1948-58 period may have occurred because of this error in measurement of the shipment variables involved. According to Shuffett (1954) errors in the independent variables tend to bias the regression coefficients between the dependent variable and the several independent variables involved toward zero. To determine the effect of the errors in shipment data for the 1948-58 period, an analysis has been made of the demand for lettuce for each of the Arizona districts with the adjusted data.

The weekly shipment data from the central Arizona district and all other districts outside of Arizona for each year were adjusted by multiplying the reciprocal of the complement to the percentage of central Arizona district lettuce production shipped by truck for each season of each year. Yuma district shipments are adjusted in relation to their annual percentage of lettuce production shipped by truck. The demand for lettuce from each district is analyzed for the subperiod 1948-58. The demand for central Arizona district lettuce for the 1948-58 subperiod is also analyzed on a seasonal basis. The equation form is the same as those used in the previous analyses of each of the Arizona districts. The resulting statistical equations are presented in Appendix Table 14. The implied income elasticity coefficients are as follows:

Central Arizona			Yuma
	1948-58	-4.56	-19.8
Fall	1948-58	-4.02	
Spring	1948-58	-5.36	

The adjusted data are also analyzed with zero-one variables included. The resulting statistical equations indicated very little change from the similar analysis made with unadjusted data. In general, the analysis with adjusted data resulted in a reduction in the size of the implied income elasticity coefficients and a slight reduction in the size of the various regression coefficients and their levels of significance.

CHAPTER V

VARIATIONS IN ARIZONA LETTUCE PRICE

Weekly average f.o.b. Arizona lettuce price is subject to extreme fluctuation. Figure 29 shows the weekly average price for the central Arizona district and the Yuma district for the years 1948 through 1967. There is no indication of any recurring trends or cyclical patterns for this period during which weekly observations are plotted.

It is to be expected that variations in the quantity of lettuce shipped would be important in explaining the price variations. The objectives of this chapter are to examine the relationships between variations in Arizona lettuce price and variations in the quantity of lettuce shipped. The price variations in each of the two major districts, central Arizona and Yuma, are analyzed separately. Price and quantity data are the same weekly observations used in Chapter IV.

Model for Analysis

The model used to analyze lettuce price variations is of the same type as developed by Firch (1963). This model allocates the variance of a dependent variable among the various independent variables. The general form of the model used in this analysis is shown by the following equation:

$$P = b_o + b_1Q_1 + b_2Q_2 + e \qquad \text{(I)}$$

It can be shown that the variance of the dependent variable (P) is a function of the variances and covariance of the two independent

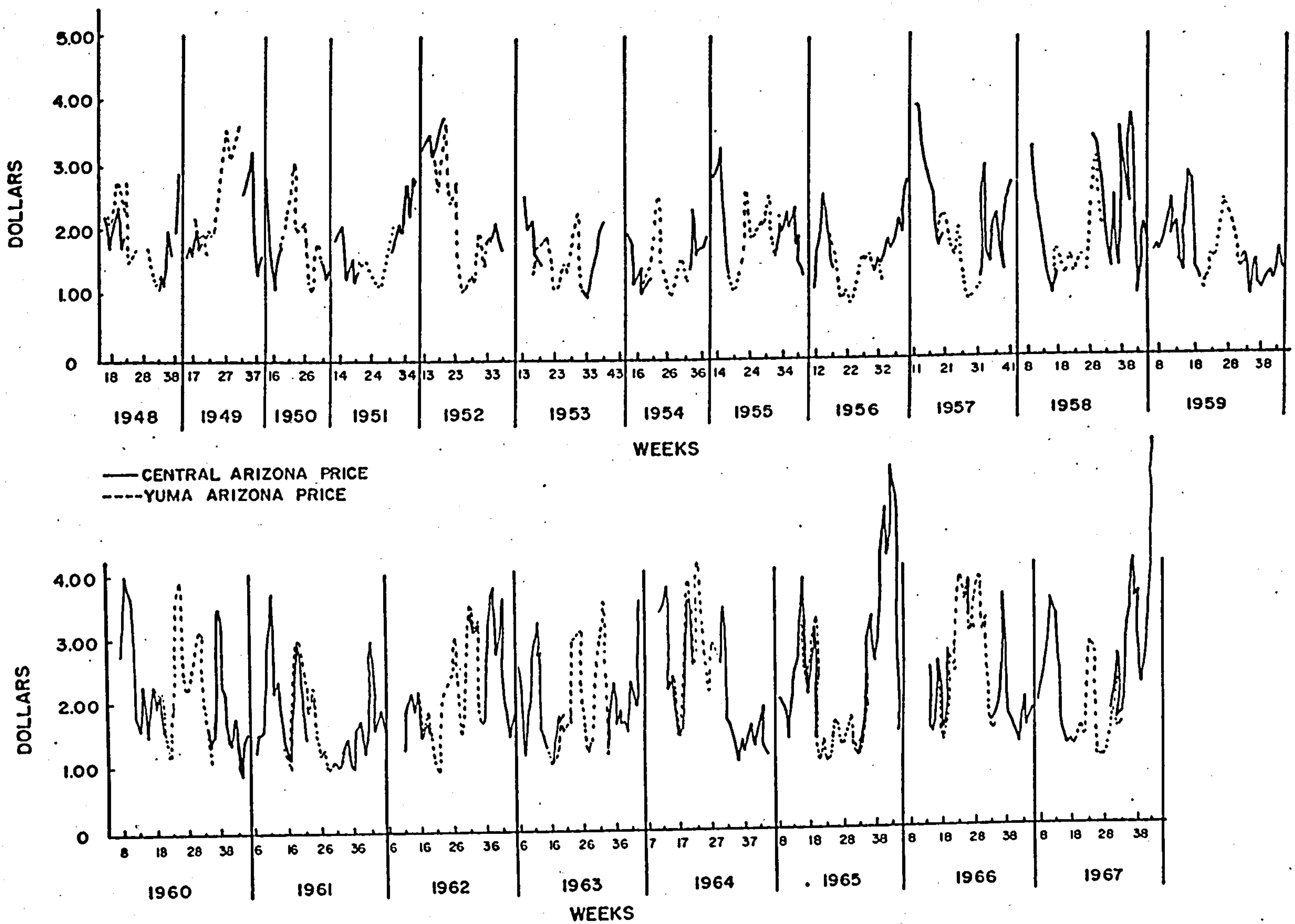


FIGURE 29 LETTUCE WEEKLY AVERAGE PRICES FOR CENTRAL ARIZONA DISTRICT AND YUMA ARIZONA DISTRICT

variables (Q_1 and Q_2) and those variables not explicitly included in the equation but represented by the term (e). This is illustrated in the following equation:

$$E_1 = E_2 + E_3 + E_{2,\,3} + E_e \qquad \text{(II)}$$

where E_1 is the variance of the dependent variable

$E_2 = b_1^2 \, \sigma Q_1^2$

$E_3 = b_2^2 \, \sigma_{Q_2}^2$

$E_{2,\,3} = b_1 b_2 \, \sigma_{Q_1 Q_2}$

$E_e = \sigma_e^2$

All of the information needed to make the allocation of the variance in Equation II is obtained from the least-square estimation of the regression coefficients (b_1 and b_2) of the equation. The value of E_e may be obtained as the difference between the variances of dependent variable (P) and the first three terms on the right side of the Equation II.

The various elements of Equation II may be interpreted in the following manner. The total variance in the dependent variable is shown on the left side of the equation. The first two terms on the right side of the equation represent the variance of the dependent variable associated with the variance of each of the two independent variables. Both of these terms are positive since the variance and the computed squares of regression coefficients can only have positive signs. The third term on the right side of Equation II is the variance of the dependent variable associated with the covariance of the two independent variables. This term may be positive or negative. A positive term indicates that the covariance of the two independent variables yields a net increase in the variance of the dependent variable. A negative term indicates that the variance of the two independent variables offsets each other, thus, yielding a smaller variance in the dependent variable than would occur if the covariance were zero. The final term in Equation II represents the variance of the dependent variable not accounted for by the sum of the variances and covariance of the two independent variables; a positive or zero value may result.

Analysis of Central Arizona District Price Variations

The analysis of the central Arizona district price variations is broken into two seasonal analyses corresponding to the fall and spring shipping seasons. The variables analyzed are:

- P - average weekly f.o.b. central Arizona district price for a carton containing two dozen heads of lettuce
- Q_1 - total weekly quantity of lettuce, in thousands of cartons, shipped from the central Arizona district
- Q_2 - total weekly quantity of lettuce, in thousands of cartons, shipped by all districts other than the central Arizona district
- e - error term representing the net effects of variables not explicitly included in the analysis

Analysis of Central Arizona District Fall Season Price Variations

Table 10 and Figure 30 show the analysis of the fall season central Arizona district weekly price variations for the years 1948 through 1967. The total variance of average weekly price has shown

Table 10. Fall Season Variance[a] of Central Arizona Price and Allocation of Variance Among Lettuce Shipments from Central Arizona District and All Other Districts.

Year	Central Arizona Price E_1	Central Arizona Shipments E_2	All Other Shipments E_3	Covariance $E_{2,3}$	R^2
1948	479	2.02	57.17	4.23	.13
1949	285	64.89	13.74	-24.96	.19
1950	1,268	463.76	283.30	104.63	.67
1951	527	8.90	151.67	-37.11	.23
1952	43	40.69	31.28	-46.70	.58
1953	133	.29	98.83	3.27	.77
1954	658	21.56	54.66	37.34	.17
1955	629	67.99	682.82	-258.49	.78
1956	724	1.35	610.09	22.91	.88
1957	164	73.09	10.60	-15.15	.41
1958	378	2.44	226.54	24.91	.67
1959	1,073	84.38	271.19	-30.38	.30
1960	1,775	38.79	1,744.64	-418.05	.77
1961	1,091	13.16	2.89	-5.63	.00
1962	628	.23	58.36	-4.37	.09
1963	1,059	19.75	12.75	-12.68	.01
1964	1,152	440.59	241.20	-448.31	.20
1965	1,068	145.88	40.35	-43.89	.13
1966	2,147	401.80	2.44	1.53	.19
1967	357	.52	5.98	2.18	.02

a. Variance in $(\%\Delta)^2$.

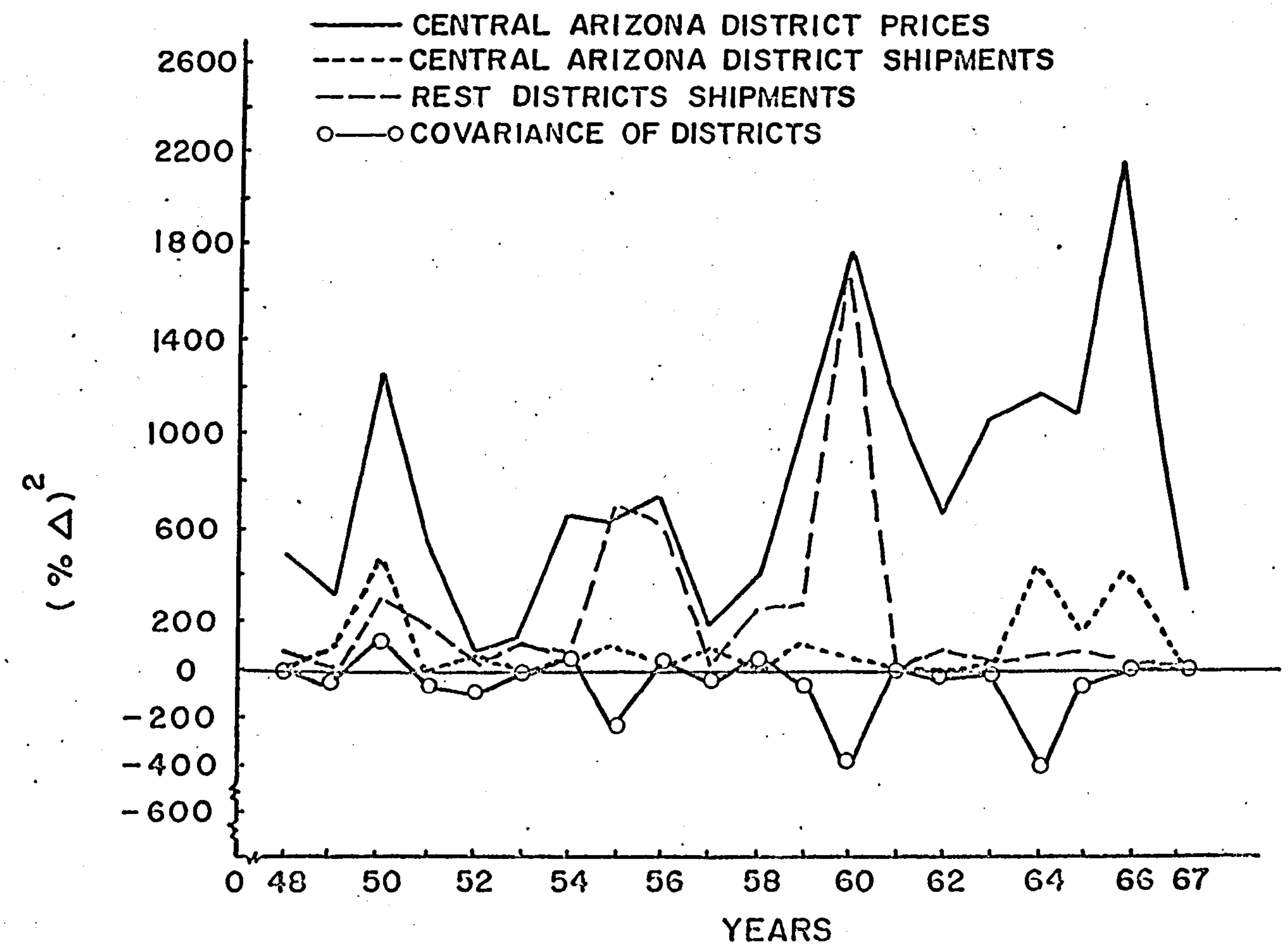


FIGURE 30 FALL SEASON VARIANCE – COVARIANCE ANALYSIS OF CENTRAL ARIZONA DISTRICT PRICES

erratic changes from year to year. The years 1959 through 1966 are characterized by extremely high variance. In 1966, the standard deviation of price was over 46 percent. This means that week-to-week changes within a plus or minus 46 percent would have been expected to include only about two-thirds of the price changes that occurred. The variance in price associated with weekly shipments originating from the central Arizona district indicates no discernible trend. This is also the case for the variance in price associated with shipments originating from districts other than the central Arizona district. For 12 of the 20 years, the effect of the covariation between shipments from the central Arizona district and those of all other districts is to reduce the price variance. The unexplained variation in price is a high proportion of the total for most of the years.

Analysis of Central Arizona District
Spring Season Price Variations

Table 11 and Figure 31 show the analysis of the spring season central Arizona district weekly price variations for the years 1948 through 1967. The total variance of price for the period shows no discernible trend. As in the fall season analysis, a large portion of the price variation is left unexplained by the variances and the covariances of the two independent variables. For 13 of the 20 years, the effect of the covariance between shipments from the central Arizona district and shipments from all other districts has been to reduce the price variance.

Table 11. Spring Season Variance[a] of Central Arizona Price and Allocation of Variance Among Lettuce Shipments from Central Arizona District and All Other Districts.

Year	Central Arizona Price E_1	Central Arizona Shipments E_2	All Other Shipments E_3	Covariance $E_{2, 3}$	R^2
1948	733	313.16	263.76	-348.55	.31
1949	942	110.10	749.47	-355.78	.53
1950	545	252.83	55.32	236.53	1.00
1951	278	6.45	11.18	5.33	.04
1952	209	1.04	209.87	-16.56	.93
1953	654	30.16	263.58	83.04	.58
1954	1,750	2,244.68	1,453.28	-2,511.35	.68
1955	422	34.25	51.09	24.01	.26
1956	224	115.14	22.95	-54.71	.37
1957	1,901	384.28	496.42	-495.02	.20
1958	1,967	8.90	14.30	-7.05	.01
1959	420	4.72	59.80	-15.08	.12
1960	1,739	546.91	224.99	-231.28	.31
1961	914	33.54	27.98	24.53	.09
1962	1,097	114.36	36.07	55.69	.17
1963	1,396	388.92	.13	-7.64	.27
1964	859	20.70	60.63	-31.45	.06
1965	1,327	.03	112.51	-1.71	.08
1966	819	10.14	21.85	-10.16	.03
1967	357	.52	5.98	2.18	.02

a. Variance in $(\%\Delta)^2$.

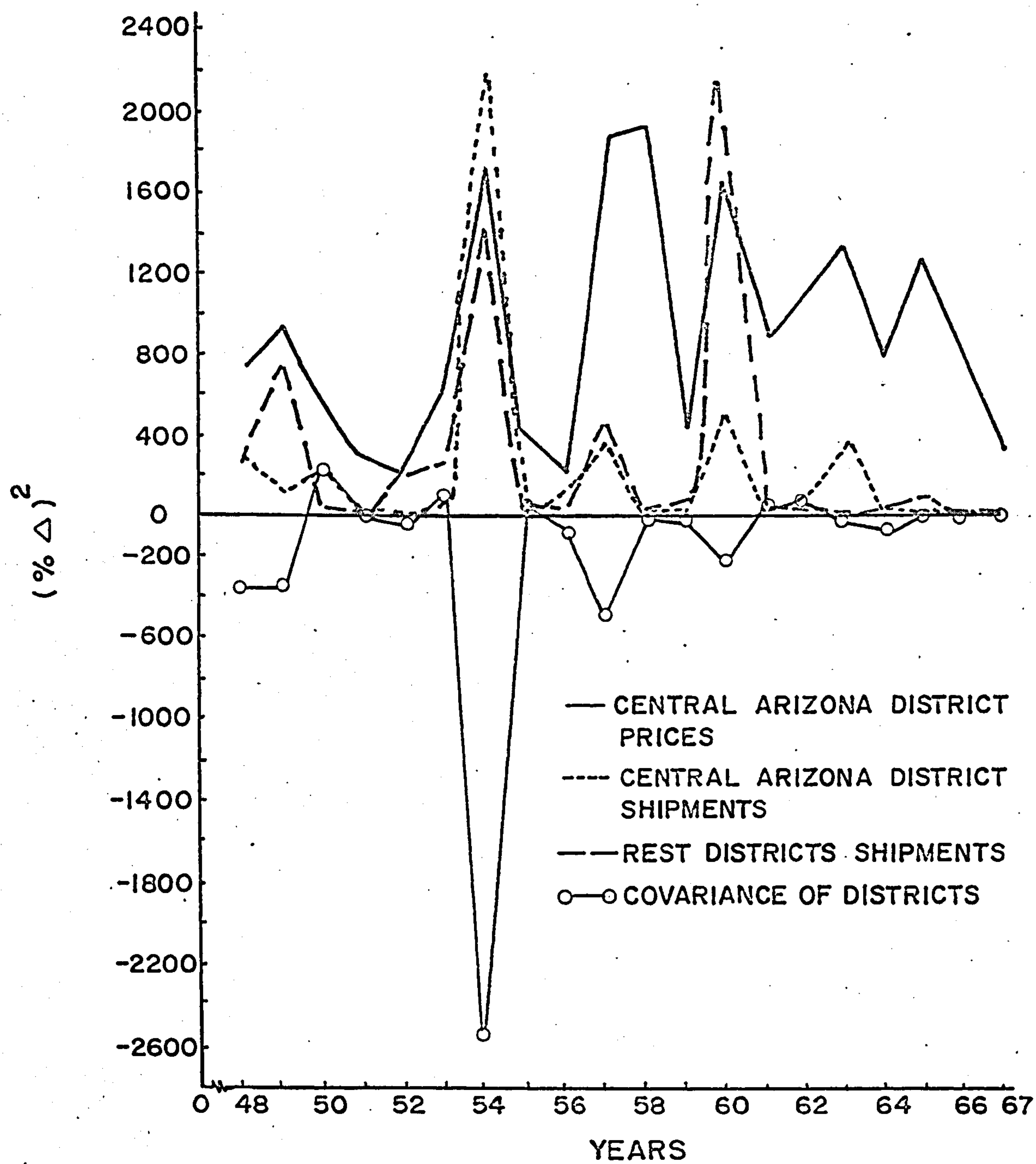


FIGURE 31 SPRING SEASON VARIANCE – COVARIANCE ANALYSIS OF CENTRAL ARIZONA DISTRICT PRICES

Analysis of Yuma District Price Variations

Table 12 and Figure 32 show the results of the analysis of the Yuma district weekly price variation for the years 1948 through 1967. The variables analyzed are:

P - average weekly f.o.b. Yuma district price for a carton containing two dozen heads of lettuce

Q_1 - total weekly quantity of lettuce, in thousands of cartons, shipped from the Yuma district

Q_2 - total weekly quantity of lettuce, in thousands of cartons, shipped by all districts other than the Yuma district

e - error term representing the net effects of variables not explicitly included in the analysis

For the years 1948 through 1967, weekly price variations have tended to increase. The variance of the Yuma price does not reach the higher levels of the central Arizona price variance. The variance associated with the two independent variables indicates no particular pattern. The variances and covariances of the independent variable leave a large amount of the variance in price unexplained. For 12 of the 20 years, the effect of the covariance between shipments from the Yuma district and shipments from all other districts is to reduce the price variance. As compared to the analysis of central Arizona district price variations, the variance analysis of the Yuma district price variations resulted in lower $\overline{R}^2$ for most of the years analyzed.

The analysis of variance of lettuce prices illustrates a fact well-known to members of the industry, that lettuce prices are extremely

Table 12. Seasonal Variance[a] of Yuma, Arizona, Price and Allocation of Variance Among Lettuce Shipments from the Yuma District and All Other Districts.

Year	Yuma, Arizona Price E_1	Yuma, Arizona Shipments E_2	All Other Shipments E_3	Covariance $E_{2,3}$	R^2
1948	543	.84	.06	-0.01	.00
1949	239	.04	41.52	1.76	.18
1950	625	1.59	39.30	-1.10	.06
1951	195	4.05	5.38	3.87	.07
1952	781	32.04	21.68	-14.11	.05
1953	465	14.72	14.82	-13.47	.04
1954	1,206	26.91	6.45	-1.57	.03
1955	534	16.89	9.55	8.49	.06
1956	325	3.64	3.66	.55	.02
1957	521	12.28	.05	-0.28	.02
1958	737	266.09	6.24	-5.10	.36
1959	333	11.09	54.32	-5.54	.18
1960	759	.55	40.76	-1.12	.05
1961	640	13.87	48.27	2.11	.10
1962	1,013	.33	297.96	-4.05	.29
1963	1,223	1.03	429.76	12.16	.36
1964	872	102.58	228.19	-125.96	.24
1965	928	295.40	37.59	-23.63	.33
1966	953	112.98	1.85	8.70	.13
1967	973	29.64	54.11	4.08	.09

a. Variance in $(\%\Delta)^2$.

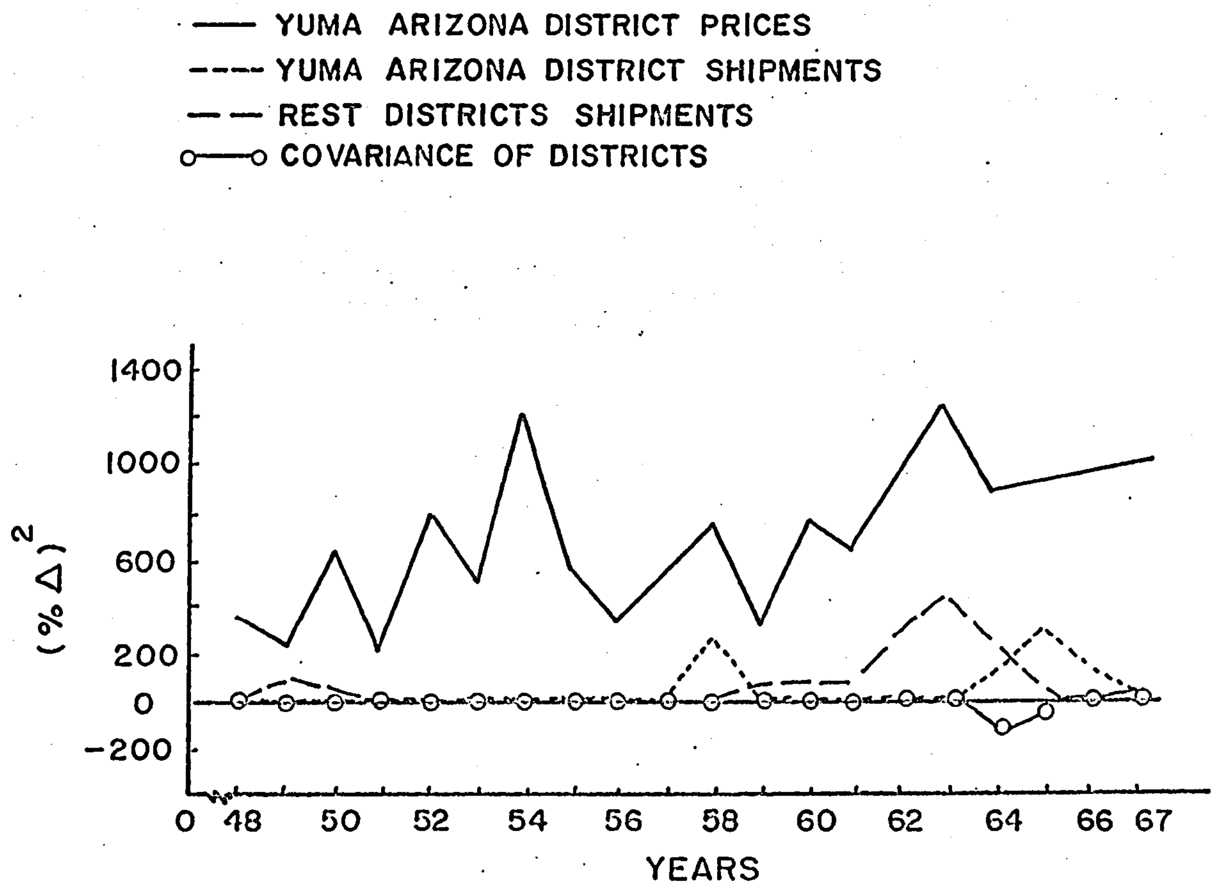


FIGURE 32 VARIANCE - COVARIANCE ANALYSIS OF YUMA DISTRICT PRICES

variable even from one week to the next. There appear to be no particular long-term trends in the variance of lettuce prices or their sources.

CHAPTER VI

SUMMARY AND CONCLUSIONS

A high proportion of commercial lettuce production in the United States takes place in the four-state area of California, Arizona, Texas and New Mexico. For the years 1948-67, the western lettuce industry has consistently accounted for over 85 percent of the total United States commercial lettuce production. Lettuce is shipped by the western lettuce industry year-round with California as the largest shipper, followed by Arizona, Texas and New Mexico.

Interregional and Intertemporal Shifts in the Production of Lettuce

Shifts in the seasonal shipping patterns of the major districts in the western lettuce industry have occurred over time. These shifts become apparent as one district begins shipping earlier or extends its season while a competing district ends its season earlier or begins its shipping season later. To analyze these shifts, a descriptive graphic analysis was made of each of the major districts for five defined periods. Shifts are analyzed as to the date each incoming district surpasses a competing outgoing district in weekly shipments.

During Periods Two (1938-42) and Three (1954-59), the shipping season for the central Arizona district shifted into weeks previously occupied by the Salinas-Watsonville district in the fall and spring seasons. This outward shift by the central Arizona district is reversed in Period Four (1959-64) and Period Five (1964-67) with the Salinas-Watsonville district's shipping season shifting into weeks occupied by the central Arizona district in Period Three.

Also in Periods Two and Three, both the Imperial Valley district and the Yuma district shifted into weeks previously occupied by the central Arizona district. This outward shift by the Imperial Valley district and the Yuma district ceased in the fourth and fifth periods.

The southern California district has established a shipping season that tends to fill the voids between the shipping season of the central Arizona district and the Imperial Valley and Yuma districts. The shipping pattern of the Texas district exhibits no significant shifts for the periods analyzed. In Period Three, the New Mexico district begins shipments of consequence. The shipping season for the New Mexico district encompasses the period when the shipping seasons for the Salinas-Watsonville district and the central Arizona district are crossing.

Analysis of Demand for Arizona Lettuce

The analysis of demand of Arizona lettuce was subdivided into the analysis of demand of central Arizona district lettuce and the analysis of demand for Yuma district lettuce. The basic price and quantity data were obtained from the Federal-State Market News Service annual summaries. Price data used are the simple weekly average of the daily quoted "mostly" f.o.b. weekly prices for a carton containing two dozen heads of lettuce. Shipment data were converted to thousands of cartons per week. Price data were deflated by the gross national product implicit price deflator and shipment data were deflated by population.

Because of the single market nature of lettuce, its perishability and the use of weekly data, the use of single equation models was felt to be appropriate for the analysis of lettuce demand. To analyze the demand, various equation forms were imposed on the data; linear in logarithms, semilog and linear. Of these, the linear equations resulted in the best fit to the data as evidenced by the consistently higher values for the $\overline{R}^2$ and lower values for the standard error of the estimate. The data for each of the districts were analyzed separately by the least-squares regression technique for the period 1948-67 and the subperiods 1948-58 and 1959-67. A seasonal analysis, fall and spring, was made with the central Arizona district data.

Statistically significant regression coefficients were obtained for all quantity variables for each time period analyzed. Income was significant only in the analysis of subperiods and seasons, but had a negative sign for the 1948-58 subperiod and the seasonal analysis in that subperiod. For this subperiod, daily truck shipment data were not reported. An additional analysis was made of the 1948-58 period with data adjusted for nonreported truck shipments. There were very few changes in the results. The implied income elasticity coefficient had a negative sign as in the previous analysis but was reduced in magnitude. In general, the adjusted coefficients of multiple determination were too low and the standard error of the estimate too high to suggest much predictive value for these equations.

Annual Analysis

The demand for lettuce for the central Arizona and Yuma districts is analyzed for each year, 1948 through 1967. Yearly excess demand curves are plotted for each district for those years in which the shipment variables for the district are significant. The resulting excess demand curves indicate a significant shift in the yearly excess demand curve for each district. A relationship has been noted between the degree of slope of the various curves and the $\overline{R}^2$ for the statistical equation for these curves. Generally the curve with the greatest slope tends to have the highest $\overline{R}^2$. This may suggest the possibility of regression bias distorting the results for certain years.

Intraseasonal Demand Analysis

Study of the cyclical shipping patterns of the major districts in the western lettuce industry indicates the applicability of the concept of excess demand. The excess demand model that has been formulated represents a comparative static analysis of the excess demand facing a district as it moves through a shipping season.

It follows from the excess demand model developed in Chapter II that as the portion of lettuce originating from a district increases, the excess demand curve for this district would shift outward and become less elastic. This shift may continue until the district is accounting for the total lettuce shipments, at which point the excess demand curve would in effect be the total market demand curve and the elasticity would have decreased until it was equal to the elasticity of the total market demand curve. As shipments from a district decrease, the excess demand curve shifts to the left and becomes more elastic.

The demand for central Arizona district lettuce and for Yuma district lettuce was analyzed separately in sets of four-week and two-week time periods. Price flexibility coefficients are estimated when significant regression results were obtained. Excess demand curves are plotted for each of the districts when their respective shipment variables have a significant coefficient. The computed excess demand curves and their respective price flexibility coefficients give strong support to the formulated excess demand model.

An analysis was made of each district for the 1959-67 subperiod in sets of four-week and two-week time periods. Zero-one shift variables were included in the demand model for those years in which significant shifts were judged to have occurred. This generally resulted in the improvement of the significance of the various regression coefficients, increases in the values of the $\overline{R}^2$, decreases in the values of the standard error of the estimate, but little or no significant change in the values of the regression coefficients.

Weekly Price Variations

Within any one season, weekly average lettuce price is subject to extreme fluctuations. A plot of the central Arizona district and the Yuma district prices for the years 1948-67 indicates no cyclical patterns or reoccurring trends. A variance analysis of weekly prices for each of the Arizona districts indicates that a substantial amount of price variation cannot be explained by variations in weekly lettuce shipments. For the majority of years, the effect of the covariance of shipments from each of the Arizona districts and shipments from all other districts has been to decrease the price variation of each of the Arizona districts.

Intercorrelation Among Independent Variables

The regression analysis of the central Arizona district and the Yuma district lettuce data resulted in a high degree of intercorrelation between the various quantity variables that were used as independent variables. The relative sizes of the partial correlation coefficients between the various independent variables and between the dependent variable and the various independent variables suggest the possibility that the statistical relationships in these analyses may be biased. However, it is felt that the high degree of intercorrelation among the independent variables may not have substantially biased the values of the regression coefficients because of (1) the stability of the various regression coefficients in the analyses over differing time periods, (2) the high degree of significance of the regression coefficients, and (3) the compatibility of the signs of these coefficients to the theoretical expectation.

Implications of Results

The Arizona lettuce industry has shown interest in controlling the supply of lettuce by restricting production through "plow up" programs. The underlying premise of such a program is that the demand for lettuce facing a district is inelastic at the farm level and that by restricting production of lettuce in that district, total revenue for the district can be increased.

The results of the intraseasonal analysis of demand for Arizona lettuce indicate that the excess demand curves facing each of the major Arizona districts have price flexibility coefficients of less than one;

thus, a one percent change in the quantity of lettuce supplied by either of these districts would result in less than one percent change in the price of lettuce. This implies that any restriction upon supply of lettuce by one of the Arizona districts would result in a decrease in total revenue from lettuce sales for that district. Because the price elasticity of demand facing a particular district appears to be higher at the beginning and end of its shipping season, a supply reduction program at those times would surely not be desirable for the producers in that district.

APPENDIX

STATISTICAL TABLES

Appendix Table 1. Supplemental Data.

Year	GNP Implicit Price Index 1958 = 100	Index of United States Population 1958 = 100	Per Capita Disposable Income (1958 Dollars)
1948	78.2	84.2	1,237
1949	79.7	85.7	1,274
1950	78.3	87.2	1,340
1951	84.8	88.6	1,440
1952	86.7	90.2	1,485
1953	88.4	91.7	1,571
1954	89.5	93.3	1,582
1955	90.2	94.9	1,620
1956	92.6	96.6	1,713
1957	96.4	98.3	1,785
1958	99.3	100.0	1,804
1959	101.1	101.7	1,882
1960	102.6	103.8	1,929
1961	104.3	105.6	1,942
1962	105.5	107.3	2,041
1963	106.7	108.9	2,103
1964	108.3	110.5	2,214
1965	110.1	112.0	2,325
1966	112.0	113.4	2,525
1967	116.0	115.2	2,667

Source: GNP Implicit Price Index was taken from the Survey of Current Business, United States Department of Commerce, Office of Business Economics, annual publications 1948-67.

Index of United States Population was taken from "Working Data for Demand Analysis," United States Department of Agriculture, Economic Research Service, April 1967.

Per Capita Disposable Income was taken from "Working Data for Demand Analysis," United States Department of Agriculture, Economic Research Service, April 1967.

Appendix Table 2. Average Number of Cartons per Railcar and Truck Van Shipped by Arizona Lettuce Districts (1948-67).

	Central Arizona District				Yuma, Arizona, District	
	Fall Season		Spring Season			
Year	Railcar	Truck Van	Railcar	Truck Van	Railcar	Truck Van
1948	666		644		670	
1949	660		640		662	
1950	670		658		668	
1951	676		666		702	
1952	664		680		714	
1953	662		654		664	
1954	639		634		630	
1955	634		632		633	
1956	625		627		631	
1957	634		624		627	
1958	517		592		634	
1959	683	642[a]	719	663	672	646
1960	670	636	642	636	651	650
1961	670	670	723	718	682	641
1962	740	634	774	639	723	642
1963	759	626	753	635	720	639
1964	751	614	852	630	769	641
1965	843	617	905	623	841	640
1966	866	612	960	807	938	831
1967	1,024	792	1,024	804	1,043	825

a. Truck shipments were not reported prior to the 1958-59 season.

Source: Computed from Federal-State Market News Service, United States Department of Agriculture, Marketing Central and Eastern Arizona Lettuce, Brief Summary of Fall and Spring Season, annual issues 1948-67, Phoenix, Arizona, and from Federal-State Market News Service, United States Department of Agriculture, Marketing Yuma District Lettuce, annual issues 1948-67, Yuma, Arizona.

Appendix Table 3. Yearly Estimated Production and Actual Production of Lettuce, in Thousands of Cartons, for Major Arizona Districts (1948-67).

	Central Arizona District Production			Yuma, Arizona, District Production		
Year	Actual	Estimated	Difference[a]	Actual	Estimated	Difference[a]
1948	8,796	8,180	616	5,230	4,330	900
1949	8,384	7,638	746	5,200	4,217	983
1950	7,574	5,038	2,536	5,090	4,106	984
1951	5,801	8,971	3,170	5,564	4,284	1,280
1952	8,225	7,059	1,166	5,494	4,241	1,253
1953	8,679	7,789	890	4,832	3,721	1,111
1954	8,652	7,860	792	1,743	3,048	1,305
1955	9,374	8,425	942	4,969	2,988	1,981
1956	11,780	9,902	1,878	4,602	3,234	1,368
1957	12,587	9,153	3,434	3,712	2,210	1,502
1958	17,085	11,166	5,919	3,758	2,037	1,721
1959	18,193	18,127	66	4,349	4,137	212
1960	18,744	18,683	61	4,349	4,331	18
1961	18,683	18,513	170	4,618	4,593	25
1962	18,226	18,189	37	6,054	5,912	142
1963	17,180	17,099	81	6,411	6,393	18
1964	15,016	14,916	100	7,939	7,963	24
1965	14,993	14,851	142	7,962	7,952	10
1966	14,314	13,945	369	7,563	7,937	374
1967	14,269	13,967	302	6,959	6,931	28

a. Difference arises as the computational process allows only for seasonal variations in the average number of cartons per railcar or truck van and not in-seasonal variations.

Source: Computed from Federal-State Market News Service, United States Department of Agriculture, Marketing Central and Eastern Arizona Lettuce, Brief Summary of Fall and Spring Season, annual issues 1948-67, Phoenix, Arizona, and from Federal-State Market News Service, United States Department of Agriculture, Marketing Yuma District Lettuce, annual issues 1948-67, Yuma, Arizona.

Appendix Table 4. Period One Average Weekly Carload Shipments of Lettuce, in Thousands of Cartons, for Each Major Western Lettuce Industry District (1939-42).

Week Number	Central Arizona	Yuma, Arizona	Salinas-Watsonville	Imperial Valley	Western Lettuce Industry
11			498		498
12			541		541
13			640		640
14	1		690		691
15	32		539		571
16	236	3	292		531
17	420	34	103	11	568
18	723	79	15	45	862
19	623	104	1	96	824
20	313	132		191	636
21	166	171		361	698
22	99	163		553	815
23	40	144		662	846
24	13	106		678	797
25	8	98		667	773
26	9	109		678	796
27	39	199		602	840
28	88	246		449	783
29	176	248		317	741
30	279	295		230	804
31	369	321		113	803
32	559	262		57	878
33	721	123	3	10	857
34	709	30	45		784
35	455	1	203		659
36	197		556		753
37	43		850		893
38	10		1,057		1,067
39			945		945
40			688		688
41			547		547
42			359		359
43			320		320
44			315		315
45			398		398
46			402		402

Appendix Table 5. Period Two Average Weekly Carload Shipments of Lettuce, in Thousands of Cartons, for Each Major Western Lettuce Industry District (1950-54).

Week Number	Central Arizona	Yuma, Arizona	Salinas-Watsonville	Imperial Valley	Southern California	Texas	Western Lettuce Industry
11	2		771			162	935
12	54		822			113	989
13	334		568		2	58	962
14	682	4	253	3	6	39	987
15	825	47	87	3	15	25	1,002
16	855	178	38	30	36	38	1,175
17	775	254	6	144	68	60	1,307
18	480	246	2	274	67	83	1,152
19	209	187		411	54	87	948
20	107	164		501	39	127	938
21	58	192		642	35	133	1,060
22	31	222		889	34	150	1,326
23	3	187		790	29	169	1,178
24	1	189		933	16	137	1,276
25	2	158		950	14	92	1,216
26	2	208		1,029	6	56	1,301
27	1	229		1,035	8	36	1,309
28	6	263		889	9	20	1,187
29	38	330		776	9	14	1,167
30	130	386		601	26	24	1,167
31	314	411		393	62	34	1,214
32	506	383		166	102	40	1,197
33	860	231	2	47	135	44	1,319
34	879	116	23	14	12	58	1,090
35	838	23	240	2	69	41	1,213
36	623		596		31	19	1,269
37	427		872		34	6	1,339
38	170		1,161		22	8	1,361
39	56		1,455		22	10	1,543
40	42		1,285		24	4	1,355

Appendix Table 5. (Continued).

Week Number	Central Arizona	Yuma, Arizona	Salinas-Watsonville	Imperial Valley	Southern California	Texas	Western Lettuce Industry
41	22		1,274		16		1,312
42	9		1,005		6		1,020
43	6		993		2		1,001
44	6		857		1		864
45	2		794				796
46			885				885

Appendix Table 6. Period Three Average Weekly Carload Shipments of Lettuce, in Thousands of Cartons, for Each of the Major Western Lettuce Industry Districts (1955-59).

Week Number	Central Arizona	Yuma, Arizona	Salinas-Watsonville	Imperial Valley	Southern California	Texas	New Mexico	Western Lettuce Industry
3	3		155					158
4	7		148		1			155
5	14		272		2			288
6	37		262		3			302
7	36		313		2	4	2	355
8	40		252		2	14	2	310
9	56		216	4	4	12	3	291
10	109		365	4	5	42	4	529
11	168		374	2	4	48	6	602
12	364		268	2	6	50	19	703
13	586	1	254	3	13	38	16	910
14	733	8	95	5	42	31	10	924
15	627	12	42	15	43	18	4	761
16	619	50	12	63	69	14		827
17	543	163	1	139	98	26		970
18	424	224	1	271	132	50		1,102
19	162	196		355	78	58		849
20	80	188		430	90	54		842
21	59	174		501	72	57		863
22	26	181		625	54	101		987
23	11	140		673	17	62		903
24	3	128		685	3	77		896
25	4	97		660	2	97		860
26	2	65		744	3	58		872
27	2	84		860	1	54		1,001
28	5	122		790	2	29		948
29	14	172		679	29	32		926
30	59	219		447	136	27		888
31	192	257		238	252	14		953

Appendix Table 6. (Continued).

Week Number	Central Arizona	Yuma, Arizona	Salinas-Watsonville	Imperial Valley	Southern California	Texas	New Mexico	Western Lettuce Industry
32	417	193	1	94	264	8		977
33	587	118	2	35	175	19		936
34	875	78	4	14	76	26		1,073
35	894	44	23	2	71	20		1,054
36	953	7	60		54	21		1,095
37	768		216		34	22	3	1,043
38	659		465		40	10	6	1,180
39	440		392		28	4	13	877
40	298		891		24	1	16	1,230
41	201		832		15		14	1,062
42	124		528		9		7	668
43	75		444		7		2	528
44	46		304		4		1	355
45	29		244		4		2	279
46	4		102		3			109

Appendix Table 7. Period Four Average Weekly Carload Shipments of Lettuce, in Thousands of Cartons, for Each of the Major Western Lettuce Industry Districts (1960-64).

Week Number	Central Arizona	Yuma, Arizona	Salinas-Watsonville	Imperial Valley	Southern California	Texas	New Mexico	Western Lettuce Industry
4	3		205					208
5	18		778		2		3	801
6	92		893		4	9	2	1,000
7	138		1,074		7	76	2	1,297
8	176		1,071		12	138	1	1,398
9	203		888		9	149	4	1,253
10	347		734	1	21	129	9	1,241
11	488		482	4	41	115	29	1,159
12	665		294	6	58	46	30	1,099
13	1,030		199	4	76	21	17	1,317
14	1,200	20	82	17	101	4	4	1,428
15	1,004	82	23	24	190	1	1	1,325
16	860	197	3	75	229	4		1,368
17	700	301	1	174	172	9		1,357
18	464	329		274	204	25		1,296
19	249	378		419	129	70		1,245
20	101	369		646	51	61		1,228
21	46	349		797	48	100		1,340
22	30	387		960	53	114		1,544
23	16	262		850	43	92		1,263
24	4	229		846	10	97		1,186
25		245		1,029	3	118		1,395
26	3	320		1,036	2	105		1,466
27	2	318		1,090	6	81		1,497
28	7	245		1,074	17	79		1,422
29	17	278		967	55	79		1,396
30	73	310		789	74	68		1,314
31	158	339		490	219	64		1,270
32	253	320	1	304	281	61		1,220

Appendix Table 7. (Continued).

Week Number	Central Arizona	Yuma, Arizona	Salinas-Watsonville	Imperial Valley	Southern California	Texas	New Mexico	Western Lettuce Industry
33	563	305	2	148	327	43		1,388
34	1,084	171	5	70	202	19		1,551
35	1,169	70	24	6	220	7		1,496
36	1,026	12	66		190	5		1,299
37	977	2	174		159	14		1,326
38	840		450		141	5		1,436
39	732		785		106	2	6	1,631
40	497		976		78		12	1,563
41	308		1,079		57		12	1,456
42	312		1,028		34		20	1,394
43	295		1,126		23		4	1,448
44	186		1,094		9			1,289
45	50		1,072		7			1,129
46	7		438		1			446

Appendix Table 8. Period Five Average Weekly Carload Shipments of Lettuce, in Thousands of Cartons, for Each of the Major Western Lettuce Industry Districts (1965-67).

Week Number	Central Arizona	Yuma, Arizona	Salinas-Watsonville	Imperial Valley	Southern California	Texas	New Mexico	Western Lettuce Industry
6	1		797		5	3	7	813
7	56		1,278		13	43	4	1,394
8	99		1,223		21	84	20	1,447
9	136		1,234		26	119	73	1,588
10	192		1,060		20	156	100	1,528
11	188		907		33	147	154	1,429
12	480		586		52	175	203	1,496
13	931	13	423		55	108	163	1,693
14	1,209	38	185	4	148	80	90	1,750
15	1,091	127	131	8	214	15	15	1,597
16	908	228	48	95	251	34	2	1,479
17	804	448	16	303	354	57		1,774
18	427	367	3	578	290	53		1,443
19	221	511		682	195	53		1,558
20	63	442		999	58	40		1,285
21	26	567		1,084	63	42		1,697
22	13	446		1,000	70	83		1,696
23	10	372		1,132	37	131		1,550
24	2	314		1,220	4	109		1,561
25	1	300		1,220	3	106		1,630
26		323		1,303	4	75		1,622
27		310		1,252	2	42		1,657
28		268		1,342	1	68		1,589
29		303		1,198	30	80		1,755
30	40	334		1,014	116	66		1,754
31	133	394		600	158	38		1,737
32	273	534		212	347	43		1,797
33	585	471	13	44	443	35		1,759
34	821	326	31	1	510	17		1,749

Appendix Table 8. (Continued).

Week Number	Central Arizona	Yuma, Arizona	Salinas-Watsonville	Imperial Valley	Southern California	Texas	New Mexico	Western Lettuce Industry
35	941	119	119		333	14		1,527
36	1,176	49	227		187	21		1,660
37	1,110	9	510		147	14	2	1,792
38	976		890		168	8	45	2,087
39	528		1,170		97	3	131	1,929
40	202		900		97		275	1,474
41	128		985		61		251	1,425
42	109		998		24		92	1,223
43	227		1,411		32		47	1,717
44	206		1,418		20		6	1,650
45	69		1,432		2		7	1,510
46	7		1,473				3	1,483

Appendix Table 9. Analysis of Demand of Central Arizona District Lettuce for 1948-67, 1948-58 and 1959-67 Periods

$$P = b_o + b_1Q_1 + b_2Q_2 + b_3Q_3 + b_6I + b_nT_n + e^a$$

Season	Time Period	Dependent Variable $\bar{P}$	Regression Constant b_o	b_1	b_2	b_3	b_6	Net Regression Coefficients 0-1 Shift Variables					Adjusted R^2
Spring & Fall	1948-67	2.08 [.82][b]	2.59	-.000953 (6.02)	-.001631 (5.60)	-.000594 (3.71)	.002688 (1.18)[c]						.100
Spring & Fall	1948-58	2.22 [.70]	8.39	-.001327 (5.42)	-.002824 (6.34)	-.001226 (4.43)	-.002745 (5.27)						.214
Spring & Fall	1959-67	1.96 [.79]	-1.01	-.001204 (5.67)	-.002085 (5.29)	-.000904 (4.18)	.002208 (5.63)						.182
Fall	1948-58	2.31 [.76]	8.34	-.001381 (2.91)	-.004588 (5.34)	-.001340 (2.18)	-.002571 (3.16)						.259
Spring	1948-58	2.14 [.61]	8.56	-.001213 (4.09)	-.002122 (4.10)	-.001013 (3.26)	-.002966 (4.35)						.182
Fall	1959-67	1.94 [.59]	-.16	-.001708 (5.45)	-.002695 (5.50)	-.001730 (4.90)	.002180 (4.49)						.237
Spring	1959-67	2.00 [.94]	-2.69	-.001220 (3.92)	-.002189 (3.58)	-.000801 (2.63)	.003041 (4.90)						.224
Fall	1948-58	2.31 [.57]	3.62	-.000578 (1.33)	-.003732 (5.45)	-.000333 (.60)		-.4869 T49 (1.58)	-.3210 T50 (1.09)	-.6680 T51 (2.34)	.8445 T52 (2.70)	-.6858 T53 (2.40)	.593
								-1.2432 T54 (4.17)	-.5555 T55 (1.85)	-.9655 T56 (3.18)	-.0047 T57 (.02)	-1.3275 T58 (4.25)	
Spring	1948-58	2.14 [.58]	3.97	-.001310 (3.76)	-.002176 (3.61)	-.000938 (2.61)		.6825 T49 (2.18)	-.3815 T50 (.94)	.0550 T51 (.17)	-.2920 T52 (.84)	-.7734 T53 (2.55)	.274
								-.8685 T54 (2.71)	-.5082 T55 (1.70)	-.7090 T56 (2.26)	-.9598 T57 (2.96)	-.6690 T58 (1.95)	
Fall	1959-67	1.93 [.53]	3.71	-.001785 (5.88)	-.003059 (6.55)	-.001828 (5.13)		.6057 T60 (2.64)	.4096 T61 (2.19)	.2637 T62 (1.18)	.6529 T63 (3.09)	1.3785 T64 (6.16)	.358
								1.1097 T65 (4.81)	1.0080 T66 (3.84)	1.1850 T67 (4.34)			
Spring	1959-67	2.00 [.84]	2.46	-.001068 (3.02)	-.001736 (2.83)	-.000606 (1.70)		.3561 T60 (1.12)	.1630 T61 (.53)	.7985 T62 (2.29)	.9930 T63 (3.19)	.4112 T64 (1.24)	.385
								1.7271 T65 (5.25)	.3927 T66 (1.20)	2.0218 T67 (5.78)			
Fall	1959-67	1.94 [.54]	.14	-.001580 (5.32)	-.002743 (5.92)	-.001556 (4.60)	.001907 (2.99)	.7184 T64 (3.67)	.2322 T65 (1.13)	-.0733 T67 (.26)			.322
Spring	1959-67	2.00 [.84]	1.57	-.001413 (4.99)	-.002129 (3.86)	-.000964 (3.49)	.000871 (1.19)	.6800 T63 (2.85)	1.3162 T65 (4.84)	1.4587 T67 (4.16)			.379

a. P - Central Arizona district price for size two dozen head carton

Q_1 - Quantity of lettuce shipped, in thousands of cartons, from central Arizona district

Q_2 - Quantity of lettuce shipped, in thousands of cartons, from Yuma, Arizona district

Q_3 - Quantity of lettuce shipped, in thousands of cartons, from all other districts

I - United States personal disposable income per capita

T - Zero-one shift variables for periods 1948 through 1958 and 1959 through 1967

b. Figures in brackets are the standard errors

c. Figures in parentheses are "t" ratio

Appendix Table 10. Regression of Central Arizona District Price for Four-Week and Two-Week Periods (1959-67).

$$P = b_o + b_1Q_1 + b_2Q_2 + b_nT_n + e^a$$

Weeks	Regression Constant	Net Regression Coefficients					
	b_o	b_1	b_2	$\overline{P}$	$\overline{Q}_1$	$\overline{Q}_2$	$\overline{R}^2$
12-15	3.16	-.001371	-.000174	2.01	900	445	.366
		(2.75)[b]	(.29)	{.53}[c]			
16-19	3.77	-.001849	-.001474	1.82	547	745	.440
		(3.54)	(2.84)	{.48}			
30-33	3.48	-.002043	-.001056	1.89	321	1,023	.482
		(3.66)	(2.51)	{.56}			
34-37	3.34	-.001299	-.001051	1.81	992	411	.276
		(2.63)	(2.41)	{.64}			
38-41	3.38	-.001506	-.001005	2.09	507	974	.550
		(3.40)	(2.20)	{.73}			
42-45	2.20	-.001764	-.000378	2.23	198	1,176	.770
		(1.35)	(.83)	{.59}			
12-13	.76	.000805	.001410	2.27	762	557	.611
		(1.25)	(2.05)	{.38}			
14-15	3.96	-.002195	-.000275	1.79	1,014	352	.707
		(3.38)	(.36)	.35			
16-17	4.64	-.002248	-.002549	1.66	737	590	.730
		(3.37)	(5.47)	{.31}			
18-19	1.88	-.000770	.000207	1.98	346	910	.380
		(.70)	(.21)	{.53}			
31-32	3.74	-.003299	-.001010	2.02	250	1,058	.541
		(3.50)	(1.76)	{.59}			
33-34	4.03	-.002384	-.001300	1.51	752	689	.640
		(5.24)	(3.73)	{.34}			
35-36	3.59	-.001472	-.000983	1.94	1,023	335	.047
		(1.61)	(1.13)	{.80}			
37-38	4.17	-.001852	-.001417	1.99	891	587	.638
		(3.94)	(3.35)	{.49}			
39-40	2.71	-.001221	-.000475	2.02	481	1,031	.580
		(1.79)	(.74)	{.67}			
41-42	2.37	-.001029	-.000216	2.37	231	1,064	.757
		(.57)	(.26)	{.74}			
43-44	2.25	-.002457	-.000266	2.30	210	1,223	.880
		(1.48)	(.59)	{.54}			

Appendix Table 10. (Continued).

a. P - Central Arizona district price for a carton containing two dozen heads of lettuce

Q_1 - Total weekly quantity of lettuce, in thousands of cartons, shipped from the central Arizona district

Q_2 - Total weekly quantity of lettuce, in thousands of cartons, shipped by all districts other than the central Arizona district

T_n - Zero-one shift variables for years 1964, 1965, and 1967 for weeks 12-25 and for years 1963, 1965 and 1967 for weeks 26-45

b. The figure in parentheses is the "t" ratio.

c. The figure in brackets is the standard error of the estimate.

Appendix Table 11. Analysis of Demand of Yuma, Arizona District Lettuce for 1948-67, 1948-58 and 1959-67 Periods

$$P = b_o = b_1 Q_1 + b_2 Q_2 + b_3 Q_3 + b_6 I + b_n T_n + e^a$$

Time Period	Dependent Variable $\bar{P}$	Regression Constant b_o	b_1	b_2	b_3	b_6	Net Regression Coefficients 0-1 Shift Variables					Adjusted R^2
1948-67	1.96	3.35	-.000950	-.000655	-.000807	-.000236						.093
	[.76][b]		(4.78)	(1.83)	(4.11)	(1.15)[c]						
1948-58	2.05	10.88	-.001170	-.002341	-.001412	-.004286						.298
	[.68]		(3.49)	(4.59)	(4.43)	(8.71)						
1959-67	1.86	1.74	-.002055	-.002495	-.001584	.001289						.290
	[.65]		(8.50)	(5.03)	(6.72)	(3.62)						
1948-58	2.05	4.22	-.001179	-.002142	-.001485		.6360 T49	-.2503 T50	-.7338 T51	-.0099 T52	-.7784 T53	.376
	[.64]		(3.44)	(4.14)	(4.47)		(2.76)	(1.15)	(3.29)	(.04)	(3.55)	
							-.7248 T54	-.5940 T55	-1.2312 T56	-1.1734 T57	-1.2897 T58	
							(3.24)	(2.62)	(5.46)	(4.75)	(4.89)	
1959-67	1.86	3.86	-.002086	-.002916	-.001503		.4416 T60	.1682 T61	.3504 T62	.6050 T63	1.2250 T64	.485
	[.55]		(9.37)	(6.66)	(6.73)		(2.39)	(.89)	(1.88)	(3.29)	(6.66)	
							.5019 T65	1.2823 T66	.4057 T67			
							(2.59)	(6.72)	(2.03)			
1959-67	1.86	3.05	-.002134	-.002874	-.001567	.000585 I	.2994 T63	.8793 T64	.8277 T66			.476
	[.56]		(10.15)	(6.66)	(7.68)	(1.70)	(2.24)	(6.78)	(5.39)			

a. P - Yuma, Arizona district price for size two dozen head carton

Q_1 - Quantity of lettuce shipped, in thousands of cartons, from central Arizona district

Q_2 - Quantity of lettuce shipped, in thousands of cartons, from Yuma, Arizona district

Q_3 - Quantity of lettuce shipped, in thousands of cartons, from all other districts

I - United States personal disposable income per capita

T - Zero-one shift variables for periods 1948 through 1958 and 1959 through 1967

b. Figures in brackets are the standard errors

c. Figures in parentheses are "t" ratio

Appendix Table 12. Regression of Yuma, Arizona, District Price for Two-Week and Four-Week Periods (1959-67).

$$P = b_o + b_1Q_1 + b_2Q_2 + b_nT_n + e^a$$

Weeks	Regression Constant b_o	Net Regression Coefficients b_1	b_2	$\bar{P}$	$\bar{Q}_1$	$\bar{Q}_2$	$\bar{R}^2$
16-19	3.71	-.000657 (.68)[b]	-.001708 (2.69)	1.76 {.59}[c]	300	1,007	.196
21-24	3.56	-.004147 (4.51)	-.000532 (.75)	2.11 {.55}	308	1,018	.625
25-28	4.03	-.003113 (2.16)	-.001464 (3.79)	1.91 {.53}	250	1,112	.549
29-32	4.51	-.002159 (2.08)	-.002180 (6.16)	1.95 {.47}	310	1,042	.629
18-19	2.38	.000143 (.07)	-.000594 (.36)	1.94 {.72}	344	921	.006
21-22	.50	-.002206 (2.00)	.001659 (1.89)	1.76 {.43}	367	1,038	.622
23-24	4.85	-.004610 (2.53)	-.001633 (2.10)	2.46 {.53}	349	997	.692
25-26	4.32	-.004956 (2.34)	-.001182 (2.30)	2.05 {.53}	250	1,089	.544
27-28	3.18	-.000856 (.41)	-.001301 (2.18)	1.77 {.47}	251	1,134	.634
29-30	3.98	-.000141 (.08)	-.002147 (5.45)	1.90 {.34}	278	1,095	.759
31-32	4.30	-.001530 (.85)	-.002230 (3.63)	1.99 {.59}	341	988	.542
33-34	4.81	-.001309 (1.59)	-.002759 (7.20)	1.53 {.27}	303	1,176	.807

a. P - Yuma district price for a carton containing two dozen heads of lettuce

Q_1 - Total weekly quantity of lettuce, in thousands of cartons, shipped by the Yuma district

Q_2 - Total weekly quantity of lettuce, in thousands of cartons, shipped by all districts other than the Yuma district

T_n - Zero-one shift variables for years 1963, 1964 and 1966.

Appendix Table 12. (Continued).

b. The figure in parentheses is the "t" ratio.

c. The figure in brackets is the standard error of the estimate.

Appendix Table 13. Percent of Arizona District's Production Shipped by Truck.

Year	Central Arizona Fall	Central Arizona Spring	Yuma
1948	7.6	5.9	16.9
1949	5.7	10.9	18.6
1950	5.3	8.6	18.1
1951	6.3	11.5	22.7
1952	14.0	10.0	22.9
1953	10.1	10.0	22.6
1954	7.1	11.2	32.4
1955	8.1	11.3	29.4
1956	11.7	18.7	29.5
1957	23.3	26.4	39.5
1958	24.7	30.1	45.5
1959	30.1	30.6	41.4
1960	29.4	32.6	46.6
1961	31.2	33.1	45.6
1962	33.8	39.4	44.2
1963	35.0	35.4	48.6
1964	42.1	35.1	46.5
1965	42.8	39.2	40.6
1966	39.5	30.7	47.3
1967	33.8	35.4	36.7

Source: Computed from Federal-State Market News Service, United States Department of Agriculture, Marketing Central and Eastern Arizona Lettuce, Brief Summary of Fall and Spring Season, annual issues 1948-67, Phoenix, Arizona.

Appendix Table 14. Analysis of Demand of Central Arizona District and Yuma, Arizona, District Lettuce with Data Adjusted for Nonreported Truck Shipments.

$$P = b_o + b_1Q_1 + b_2Q_2 + b_3Q_3 + b_6I_6 + e^a$$

Season	District	Dependent Variable $\overline{P}$	Regression Constant b_o	b_1	b_2	b_3	b_6	Adjusted R^2
Fall and Spring	Central Arizona	2.22 {.70}	6.98	-.001150 (5.24)	-.002251 (6.52)	-.001056 (4.30)	-.001901 (4.03)	.210
Fall	Central Arizona	2.31 {.76}	7.00	-.001293 (2.70)	-.003635 (5.78)	-.001194 (1.94)	-.001742 (2.38)	.275
Spring	Central Arizona	2.14 {.62}	7.06	-.001007 (3.73)	-.001621 (3.87)	-.000868 (3.03)	-.002085 (3.43)	.156
	Yuma	2.05 {.68}	9.57	-.001014 (3.26)	-.001905 (4.74)	-.001248 (4.20)	-.003478 (7.74)	.280

a. See Appendix Tables 9 and 11 for definition of variables.

LIST OF REFERENCES

FIRCH, ROBERT S. (1963) "Stabilization of the United States Economy and Stability of Farm Income," Unpublished Ph.D. Dissertation, Chapter II, University of Chicago, Chicago, Illinois.

FOX, KARL (1953) The Analysis of Demand for Farm Prices, Technical Bulletin 1081, United States Department of Agriculture, Washington, D. C., pp. 8, 13.

HILLMAN, JIMMYE S. (1955) Seasonal and Inter-Area Shifts in the Western Lettuce Industry, Report No. 123, Agricultural Experiment Station, The University of Arizona, Tucson, Arizona.

JAMES, SIDNEY C. (1963) Production and Marketing Consideration for New Mexico Vegetables and Related Field Crops, Bulletin 482, New Mexico State University, Las Cruces, New Mexico.

MIKLIUS, W. (1966) "Short-Run Effect of the California Summer Head Lettuce Marketing Order," Proceedings 1966, Western Farm Economics Association, M. V. Waananen, Editor, Washington State University, Pullman, Washington.

SHUFFETT, MELTON D. (1954) The Demand and Price Structure for Selected Vegetables, Technical Bulletin 1105, United States Department of Agriculture, Washington, D. C., pp. 19, 30.

THOMSEN, FREDERICK L. (1951) Agricultural Marketing, McGraw-Hill, New York, New York, pp. 171-173.

UNITED STATES DEPARTMENT OF AGRICULTURE (1954) Technical Bulletin 1105, United States Government Printing Office, Washington, D. C., p. 18.

UNITED STATES DEPARTMENT OF AGRICULTURE, ECONOMIC RESEARCH SERVICE (1967) "Working Data for Demand Analysis," United States Government Printing Office, Washington, D. C.

UNITED STATES DEPARTMENT OF AGRICULTURE, FEDERAL-STATE MARKET NEWS SERVICE Marketing Central and Eastern Arizona Lettuce, Brief Summary of Fall and Spring Season, annual issues 1948-67, Phoenix, Arizona.

________. Marketing Yuma District Lettuce, annual issues 1948-67, Yuma, Arizona.

LIST OF REFERENCES--Continued

UNITED STATES DEPARTMENT OF COMMERCE, OFFICE OF BUSINESS ECONOMICS Survey of Current Business, annual publications 1948-67, Washington, D. C.

WAUGH, FREDRICK V. (1964) Demand and Price Analysis, Technical Bulletin 1313, United States Department of Agriculture, Washington, D. C., pp. 19-26.