SOME FACTORS AFFECTING FRESH APPLE PURCHASES IN RETAIL STORES

by

Sidney Edward Brown

Thesis submitted to the Graduate Faculty of the

Virginia Polytechnic Institute

in candidacy for the degree of

MASTER OF SCIENCE

in

Agricultural Economics

APPROVED:

| | |
|---|---|
| Director of Graduate Studies | Head of Department |
| Dean of Agriculture | Major Professor |

July, 1955

Blacksburg, Virginia

## ACKNOWLEDGEMENT

The writer is immeasurably indebted to
under whose able guidance this study was made for his helpful suggestions and constructive criticisms. He wishes also to express appreciation to the persons in the Department of Statistics who provided statistical advice and to the staff members of the Department of Agricultural Economics who reviewed the manuscript for their pertinent and timely suggestions.

The ladies in the Department of Agricultural Economics were most patient and obliging in providing clerical and typing assistance. To these persons and all others who aided in this research project, the author is sincerely grateful.

The thesis is based on data collected for the Northeastern Regional Apple Marketing Project, NEM-9, conducted by the Agricultural experiment stations of Maine, Pennsylvania, New York, Virginia, and West Virginia and the Market Research Division, Agricultural Marketing Service, United States Department of Agriculture.

TABLE OF CONTENTS

# LIST OF TABLES AND FIGURES

## APPENDIX TABLES AND FIGURES

APPENDIX TABLES AND FIGURES (Continued)

# I

# INTRODUCTION

In an economy characterized by keen competition among commodities for consumers' disposable income, the per capita demand for a product may shift over a period of time. With a decline in demand (a shift to the left of the demand curve) for a commodity, the total consumption may be less than in previous years even with an expanding population.

In the past four decades the trend in per capita consumption of apples has been downward. This downward trend is evident when the per capita rates of apple consumption are compared for various time periods during these years. In fact, the trend in per capita consumption of apples has been steadily downward from 1909 to 1953 as shown by the averages for each five-year period beginning with 1909[1]. The trend in total yearly consumption of apples in the United States has likewise been downward. However, this decline has been less pronounced than per capita consumption declines because of the counteracting influence of population increases in this country.

Shifts in demand for a commodity create economic problems in both production and marketing. These problems are especially acute for products such as apples, which require large fixed investments of capital for production and handling. Apple production initially

---

[1] See Appendix A for the average yearly per capita consumption figures for each five-year period from 1909 to 1953.

requires large outlays of capital for land, labor, and nursery stock. It is approximately eight years before an apple tree is brought into production and the orchardist begins to realize a return on his investment. During these formative years, and more especially in later years, the land planted in trees is not easily and readily shifted into production of other commodities. Likewise, the special equipment and storage facilities necessary for efficient marketing of apples represent a sizable investment of capital of a specialized nature that is not easily and readily adaptable for other uses.

In order to make production and marketing decisions that are economically sound, people in the apple industry need adequate information on changes in consumer reactions to apples. To be adequate, this information must not only reflect the changes in the movement of apples moving into consumption, but must also provide information concerning the effectiveness of current merchandising practices on apple sales. The best source of this information is the market place where consumer preferences are registered.

## Problem

Apples are harvested over a relatively short period of time and must be stored over a longer period of time. In order to facilitate an orderly release of apples from storage into consumption, shippers and handlers of apples need adequate and timely information on (1) the rate of movement of apples at the retail level, and (2) the changing conditions in the market affecting the rate of movement.

At the present time the only sources of information available on apple movements into retail outlets are United States Department of Agriculture cold storage holding reports and reports on carlot unloads in specified cities. These reports reflect the movements of only a part of the fresh apples going into consumption, since only apples held in public storage are covered by the cold storage reports and very few truck loads of apples are included in the carlot reports. Not only are these reports incomplete, but they are from two to six weeks late in reaching the shippers. For example, the first cold storage report is released November 15, giving storage holdings as of October 31. Available reports are also deficient in that they give no indication to the apple trade concerning factors influencing the changes in the rate of apples moving into consumption.

In order to market apples in an orderly manner over a marketing season that corresponds to the storage like of the apple, shippers and handlers of the fruit need current information on the rate at which apples are moving through retail outlets and the factors affecting the rate of movement. Knowledge of these factors is needed to permit more flexibility in making marketing decisions.

## Objectives of the Study

The broader study[1] of which this thesis is a phase was designed

---

[1] Northeastern Fruit Marketing Project conducted by the agricultural experiment stations of Maine, New York, Pennsylvania, Virginia and West Virginia, and the Horticultural Crop Section, Marketing Organization and Cost Branch, Marketing Research Division, Agricultural Marketing Service, United States Department of Agriculture.

to investigate ways of determining the rate of fresh apple sales in retail stores and of reporting this information to the apple industry. A second objective of the overall study was to discover some of the factors which influence the rate of apple movement at retail.

The primary objective of this thesis was to determine statistically the effect and relationship of selected factors on apple sales in retail stores. The second objective of this project was to evaluate the sampling design used for the collection of data on the rate of movement of apples and on the effect of merchandising factors.

## Review of Literature

Only one study on the rate of movement of fresh apples through retail stores with analysis of the factors associated with the changes in rate of movement was found from a search of available literature. However, in this study no periodical reports on rate of movement were issued, and a cross tabular analysis was the method used to analyse the factors associated with apple sales. There appears to be little published information on apple movement rates at retail except the volumes of sales recorded during controlled studies of merchandising practices. Some of these studies pointed out certain factors that affected apple sales at retail and others that did not.

The only study found in which an effort was made to observe apple sales and determine the effect of certain factors on sales was conducted in Detroit during a portion of the 1950-1951 apple marketing

season. The analysis of the data collected in nineteen retail food stores in Detroit showed that apple prices and display space were the most important observed factors affecting apple sales. When the relative price of apples increased one percent, a negative change of one percent in sales appeared to result. Also, an increase in the size of an apple display was accompanied by an increase in apple sales[1].

Dougherty and Yeager found that a small change in the price of McIntosh apples of the highest quality resulted in no appreciable change in sales. Their study in New England markets also indicated that apple sales varied among types of stores, days of the week, and time periods within days[2].

In an apple merchandising study in New York State, Dominick found that McIntosh apple sales increased forty-four percent when the prices were reduced thirty-five percent. On the other hand, no substantial changes in sales occurred when the amount of display space given to this variety was doubled. He found that more apples were sold from combination displays of packaged and bulk fruit than were sold from displays of either packaged or bulk alone. Also, the study disclosed a close relationship between the volume of apple sales and the size of pricing unit as customers tended to make

---

[1] M.E. Gravens, Jr., et. al., Studies in Midwest Apple Marketing, Michigan Agricultural Experiment Station Special Bulletin 376, June, 1952.

[2] L. A. Dougherty and A. F. Yeager, Marketing New Hampshire McIntosh Apples, New Hampshire Experiment Station Bulletin 347, June, 1943.

purchases in the size of unit priced. This study also showed that greater sales were obtained when apples were priced in six-pound units than when priced in either two-, three-, or four-pound units[1].

The findings of Dominick on combination displays of packaged and bulk apples, on the size of pricing unit, and on the optimum size package were substantiated in a later study by Henderson. Henderson also found that customers tended to purchase apples in quantities suggested in the pricing unit. This study revealed that after correcting for the carry-over effect of other treatments in the test, McIntosh sales were maximized when displayed in six-pound packages along with bulk fruit. His study also showed that apples packaged in polyethylene bags had significantly higher sales than when offered in either paper, pliofilm, or mesh bags[2].

In a study conducted in the Buffalo, New York, area by Cravens, apple sales varied among stores of different sizes and types of ownership. Cravens' findings indicated that the larger stores had the highest rate of apple sales, and that after adjustment was made for store size and the income of the customers patronizing each type, owner-operated stores had greater apple sales than stores operated

---

[1] Bennett A. Dominick, Jr., "Merchandising McIntosh Apples Under Controlled Conditions - Customer Reaction and Effects on Sales", Ph. D. thesis, Cornell University, Ithaca, New York, 1952, pages 170-171.

[2] Peter L. Henderson, "Influence of Selected Marketing Services of Apple Sales", Ph. D. thesis, Cornell University, Ithaca, New York, 1952.

by chain organizations[1].

The studies by Henderson and Dominick and portions of the Dougherty and Yeager study were under controlled conditions. Test items were manipulated in the predetermined manner called for in the design of the experiments. Cravens' studies and parts of the Dougherty and Yeager study were of the survey types.

## Procedure

### Source of Data

The data used in this study were obtained from observations of produce customers and fruit merchandising practices in a sample of retail food stores. A trained enumerator collected these data in each of the eight cities covered in the sample. The data included the number of customer units[2] passing through the produce department of the stores and the weight of each purchase of apples during a given period of time. The enumerator also recorded the varieties of apples displayed; the number of square feet in each display; the quality of the fruit; the price of apples; size of the pricing unit;

---

[1] M. E. Cravens, Retail and Wholesale Distribution of Apples in Upstate New York, Cornell University Agricultural Experiment Station Bulletin 794, Ithaca, New York, 1943, page 4.

[2] A customer unit consisted of one person or several persons when it was obvious that they were purchasing for the same family unit. Only persons entering the produce department were considered produce customers.

the kind of packaging material used; and the type of display, whether containing bulk fruit alone, packaged alone, or a combination of both. Excluding the pounds of fruit purchased, the type of packaging material and the type of display, the same information was recorded for each of the other fruits offered in the store[1].

## Design of the Sample

This study was designed to permit observation of consumer reaction under normal store operating conditions. No effort was made to modify the manner in which apples were being merchandised in the stores.

As indicated by previous apple marketing studies cited earlier, the volume of fresh apple sales varies by store types, by days of the week, and by time periods within days[2]. In order to determine and eliminate the effects of these sampling variables on apple sales and the merchandising practices observed, a balanced design for sampling and visiting stores was used. The design was balanced in such a way that the influence of store type, day, time period within days, and cities could be removed from the data by an analysis of variance.

In developing the design, it was recognized that with the funds available only one enumerator could be placed in each city if a representative number of cities were to be sampled. To give the

---

[1] See the sample data sheet in Appendix B.

[2] Dominick, op. cit., Gravens, op. cit., and Dougherty and Yeager, op. cit.

observer one day free and to permit more flexiblilty in his schedule, observations were made only five days each week. The free day permitted him to visit all sample stores every week even though holidays occurred. Since previous research had shown that the volume of apple sales was smallest during the earlier part of the week and during the early morning hours of each day, Monday was omitted from the design and store observations were not started before ten o'clock each day. Since the pattern of store traffic varies among time periods of the day, the sample was designed to permit observation of customers at different intervals. A day was divided into five time periods as follows: ten to twelve; twelve-thirty to two-thirty; two-thirty to four; four to six; and six-thirty to eight-thirty o'clock[1]. These periods were of sufficient length to permit an observer time to travel from one store to another, record the desired information, and observe customer purchases for an hour. In each city observations were made daily Tuesday through Saturday, in different stores during each of the first four time periods. An additional store was visited during the fifth time period on Fridays only. Thus, the four observations on each of five days with an additional observation on Friday night gave a total of twenty-one stores visited each week in each city.

---

[1] Thirty minute breaks were provided between twelve and twelve-thirty o'clock and between six and six-thirty o'clock to allow the observer additional time for meals. The period beginning at two-thirty was shortened to make up for the thirty minutes provided the observer for lunch.

Stores in the sample were stratified according to the type of ownership and store sizes. The classifications used were small independent, large independent, and chain stores. In each city, the twenty-one sample stores included seven stores in each classification. In this design, three sample cities were required to permit balance in making observations in the three types of stores among time periods and days. The manner in which store types were balanced when three sample cities were grouped can be seen from Figure 1 (a complete design of store visits for eight cities is given in Appendix A, Figure 1). Thus, in each group of three cities, one chain store, one large independent store, and one small independent store were visited during each time period, and an equal number of each type was visited each day.

Originally the study was designed to include nine cities in the sample, as multiples of three cities were needed in order to balance the store classifications. However, in order to better coordinate the study, one of the cities was later omitted from the sample and the funds available for sampling this city were used to coordinate the work in the other eight cities. The two cities that were not balanced in the design as a result of this reduction of the sample were continued in the study. Data from these two cities were obtained in the event incomplete data were taken in other cities and to obtain current rate of movement data from these markets.

| Time Period | City 1 T | W | Th | F | S | City 2 T | W | Th | F | S |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | $C_1$ | $L_5$ | $S_9$ | $C_{13}$ | $L_{18}$ | $S_1$ | $C_5$ | $L_9$ | $S_{13}$ | $C_{18}$ |
| 2 | $L_2$ | $S_6$ | $C_{10}$ | $L_{14}$ | $S_{19}$ | $C_2$ | $L_6$ | $S_{10}$ | $C_{14}$ | $L_{19}$ |
| 3 | $S_3$ | $C_7$ | $L_{11}$ | $S_{15}$ | $C_{20}$ | $L_3$ | $S_7$ | $C_{11}$ | $L_{15}$ | $S_{20}$ |
| 4 | $C_4$ | $L_8$ | $S_{12}$ | $C_{16}$ | $L_{21}$ | $S_4$ | $C_8$ | $L_{12}$ | $S_{16}$ | $C_{21}$ |
| 5 | | | | $S_{17}$ | | | | | $L_{17}$ | |

City 3

| Time Period | T | W | Th | F | S |
|---|---|---|---|---|---|
| 1 | $L_1$ | $S_5$ | $C_9$ | $L_{13}$ | $S_{18}$ |
| 2 | $S_2$ | $C_6$ | $L_{10}$ | $S_{14}$ | $C_{19}$ |
| 3 | $C_3$ | $L_7$ | $S_{11}$ | $C_{15}$ | $L_{20}$ |
| 4 | $L_4$ | $S_8$ | $C_{12}$ | $L_{16}$ | $S_{21}$ |
| 5 | | | | $C_{17}$ | |

Figure 1: Example of Balance Design for Sampling Stores by Type, Day, Time Period, and City in Three Cities.

Note: A store of each type (C= chain, L= large independent, and S= small independent) was visited in this group of cities during each of the time periods in which observations were made.

## Selection of Sample Stores and Cities

A set of twenty-one primary and two sets of twenty-one alternate stores were selected at random from newspaper route lists, Dun and Bradstreet credit listings, and similar sources in each city. The primary stores were visited prior to the start of observations to determine by inspection their desirability as sample stores and to obtain the cooperation of store managers. In some cases it was obvious that because of their proximity to other selected stores, their being in the process of remodeling, or their being subject to influences that would impair their normal operation, such stores would not be suitable for the study. Where primary stores were found unsuitable or their management did not choose to cooperate, a store was substituted from the first alternate list, or the second alternate list if the store from the first alternate list was not suitable.

The eight eastern cities used in the study were selected on the basis of size, distance from apple growing areas, and their importance as outlets for apples produced in the states cooperating in the study. Since the eastern market is composed of large and small cities which are various distances from supply areas, the sample cities were chosen for these characteristics. These cities were Boston, Massachusetts; Rochester, New York; Philadelphia, Pennsylvania; Pittsburgh, Pennsylvania; Knoxville, Tennessee; Atlanta, Georgia; Richmond, Virginia; and Ithaca-Elmira, New York[1].

---

[1] Twenty-one stores were divided between Ithaca and Elmira, and therefore, these two were treated as one city.

## Duration of the Study

The study was planned originally for the seventeen-week period from October 5, 1953, to January 30, 1954, as this was assumed to be the heaviest part of the apple marketing season. However, at the end of January the rate of apple movement was sufficiently strong that an additional month's data were collected in five of the eight cities[1].

The cities in which observations were made during October through February were Boston, Rochester, Philadelphia, Atlanta, and Ithaca-Elmira.

## Procedure of Analysis

The following steps were used in analysis of the data:

1. Exploratory analysis was made by summary tabulations from punched cards.
2. From this tabular analysis those variables appearing to have the most influence on apple sales were selected.
3. By an analysis of variance the data for these variables were adjusted for sampling variables (city, store type, day, and time period).
4. The effect of the selected factors on sales was determined by a covariance analysis and multiple regression.

---

[1] Data were not collected in the other cities because of insufficient funds of the cooperating agencies which were responsible for enumeration of these three cities.

# II

# TABULAR ANALYSIS OF DATA

The data were tabulated and summarized for the purpose of selecting for further analysis those variables appearing to have the greatest influence on apple sales. City, type of store, day, and time period were expected to be associated with variations in apple sales, and the sample was designed to permit the influence of these factors to be removed from the data by the analysis of variance technique. Other variables were selected on the basis of their apparent importance as indicated in the tabular analysis.

## Sales Fluctuations

### Monthly Movement

The variation among months in the rate of observed apple sales per one hundred customers was within a range of 3.5 pounds (Table 2). The highest rate of sales was found to be during January, even though in total volume of apples sold, this was the lowest of the four months. On the basis of volume of sales, October and November were the most important months (all months being adjusted to an equal number of days), but the greater volume resulted from a larger number of customers rather than from a higher per customer rate of purchase. When the average sizes of individual purchases were compared, the averages among months varied little. Likewise, the number of apple customers observed fluctuated less than the total number of produce

customers, indicating that persons buying apples generally continued to do so throughout the season. Less favorable weather during the winter months as compared with the fall months could have affected the frequency with which a customer visited the store. It is highly probable that customers would be more likely to shop for only one or two items during favorable weather than during bad weather.

Table 1

Distribution of Rate of Apple Sales, Total Customer Units, Apple Customers, Percent of Customers Purchasing Apples, and Average Price per Pound by Month, October through January, 1953-1954

| | October | November | December | January |
|---|---|---|---|---|
| Pounds Sold Per 100 Customers | 40.0 | 40.4 | 39.5 | 43.0 |
| Number of Customer Units | 25,790 | 24,245 | 29,395* | 21,950 |
| Number of Customers Purchasing Apples | 3,556 | 3,499 | 4,157** | 3,404 |
| Percent of Customers Purchasing Apples | 13.8 | 14.4 | 14.1 | 15.5 |
| Average Price Per Pound (Cents) | 13 | 14 | 15 | 15 |
| Weight of Average Purchase (Pounds) | 2.9 | 2.8 | 2.8 | 2.8 |

* Since five weeks were included in December, this figure may be made comparable with other months by using four-fifths of this total or 23,516.

** Five weeks were included in this total also, and four-fifths of the number is 3,326.

During the period from October through January, there were changes in several seasonal factors that possibly affected the rate of sales. Apples move on the eastern market in volume earlier than

citrus fruits and, therefore, receive less competition from these fruits during October and November. Likewise, a wider selection of apple varieties was available during the harvest season when more apples of minor commercial importance were on the market. The virtual disappearance of apples from the market several months before the new crop was harvested meant that a possible latent demand for apples was being satisfied during October and November. Also, during the harvest season when apples are being moved from the packers to retail markets, the price of apples was lower than later in the marketing season as less storage and handling costs were involved.

The rate of observed apple sales actually went up in January after the relative advantages discussed above had disappeared. Apparently, there were other factors present in January which offset the absence of a more favorable price, more apple varieties, and less competition from citrus fruits. Since it is a common practice for growers and shippers to store their best quality fruit, it is probable that the apples appearing on the market in January were of a better quality than those appearing earlier as all the apples offered at this time were from storage holdings. Another contributing factor could have been the percent of packaged apple sales which was greater during January than observed in any preceding month. Also, apples for cooking purposes would likely be substituted for fresh produce items that were out of season in January. Less competition from fruit stands and the huckster trade was another possible reason for the rate of sales holding up throughout the season.

## Weekly Movement

Average weekly apple sales per 100 customers for the eight cities were highest during the third week in December. In the five cities where observations were extended to twenty-one weeks, two peaks occurred in the average weekly sales. The first came the latter part of October and the second during February (see figures 2 and 3). Apple sales seemed generally to vary less in Pittsburgh, Richmond, and Knoxville except for the pre-Christmas sales which were more important in these than in other cities[1].

Average weekly sales per 100 customers were highest in Atlanta and Rochester early in the season. Peak sales occurred in Boston only a few weeks later. The sales curves in Ithaca-Elmira and Pittsburgh most nearly followed the average line for all cities.

The variation in average weekly apple sales was greater than the variation in monthly sales. This variation was even more pronounced when weekly averages were compared within a city than when averages for all cities were compared. This greater variation in weekly sales was probably influenced by several factors, the effects of which were leveled out in monthly averages. Such influences as carry-over effects from one week to the next, periodic price specials, advertising, and holidays would likely influence weekly fluctuations, but would not be as apparent in the monthly volume of sales.

---

[1] See figures 1 to 8 in Appendix B for average weekly sales curves for individual cities.

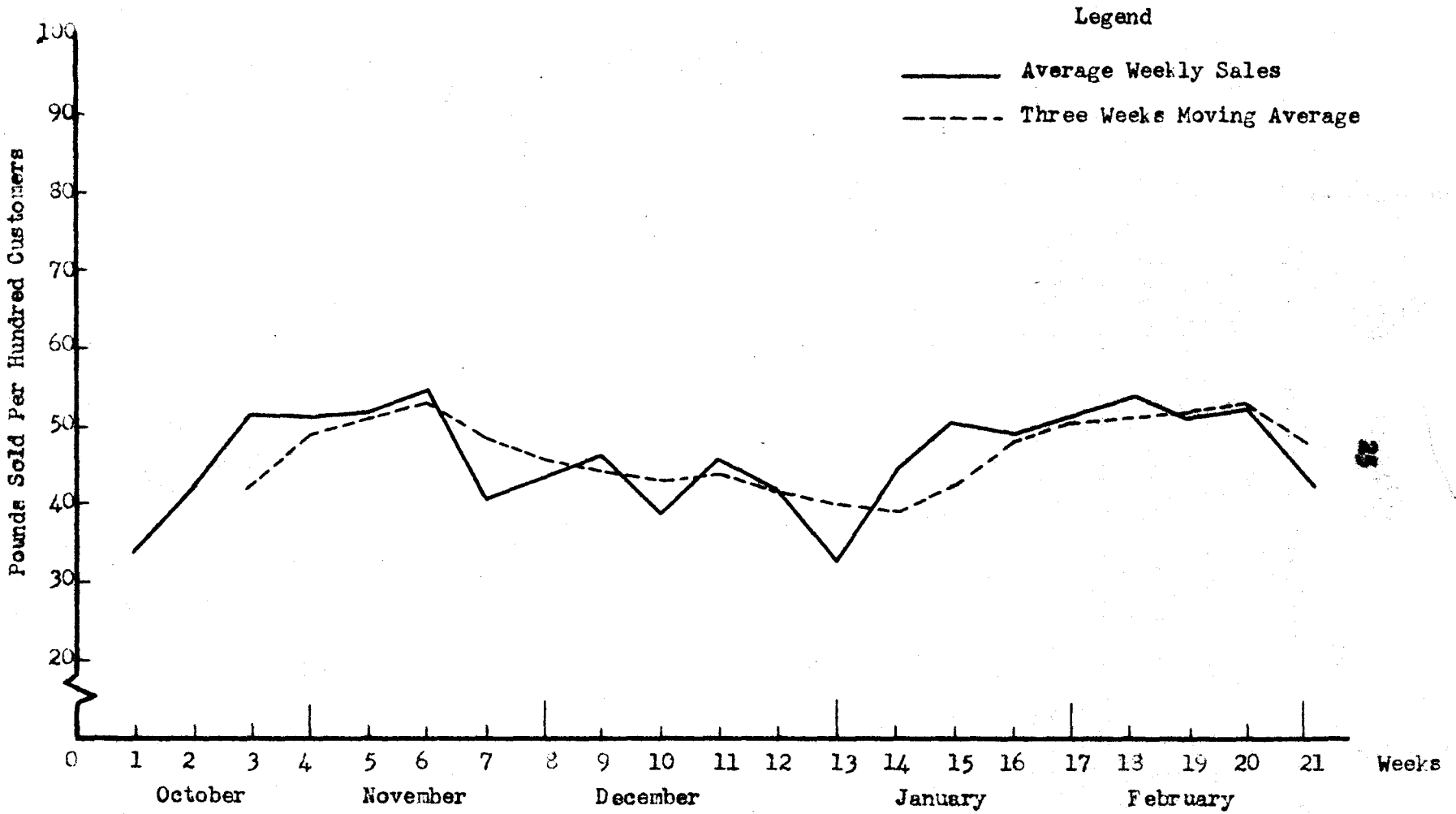


FIGURE 2: OBSERVED APPLE SALES IN BOSTON, ROCHESTER, PHILADELPHIA, ATLANTA, AND ITHACA-ELMIRA, 1953-1954.

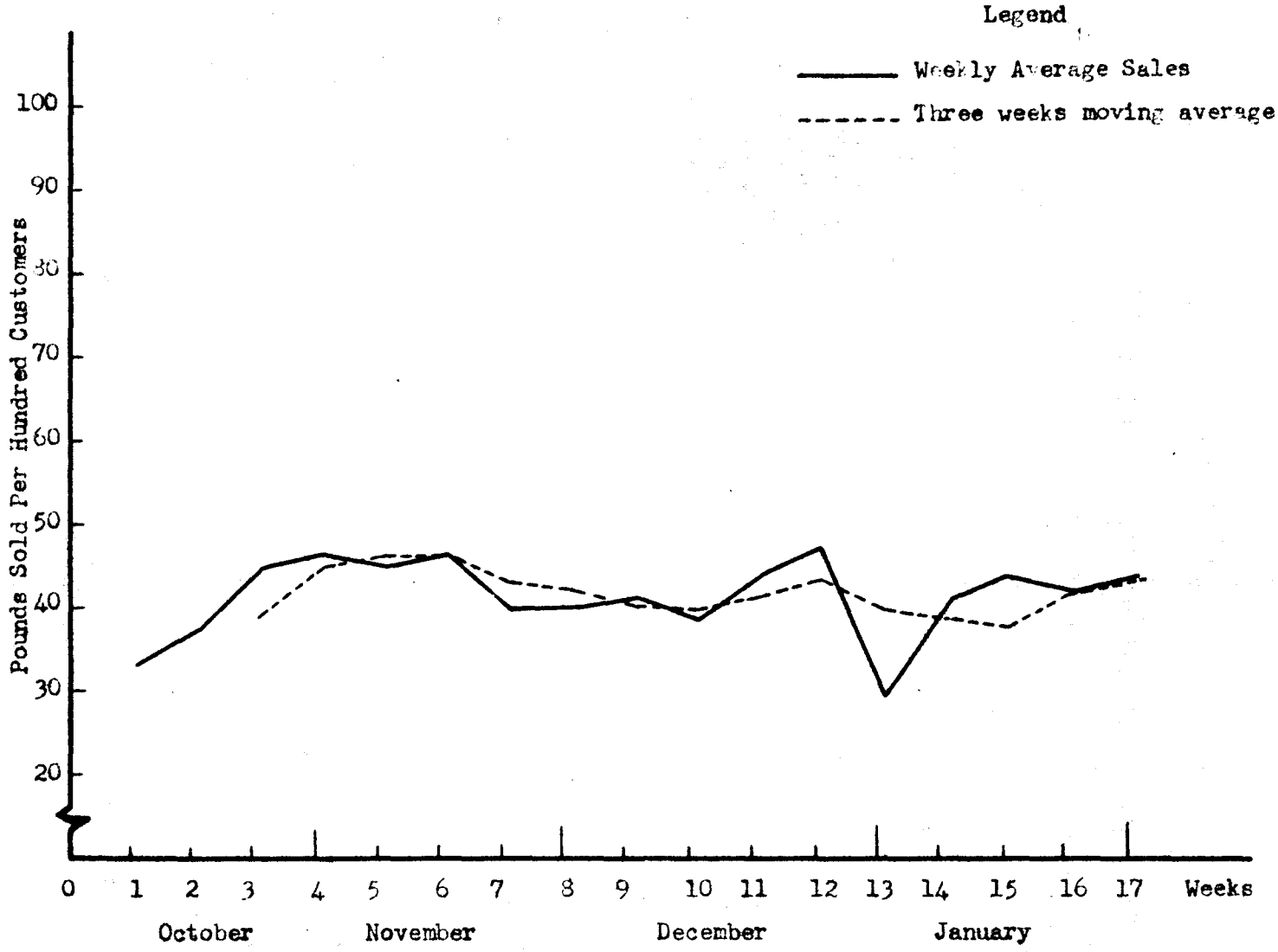


FIGURE 3: OBSERVED APPLE SALES IN BOSTON, ROCHESTER, PITTSBURGH, PHILADELPHIA, ATLANTA, KNOXVILLE, RICHMOND, AND ITHACA-ELMIRA, 1953-1954.

## Days and Time Periods

As was expected, sales varied among days of the week and among time periods within days. Tuesday and Wednesday had lower sales than other days. Thursday sales were considerably higher than Wednesday sales, while Friday and Saturday sales were heaviest.

Table 2

Total Observed Apple Sales in Pounds by Day and Time Period in Boston, Rochester, Pittsburgh, Knoxville, Atlanta, and Ithaca-Elmira for a Seventeen-Week Season From October, 1953, through February, 1954

| Time Period* | Tues. | Wed. | Thur. | Fri. | Sat. | Total Pounds |
|---|---|---|---|---|---|---|
| 1 (10:00-12:00) | 832 | 382 | 1146 | 1467 | 1304 | 5131 |
| 2 (12:30-2:30) | 767 | 966 | 754 | 1618 | 1903 | 6008 |
| 3 (2:30-4:00) | 718 | 1250 | 2236 | 2294 | 2272 | 8770 |
| 4 (4:00-6:00) | 908 | 1636 | 1413 | 2024 | 1624 | 7605 |
| 5 (6:30-8:30) | | | | 3588 | | 3588 |
| Total Pounds | 3225 | 4234 | 5549 | 10991 | 7103 | 31102 |

* An observation lasting for an hour was made during each time period. Only on Friday nights were fifth period observations made.

On the basis of total sales, the time period from two-thirty until four in the afternoon had the highest apple sales. The next best time period was from four o'clock until six. The volume of sales observed during the first time period was considerably smaller than during other periods. Compared with other time periods on Friday, the period from six until eight-thirty had the highest sales during the seventeen-week season. In comparing these time periods, it was

observed that during the periods of high apple sales, the number of customer units was also high; likewise, during periods when apple sales were low, the number of customers observed was low. This indicated that the volume of apple sales was closely associated with the number of customers patronising the stores. These comparisons were made on the basis of an hour's observation during each period.

## Seasonality of Varieties

Many apple varieties, especially those of lesser commercial importance, moved seasonally on the market. Early harvested varieties and those that do not store well, like Jonathan, came on the market early and disappeared during the first few weeks of the study. Stayman Winesaps and York Imperials were important varieties which sold in their greatest volume during the months of October to December. Rome Beauties and Winesaps appeared on the market in greatest quantities during the winter months (December, January, and February). McIntosh and Red Delicious, which accounted for better than fifty-five percent of all observed apple sales, remained in the stores in volume throughout the seventeen-week season. (See Table 3).

## Number of Kinds of Other Fruit

The number of kinds of other fruits offered in different size stores varied considerably. The large stores generally offered more other fruits than the small stores, and there was an appreciable difference among store types in the number of kinds of other fruits

Table 3

Leading Apple Varieties as Percentage of Total Monthly Sales Observed in Eight Eastern Cities October, 1953, through February, 1954

| Variety | Oct. | Nov. | Dec. | Jan. | Feb.* | Total Sales (Seasonal) |
|---|---|---|---|---|---|---|
| | | | Percent | | | |
| McIntosh | 37 | 36 | 33 | 36 | 40 | 36 |
| Red Delicious | 21 | 20 | 23 | 23 | 24 | 22 |
| Stayman | 9 | 14 | 13 | 7 | 2 | 10 |
| Winesaps | 2 | 3 | 8 | 9 | 10 | 6 |
| Cortland | 7 | 6 | 5 | 6 | 6 | 6 |
| Rome | 1 | 2 | 3 | 6 | 10 | 4 |
| Golden Delicious | 4 | 4 | 5 | 3 | 2 | 4 |
| York | 3 | 3 | 3 | 3 | 1 | 3 |
| All Others | 16 | 12 | 7 | 7 | 5 | 9 |
| Total Percent | 100 | 100 | 100 | 100 | 100 | 100 |

* From October through January observations were made in Boston, Rochester, Ithaca-Elmira, Philadelphia, Atlanta, Knoxville, Pittsburgh, and Richmond. The latter three cities were not sampled during February, however.

displayed. Also, there was a significant difference among the cities in the kinds of fruits other than apples available for purchase. In other words, a customer did not have the same number of kinds of other fruits from which to select in each city and store.

## Price Fluctuations

The prices of apples and of other fruits varied among store displays as a result of differences in quality, size, and variety or kind of fruit. In calculating average store prices, the relative importance of each display was taken into consideration. The average price was weighted by the number of square feet in each display[1]. The amount of surface area was assumed to be an indication of the relative importance of each display of apples or other fruit. The average weighted apple price and the average weighted price of all other fruits on display were calculated for each store. Hereafter, any reference to the price of apples or other fruit will refer to this average weighted price.

Since there were only slight changes in apple prices during short periods of time, prices varied only slightly between consecutive weeks.

---

[1] For example, the price per pound of apples offered in each store display was multiplied by the square feet of the area of the display. The average weighted price of apples was then obtained by dividing the sum of the products of the price and display area of individual apple displays by the total number of square feet in all apple displays in the store. The average weighted price of all other fruits was obtained in the same manner.

However, the trend in average prices was consistently upward for the seventeen-week season. There was a noticeable variation in apple prices among cities and among individual stores, but no apparent significant variation in prices among store types. Apple prices were lower in those cities nearest the growing areas generally than in cities at greater distances. The lower apple prices nearest growing areas probably resulted from several interrelated factors. The most important influences were probably transportation charges and quality. Transportation costs relative to the value of the commodity would encourage the sale of the lower quality (hence, lower priced) apples in markets near the growing areas. With lower transportation costs, the total cost of marketing would be less near the orchards; consequently, with lower marketing costs and lower quality, apples would be retailed at lower prices in nearby cities. One other possible influence on pricing policies in markets adjoining sources of supply was more competition from the huckster trade than was felt by retailers in more distant cities. This latter consideration was likewise connected with the cost of transportation.

The variation in average prices of other fruits was greater than the variation observed in average apple prices. No doubt, a large amount of the variation in the price of other fruit was a result of seasonal changes in the kinds of other fruits offered in the stores during the observed season. There was a wider range in price among kinds of other fruits than among apple varieties, and the change in the kinds of other fruits offered could be expected to have a more pronounced effect on the average price.

## Size of Pricing Unit

Apples were offered for sale in pricing units that ranged from one apple to a bushel of apples. Approximately seventy percent of all observed apple sales was made from displays containing apples priced in units of from one to three pounds. Only about seven percent of the sales was from displays on which apples were priced in units of six pounds and above. The most common pricing units for apples were two- and three-pounds. Displays featuring apples priced in two-pound units accounted for thirty-three percent of observed sales, while the displays priced in three-pound units had thirty percent of the sales.

When pricing units were tabulated by varieties, there appeared to be some relationship between the size of the pricing unit and varieties. For example, forty-two percent of Rome Beauty sales and about fifty percent of observed McIntosh sales were from displays containing apples priced in three-pound units. About twice as many pounds of minor apple varieties were sold from this pricing unit as from any other single pricing unit. On the other hand, only ten percent of Red Delicious sales was from displays of apples offered in three-pound units, while displays with apples priced in two-pound units accounted for over fifty percent of Red Delicious sales. Stayman Winesaps, York Imperials, Golden Delicious, and Winesaps were other varieties of apples which had from forty-seven to sixty-three percent of their sales in two-pound pricing units.

The extent to which a variety was sold packaged would help to

determine the size of pricing unit commonly associated with that variety. For example, higher percentages of Winesaps and Staymans were sold in five-pound units than of any other varieties. It was observed that Stayman and Winesaps, especially the smaller sizes, were commonly merchandised in five-pound packages.

There was an observed tendency on the part of retailers to price in larger units those varieties suited mainly for cooking purposes, as well as apples of all varieties which were low in quality and small in size.

## Packaging

About forty percent of all observed apple sales was from displays containing packaged fruit only and about eight percent of apple sales was from combination displays of both bulk and packaged fruit. The remaining proportion of sales was from displays on which only bulk fruit was featured. From work cited earlier by Henderson and Dominick, combination displays appeared to increase apple sales. However, the most common practice observed in this study was to display packaged apples alone, as only about nine percent of the observed apple displays containing packaged fruit also offered bulk fruit.

The average size of combination displays of packaged and bulk apples was larger than the average display size of packaged or of bulk fruit alone. Only three percent of the total number of displays was of the combination type, while seven percent of the square feet

of display area was occupied by combination displays (Table 4). On the other hand, in the case of packaged apples, twenty-nine percent of the total displays occupied thirty-five percent of the square feet of area and the remaining sixty-eight percent of the displays occupied only fifty-eight percent of the total display area. One might assume from the data in the table below that bulk fruit requires more display space per pound of apples sold. However, store observations indicated that packaged fruit was found mostly in stores having a large volume of apple sales. From observations it appeared that small store operators were least likely to package or offer for sale packaged apples. Thus, the influence of smaller stores may have accounted for the extra amount of space given to bulk displays rather than any need by bulk fruit for a relative advantage in display area.

Table 4

Distribution of Observed Apple Sales, Number of Displays and Display Space, in Eight Eastern Cities October through February, 1953-1954

| Type of Display | Percent | | | |
|---|---|---|---|---|
| | Bulk | Packaged | Combination* | Total |
| Total Pounds Sold | 52 | 40 | 8 | 100 |
| Number of Displays | 68 | 29 | 3 | 100 |
| Square Feet of Display Space | 58 | 35 | 7 | 100 |

* Because of the possible interaction effect on sales of packaged and bulk fruit, combination displays are treated separately.

Polyethylene was by far the most commonly used type of packaging material for apples. Polyethylene bags were used for fifty-nine per-

Table 5

Distribution of Observed Apple Sales, Display Space, Price, and Apple Customers by Packaging Material in Eight Eastern Cities
October, 1953, through January, 1954

| Types of Packaging Materials Most Commonly Used | Packaged Sales (Percent) | Display Space in Packaged Apples (Percent) | Average Price Per Pound of Apples (Cents) | Customers Making Packaged Purchases (Percent) |
|---|---|---|---|---|
| Polyethylene Bags | 59 | 53 | 13 | 49 |
| Mesh Bags | 7 | 6 | 12 | 10 |
| Paper Window Bags | 1 | 2 | 12 | 1 |
| Pliofilm Bags | 1 | 1 | 15 | 2 |
| Cellophane Bags | 4 | 4 | 14 | 5 |
| Pressboard Trays and Boxes | 6 | 12 | 17 | 15 |
| Combination of Bulk and Polyethylene Bags | 7 | 6 | 14 | 5 |
| Combination of Bulk and Paper Window Bags | 7 | 6 | 14 | 4 |
| All Other Materials | 8 | 8 | 15 | 9 |
| Total Percentage | 100 | 100 | - | 100 |

cent of all packaged sales even though polyethylene was found in only about fifty-three percent of packaged displays and about the same percentage of display area. Mesh bags were the next most important single material used as it accounted for seven percent of packaged sales and occupied six percent of the display area devoted to packaged apples. Table 5 shows the most important types of packaging materials observed as well as the relative display space, the price per pound, and the number of customers related to each type.

## Display Space

Apples of average and above quality were displayed on areas ranging from less than one to over forty square feet[1]. Approximately one-third of observed apple displays had less than three square feet of area. Forty-one percent of apple displays measured between three and six square feet in area, sixteen percent was in the range from six to nine square feet, while only eleven percent of all displays occupied an area greater than nine square feet.

The tabulations of total sales and the total number of square feet in each display range suggested no significant variation in

---

[1] Apples of below average quality were omitted from this analysis of display ranges for two reasons: (1) Apples of this quality constituted only about four percent of total observed sales. (2) Low quality apples are often displayed in an irregular manner - in grocery carts, small boxes, and salvage tables - which would tend to distort the tabulations.

sales per square foot of display space in different ranges. In fact, the pounds sold per square foot of display area appeared to be fairly constant regardless of the size of the display as the percent of sales and percent of display area tended to move together. This indicated that there was a close correlation between sales and square feet of display space. The assumption might be drawn from this summary that apple sales depended on the square feet of display area devoted to apples in the store. However, this may be a spurious assumption as the tabulations of display space were averages of all observed displays and the data still contained the effect of many confounded variables such as store type, day, price, and number of customers. It is possible that stores selling a large volume of apples had large displays devoted to apples rather than selling a large quantity of apples because of the larger amount of display area. The labor efficiency resulting from not having constantly to replenish displays having a high rate of apple sales would help to justify the maintenance of large displays in such stores. A more refined analysis than this tabular analysis is required to remove the effect of other variables, in order to determine the relationship of display space and sales volume.

## Summary of Important Variables

As was expected in designing the study, such sampling variables as city, store type, day, and time period were associated with

variations in observed apple sales[1]. It appeared from the tabular analysis that a number of merchandising practices and other factors were also closely related to variation in apple sales. The number of apple varieties, availability of other fruit, price of apples, number of customers, amount of display space, size of pricing unit, and quality of the fruit were some of the factors appearing to be associated with fluctuations in apple sales. However, the presence of so many confounded variables necessitates a more refined analysis than this summary treatment to determine the effects of these multivariables independent of each other on observed apple sales.

---

[1] Hereafter the four variables mentioned here will be referred to as sampling variables.

# III

## STATISTICAL ANALYSIS

As mentioned in the preceding section, variables affecting apple sales were selected for further statistical analysis on the basis of their apparent importance. The analysis of variance method was used as a means of removing from apple sales and the selected factors associated with sales, the variations occurring among cities, types of stores, days, and time periods. The ultimate desire in analysing these data was to obtain the regression effect of significantly important variables on apple sales. The regression coefficients were sought as a numerical measure of the influence of each variable independent of the influences of other recognisable variables on apple sales.

Some variables which appeared to have influenced apple sales could not appropriately be analysed as store averages. The variables were individual apple varieties, size of pricing unit, type of display, type of packaging material, and the quality of the fruit[1]. Since the analysis of variance approach was not feasible with the unequal observations that result from treating individual displays[2],

---

[1] These variables are later referred to as display variables as they vary among displays and are not used as store totals or averages.

[2] The design would not be orthogonal as necessary for an analysis of variance. For example, the number of observations of polyethylene bags might not be the same for chains, large independent, and small independent stores.

another statistical method was applied in an effort to determine the effects of the above-mentioned display variables on apple sales[1]. The large number of observations collected in this study appeared to be adequate for matched comparisons analysis. However, the number of observations which were homogeneous for all recorded variables except one was much too small to give a reliable indication of the sales effect of the unmatched variable. It was found that the variance in sales resulting from chance and error for such a small number of observations was so large that little confidence could be placed in the results obtained.

The proper method of testing the effects of display variables such as those discussed here appears to be controlled experiments which would permit some important variables to be held constant while others are varied. The studies done by Henderson[2] and Dominick[3] were controlled studies of this nature and were designed to test the effects of some of these same merchandising practices on apple sales. The analysis of the sales effects of varieties of apples, size of pricing unit, type of display, type of packaging material,

---

[1] F. A. Harper, Analyzing Data for Relationships, Cornell University Memoir 231, June, 1940, and P. E. Grayson, "A Technique for Analysing Causally Related Factors Affecting Price", Master's thesis, Cornell University, February, 1949.

[2] Henderson, op. cit.

[3] Dominick, op. cit.

and fruit quality will be left for subsequent phases of the broader study. In view of the enormous adjustment of these data required to test the significance of each of these variables independent of other variables and in view of the previous tests that have been conducted on some of these, further treatment of these variables was not justified in this thesis.

## Analysis of Variance[1]

Those variables singled out for further statistical treatment because of their apparent association with variations in apple sales are as follows: relative amount of display space assigned to apples,[2] number of produce customers, number of apple varieties, number of kinds of other fruits displayed, and price of apples[3]. The analysis

---

[1] The following analyses were based on the data collected in Boston, Rochester, Pittsburgh, Ithaca-Elmira, Atlanta, and Knoxville from October through January. The data collected in Richmond and Philadelphia and during February in all cities were omitted from this analysis in order to obtain orthogonality in the design.

[2] The total display area given to apples and the total area given to all other fruits in each store were plotted against each other. These points tended to lay on a straight line showing a close relationship between the two variables. In view of this high correlation the amount of display area assigned to apples relative to other fruits was used in the analysis. Hereafter, reference to relative display space will be to the display area given to apples relative to other fruits.

[3] Although the price of other fruits was discussed earlier, it is not used in these following analyses. The weighted price of other fruit per store would tend to be distorted to the extent that kinds of other fruits (with a wide range of prices) differed greatly among store types and among cities. An adjustment for the variations in the number of kinds of other fruits among cities and types of stores could have been made, but this adjustment would not have corrected the differences in the relative value of the kinds of other fruit.

of variance was used in order to remove the variations among cities, types of stores, days, and time periods from the data collected for sales and from the data for each of the above five independent variables which could not be balanced in the sample design[1].

## Apple Sales

The variation in apple sales among different types of retail stores was highly significant (one percent level) on the basis of the F-ratios computed from the analysis of variance[2]. That is, the probability of obtaining variation as large as the variations among store types resulting from chance and sampling error was less than one in one hundred, or one percent. Likewise, a significant proportion of the variation in apple sales occurred among cities. However, the variation in sales among cities was smaller than among store types, as the difference among cities was significant at the five percent level while the variations among store types was significant at the one percent level.

The F-ratios found for the variations by days and time periods[3] on apple sales were not sufficiently large to appear significant at the five percent level. Still variations in apple sales by days was

---

[1] For a discussion of the analysis of variance and an example of the procedure in adjusting apple sales see Appendix B.

[2] This and the following tests of significance (one and five percent) were based on the F distribution given in G. W. Snedecors Statistical Methods, Iowa State College Press, 4th Edition, 1946.

[3] The first four time periods were compared. The fifth period was not comparable with these as it occurred only one day per week.

greater than would have been expected from chance as much as ten percent of the time (see Appendix C, Table 1).

From this analysis of the variations in apple sales occurring among sampling variables, it appeared that the study was properly designed to obtain information on the retail movement of apples. It indicated the importance of including different cities, types of stores, days, and even time periods in a sample designed for a reliable estimate of the rate of movement of apples into consumption. However, this analysis of variance alone did not allow for other variables which might have accounted for the significant sales variations among store types and cities.

## Customer Units

The variations by time periods as well as the variations among cities and types of stores accounted for a significant portion of the variation in customer numbers. The greatest variation in the number of customer units occurred among types of stores. It was also found that the pattern of customer traffic was not the same each day in the various types of stores as there was a significant interaction in customer numbers among store types and days. It appeared that chain stores had a greater proportion of customers the last half of the week. It may have been that some customers were patronizing the small stores during the first half of the week and visiting the larger stores for their weekend orders.

Even though the variations by days accounted for a sizable

portion of the variation in customer units, the F-ratio for days was not sufficiently large to be significant at the five percent level (see Appendix C, Table 2).

## Price

The variance in prices among cities was responsible for a significant part of the variations in apple prices. As mentioned previously, the location of cities relative to apple growing areas, transportation costs, and the difference in apple quality were probably responsible for the variations in prices among cities. Price did not vary significantly among store types, days, and time periods (see Appendix C, Table 3).

## Number of Apple Varieties

The number of apple varieties offered in a store varied significantly among both store types and cities, with the greatest proportion of the variations in apple varieties resulting among store types (see Appendix C, Table 4). The wider selection of apple varieties available in large stores was quite evident to enumerators. The smaller stores generally offered only a few varieties; many times they displayed only one variety suitable for eating and one suitable for cooking purposes.

The small volume of apple sales in many of these small stores was not conducive to merchandising a large number of apple varieties. There are several possible reasons why a small volume of sales dis-

courages displaying a wide selection of apple varieties. An increase in the number of apple varieties displayed in a store would likely result in a smaller turnover from each display as the number of displays would be increased. If apples of each variety were left on display or in the store longer as a result of the lower rate of turnover, the volume lost from spoilage would be greater. Also to put only a small volume of apples on each display and to keep them rotated would require more time than to maintain one or two displays. With a limited amount of display area available - and all stores have this limitation - store managers generally distribute display space among commodities according to the volume of sales expected from each. Consequently, in some stores display space may not be made available for several varieties of apples. It is also possible that customers patronizing these stores may not have been as selective as those who shopped in stores having wider selections of varieties; hence, there may not have been the need for as many varieties in these stores in order to have the same rate of apple sales per customer as in stores offering more varieties.

## Number of Kinds of Other Fruit

The number of kinds of other fruits available in a store appeared to vary even more among store types and cities than apple varieties did. Here again, the volume of sales in a store probably influenced the number of kinds of other fruits for the same reasons the volume of apple sales may have affected the number of apple varieties dis-

played in a store. The location of cities relative to sources of citrus fruits and to apple growing areas and the transportation mediums connecting them with these sources were probably other reasons for the availability of more kinds of other fruits in some cities than in others.

The interaction of days and store types accounted for a significant part of the variation in kinds of other fruits. Apparently, the shifts in the relative availability of other fruits in different store types on different days offset each other, as days themselves had no appreciable variation in the kinds of other fruits displayed. During the time periods in which the observations were made, the number of kinds of other fruits displayed, likewise, did not show a significant variation (see Appendix C, Table 5).

## Relative Display Space

Within each city there appeared to be no important variation among store classifications in the relative amount of display area assigned to apples. However, there was a variation among store types in different cities in the amount of display space alloted apples relative to other fruits, as the interaction among cities and types of stores was significant. Stores of each type in some cities apparently gave more advantage in display space to apples than stores of the same type did in other cities. The relative display space apples received varied significantly among cities themselves. The display area used in each city to merchandise apples was no doubt closely related to the number of kinds of other fruits generally

available in that city.

The relative amount of display space devoted to apples did not vary significantly by days and time periods (see Appendix C, Table 6).

## Summary of Analysis of Variance

There were significant variations among cities in apple sales and in each of the five independent variables (customer units, number of apple varieties, number of kinds of other fruits displayed, price, and relative display space devoted to apples) discussed in this section. These significant variations emphasize the importance of having a representative group of cities in a sample designed to estimate the rate of apple sales and to study the influence of merchandising practices. However, the reasons for the variations in apple sales among cities were not determined by the analysis of variance but by the covariance analysis which is discussed later.

The next largest variation within any sampling factor in apple sales, customer units, number of apple varieties, and number of kinds of other fruits was found to be among types of stores. On the other hand, there was no important difference in the apple prices or relative display space resulting among store types. The need for stratification of stores, classified by type of ownership and by size, in this sample design was affirmed by the variation among store types in apple sales and three of the independent variables.

It is reasonable to assume that the day of the week and time of day would not have greatly affected the price of apples, number of

apple varieties, number of kinds of other fruits, or relative display space as observations indicated that these variables tended to change between weeks rather than within each week. As a result of sampling error and chance, some small variations (Appendix C, Tables 3 to 6) did result by time periods and days. The variations by days and time periods found in the data for price, number of apple varieties, number of kinds of other fruits displayed, and relative display space were removed to make these data comparable with the data for apple sales and number of customer units.

## Analysis of Covariance

An analysis of covariance was made of apple sales and each of the five selected variables. This analysis was made to determine whether the selected independent variables not balanced in the design of this study were responsible for the significant variations in apple sales among cities, types of stores, and days obtained in the analysis of variance. For example, the covariance analysis showed that the significant variation among store types was the result of the varying number of customer units among the stores of the three classifications. In effect, what the covariance analysis did was to adjust all three store types to an equal number of customers, after which sales did not significantly vary among the types of stores. The insignificant variance among store types after making adjustments for number of customers indicated that customers purchased apples at the same rates regardless of the type of store in which the purchases

were made.

It was also necessary to make the covariance analysis in order to obtain the sums of squared deviations and sums of products of apple sales and each of the independent variables free from the variations resulting among cities, store types, days, and time periods. This was necessary so that the partial regression coefficients for the independent variables could be calculated free from the influence of cities, types of stores, days, and time periods as well as from the effect of each other.

Even though the variation in apple sales among store types was no longer important after adjusting for customer units, the variance in sales was still highly significant (one percent level) among cities after this adjustment. Thus, produce customers did not purchase apples at the same rate in all cities. The factors which influenced the variation in this rate per customer revealed by two other covariance analyses. When the variation among cities in apple prices or in the number of kinds of other fruit available was taken into consideration, variation among cities in apple sales was no longer significant. Both apple prices and the kinds of other fruits had varied greatly among cities and these fluctuations were apparently responsible for the variation in the per customer purchases of apples among cities.

The significant variance by the days of the week in sales was explained by adjustment for the variation in customer units by days. Even though the fluctuation in sales by time periods had not appeared statistically important, the variation was even less important after

elimination of the effect of varying customer traffic among time periods.

In summary, the covariance analysis indicated that the variation in apple sales resulting among the types of stores, cities, and days was actually caused by the number of customers patronizing the stores, the price of apples, number of kinds of other fruits available, and the other independent variables observed in the stores (see Appendix C, Tables 7 to 11).

## Regression Analysis

A multiple regression analysis was used (1) to determine which of the selected variables - customer units, price, relative display space, apple varieties, and kinds of other fruits - significantly affected apple sales over and above the variations associated with the selected sampling factors, and (2) to calculate the partial regression coefficients for those variables which appeared statistically significant (five percent level). The partial regression coefficients are measures of the mathematical relationships of apple sales and the independent variables which affect sales. The residual sum of squares and sum of products from the covariance analysis, which were free from the variations among cities, store types, days, and time periods, constituted the data on which the multiple regression was based.

Table 6 shows the total amount of variation in sales that resulted from the combined influence of differences in customer units, price,

relative display space, apple varieties, and kinds of other fruits. The five variables combined had a coefficient of determination of .7110. In other words, about seventy-one percent of the variation in apple sales over and above the variation occurring among the sampling variables was explained by the influence of these five independent variables.

Table 6

Total Regression of Customers, Price of Apples, Relative Display Space, Number of Apple Varieties, and Number of Kinds of Other Fruit on Adjusted Apple Sales, in Six Eastern Cities October, 1953, through January, 1954

| Source | Degrees of Freedom | Sum of Squares | Mean Squares | F-ratios |
|---|---|---|---|---|
| Regression | 5 | 1,574,891 | 314,978 | 17.22** |
| Error | 35 | 640,022 | 18,286 | |
| Total | 40 | 2,214,913 | 55,373 | |

** Significant at the one percent level.

Some of these five variables in the multiple regression analysis exerted more influence on apple sales than other variables did (Table 7). For example, sixty-three percent of the variance in apple sales was explained by the effect of customer numbers. The next most important influence was the number of kinds of other fruits offered for sale. In fact, customer numbers and the kinds of other fruits were the only two variables that accounted for statistically important portions of the variations in apple sales. About sixty-five percent of the sales variation resulted from the influence of those two variables as indicated by their coefficient of determination of .647. The effect of

the number of customer units on observed apple sales was greater ninety-nine percent of the time than could have been expected from chance and sampling error. The variation in sales attributed to the influence of the number of kinds of other fruits was large enough to be significant at the five percent level. The three variables that did not appear to have a significant impact on sales were price, number of apple varieties, and relative display space.

Table 7
Partial Regression of Customers, Price of Apples, Relative Display Space, Number of Apple Varieties, and Number of Kinds of Other Fruit on Adjusted Apple Sales in Six Eastern Cities October, 1953, through January, 1954

| Source | Degrees of Freedom | Sum of Squares | Mean Squares | F-ratio |
|---|---|---|---|---|
| Regression of Customers ($X_1$) | 1 | 1,398,763 | 1,398,763 | 76.49** |
| Regression of Relative Display Space ($X_2$ over $X_1$) | 1 | 51,320 | 51,320 | 2.81 |
| Regression of Price ($X_3$ over $X_1$ and $X_2$) | 1 | 10,771 | 10,771 | .59 |
| Regression of Number of Apple Varieties ($X_4$ over $X_1$, $X_2$, $X_3$) | 1 | 2,746 | 2,746 | .15 |
| Regression of Number of Kinds of Other Fruit ($X_5$ over $X_1$, $X_2$, $X_3$, $X_4$) | 1 | 111,291 | 111,291 | 6.09* |
| Error | 35 | 640,022 | 18,286 | |
| Total | 40 | 2,214,913 | 55,373 | |

** Significant at one percent level.
* Significant at five percent level.

The insignificant influence of prices on apple sales might appear to contradict a basic marketing principle. The explanation of this apparent paradox is found in the small variation in the prices being analyzed. Even from a preliminary analysis of the data before adjustments were made for sampling influences, price changes did not appear to affect apple sales significantly. After the removal of the variations in prices resulting among cities, type of stores, days and time periods, the effect of price fluctuations among stores was even smaller. Apparently the average seasonal price of apples did not vary enough among the 126 retail stores to influence apple sales appreciably (see Dougherty and Yeager, supra).

## Regression Coefficients

As the number of customer units and the number of kinds of competing fruits affected apple sales significantly, the partial regression coefficients for these variables were calcualted. The partial regression coefficient for customer numbers was .5452 while the coefficient for the number of other fruits was -3.5823. The sign of the latter coefficient indicated a negative regression of the number of kinds of competing fruits on apple sales. In other words, as a customer was given a wider selection of other fruits, he purchased fewer apples. These partial regression coefficients are a mathematical measure of the relationships between apple sales and these two important factors. The coefficient for customer units indicated that an increase in apple sales of about 54 pounds can be expected from

an increase of 100 customers, assuming other factors remain relatively unchanged. As denoted by the partial regression coefficient for the number of kinds of other fruits, apple sales decrease about 3.6 pounds per hour when an additional fruit[1] is offered in competition with apples.

The two partial regression coefficients are useful as aids in estimating the volume of apple sales when the number of customer units or the number of kinds of other fruits available has changed, but where there is no appreciable change in other factors such as price, display area, quality, et cetera. The use of these coefficients would be of little value in estimating apple sales where price or other variables, which varied only slightly during the period when these data were collected, vary greatly, or when used with an extremely small sample. However, since under normal conditions the retail price of apples and merchandising factors tend to be "sticky" (change very slowly), the regression formula is useful in predicting changes in apple sales based on changes from one week to the next in customer numbers and the availability of competing fruits. Unless major price breaks occur in the market, retailers prefer to absorb the difference in prices rather than to confuse the customers by price fluctuations over short periods of time. Price specials do occur, but the few cases of price reductions lose their significance in a large sample of stores.

---

[1] Florida oranges, California oranges, tangerines, grapefruit, grapes, bananas, or pears.

The regression equation will give the most accurate results when used on data obtained in a sample similar in composition to the one used in this study. Preferably, the data should be obtained from a sample larger than the minimum size sample of 126 stores used in this analysis.

The regression formula in which the partial regression coefficients given above may be used in estimating apple sales is as follows:

$$Y_e = b_o + b_1X_1 + b_2X_2$$

Where $Y_e$ = estimated apple sales

$b_o$ = a constant for a particular size sample and time interval

$b_1$ = the partial regression coefficient .5452 for customer units

$X_1$ = the number of customer units for period of time for which apple sales are to be estimated

$b_2$ = the partial regression coefficient -3.5823 for a number of other fruits

$X_2$ = the sum total of the number of kinds of other fruits for period of time for which apple sales are to be estimated[1].

The constant $b_o$ is calculated from the original data from which the coefficients were obtained or from previous data (apple sales, number of customers, and competing fruits) from the sample for which it is to be used. The formula for the derivation of $b_o$ is as follows:

$$b_o = \bar{Y} - b_1\bar{X}_1 - b_2\bar{X}_2$$

Where $\bar{Y}$ = average sales for previous week, month, et cetera for the sample or for the average taken from the data used in this study

---

[1] This sum of the kinds of competing fruits represents the sums of the number of kinds of other fruits in each of the sample stores for each hour's observation in the stores. For example, bananas would be counted once for each store in the sample, not just one for the whole sample.

$\bar{X}_1$ = average number of customers for the same period of time

$\bar{X}_2$ = average sum total of the number of other fruits for the same period of time

The mean values for sales ($\bar{Y}$), customer units ($\bar{X}_1$), and the number of competing fruits ($\bar{X}_2$), taken from previous data are used in this formula to find $b_o$. For example, the six cities (126 stores) used in the analysis had an average weekly volume of apple sales of 1830 pounds, a weekly average of 4328 customers and a weekly average sum of 734 other kinds of fruits[1]. From these data $b_o$ is found.

$$b_o = 1830 - (.5452)(4328) - (-3.5823)(734)$$
$$= 2099$$

The application of the partial regression coefficients is illustrated by using them to estimate apple sales from the data collected during one week of this study. For example, during the last week of October there were 4210 customer units and a sum of 649 other kinds of fruits observed in the 126 stores. From these data for the fourth week in October and the constants, $b_o$ (computed above), $b_1$ and $b_2$, an estimate of sales is found as follows:

$$Y_e = 2099 + (.5452)(4210) + (-3.5823)(649)$$
$$= 2069 \pm 2s$$

This estimate of apple sales is close to the actual observed sales of 2120 pounds for that week. Most of the time an estimate of sales should be within a narrow range above and below actual sales. In

---

[1] This is the sum of the average number of competing fruits in each store or 126 x 5.825 (the average number of other fruits in each store).

order to establish this range in which the estimate should fall a large portion of the time, sigma (s), which is the standard deviation or standard error of the estimate, is added to the formula. The standard error of estimate for weekly sales in the above data was found to be 135; hence, the estimate of weekly sales in the above example would be expected to be within a range of plus or minus 2s or 270 pounds ninety-five percent of the time.

During a marketing season, the rate at which apples are selling in a sample of retail stores may indicate to the members of the apple trade that the supply of apples will not be completely sold during the season unless the rate is increased. The trade may concentrate on ways of increasing sales. One method of promoting sales would be to encourage retailers to give more emphasis to apples relative to other fruits. By advertising and promotional campaigns more persons might be attracted into the stores; hence, the volume of apple sales would be expected to increase. The regression formula given above would be helpful in estimating the number of customers needed to sell a given volume of apples when other factors remain relatively constant. For example, on the basis of past experience members of the apple industry may have felt in November, 1953, that in order to market the crop, apples should have been moving at the rate of 2250 pounds per week in the sample stores rather than 2120 pounds as recorded during the last week in October. This regression formula would have given the approximate number of customers necessary, assuming there were little or no changes in other variables, to move 2250 pounds of apples

weekly during store observations. As shown by the tabulations below, about 4550 customer units would have been needed to increase the movement to 2250 pounds:

$$2250 = 2099 + .5452X_1 + (-3.5823)(649)$$

$$X_1 = 4541$$

# IV

# SUMMARY

## Factors Influencing Sales

The data obtained on the rate of apple movement in retail stores in eight eastern cities during the period from October, 1953, through January, 1954, revealed that apple sales fluctuated by weeks and among stores during weeks. A number of merchandising factors and sampling variables were found to vary along with apple sales. The data obtained in six of these cities were analyzed to determine and measure the effects of some of these variables on observed sales in these cities.

The analysis of these data revealed the following:

1. The greatest recognized single sampling variation (cities, store types, days and time periods) in apple sales was among store types. Apple sales varied significantly among different types of stores.

2. The next most important variation in sales among sampling variables occurred among cities.

3. A significant (ten percent level) amount of variation likewise resulted among days of the week.

4. Likewise the variations occurring separately among cities and types of stores accounted for significant portions of variations in customer units, number of apple varieties and number of kinds of other fruits.

5. The only significant variation in apple prices resulted among cities, and this variation was highly significant.

6. Time periods showed a significant influence on the number of customer units, while day of the week did not. One possible reason for the

insignificant variation by days was the offsetting effect caused by the variation in the pattern of customer traffic among different store types on various days of the week.

7. The number of kinds of other fruits available in the three types of stores varied among days. This indicated that the relative number of competing fruits displayed did not remain the same for each store type on all days of the week.

8. The amount of display space given to apples relative to other fruits did not vary appreciably among store types, but did vary significantly among cities. Also, the variation occurring among cities and types of stores together accounted for an important part of the variation in relative display space used for apples. This interaction among cities and types of stores meant that stores within one classification did not assign the same proportion of total fruit display area to apples in all cities.

9. When apple sales were adjusted for the difference in customer units, sales no longer varied significantly among store types or among days. This indicated that sales varied among types of stores because of the varying customer traffic found in the stores. However, the variation among cities was still significant even when adjustment was made to an average number of customers in each city.

10. Either when adjusting apple sales for the differences in prices among cities or when adjusting for the differences in the number of kinds of other fruits, the variation in apple sales among cities was no longer significant. Hence, the difference in the prices of apples and

number of kinds of other fruits displayed in stores accounted for the significant difference in apple sales among cities.

11. After the variations among cities, store types, days, and time periods were removed from the data, a multiple regression analysis showed that the number of customer units and the number of kinds of other fruits had significant effects on observed apple sales. It failed to reveal any significant (one or five percent level) influence on observed sales of either price of apples, number of apple varieties, or relative display space assigned to apples. These three variables may not have been highly correlated with apple sales; however, it appeared that the variation of these factors in the data was not sufficiently large to detect the relationship. The latter is especially applicable to prices.

12. The regression of customer units and number of kinds of other fruits explained sixty-five percent of the residual variation[1] in apple sales. All five of the independent variables (customer units, number of apple varieties, price of apples, number of kinds of other fruits, and relative display space) used in the regression analysis had a coefficient of determination of .71104, or explained seventy-one percent of the residual variation.

13. From the multiple regression analysis of the data adjusted for the variations among sampling variables, the partial regression coefficients were found to be .54527 for the number of customer units and -3.5823 for the number of kinds of other fruits available. The signs of

---

1 Variation remaining after the variations resulting among city, type of store, day and time period were removed.

these coefficients indicated that apple sales increased as customers increased and that apple sales decreased as the number of other kinds of fruits offered by stores increased.

# V

# CONCLUSIONS

## Factors Influencing Sales

The study revealed some of the factors that significantly influenced apple sales and some that did not. The most important influences on sales were found to be the number of customer units patronizing a store, and the number of other fruits offered in the stores. When the number of customers increased, sales increased. An increase in the number of other fruits was accompanied by a decrease in apple sales. Partial regression coefficients were computed to show the numerical relationship of customer numbers and the number of other fruits on apple sales. These coefficients were .5452 for customer units, and -3.5823 for the number of kinds of other fruits.

The price of apples, number of apple varieties, and relative display space devoted to apples showed no significant influence on apple sales in this analysis. These variables may not affect apple sales appreciably, or, what is most probable in the case of price, these variables did not vary enough in these data for their influences to be significant. The difference in prices of apples did help to explain the variation in the rate of apple sales per 100 customers among cities. In fact, the variations in apple sales among cities, types of stores, days and time periods were explained largely by the influences of customer units, price of apples, and the number of other fruits available.

## Sampling Design

The findings of this study substantiate in a large measure the basic assumptions made in designing the study for sampling stores from which the data were obtained. The study was concerned with the problem of the need

of the apple trade for current information on both the retail movement of apples and on factors (retail practices) which in some cases might be manipulated to lessen the fluctuation of the volume of apple sales associated with changes in the rate of movement. The sample used in this study was purposely designed to provide both types of information as it was necessary to secure both types of information in order to correlate and measure the degree of association between apple sales and the various factors affecting apple sales. In view of the sampling information available for studying rate of movement and the restriction on the size of the sample imposed by funds, the sample design appeared to be the logical type to use.

This study has contributed to a better understanding of stratification of a sample by store type and time intervals for studying the rate of apple purchases per person. It has shown that when adjustments were made for variation in customer units among time periods, days, and types of stores, no significant variations in apple sales occurred among these sampling factors. It was also found that very little variation occurred in merchandising practices among time periods and days. These findings suggest that for a rate of movement or a merchandising study of the observation type it may not be necessary to make observations when few customers are in the stores.

A better sampling design than the one used in this study can be devised if either rate of movement data or a study of merchandising factors alone is the purpose of an observation study. A sample giving greater weight to the stores with the greatest shopper traffic appears to be best for the

study of only the rate of movement of apples per 100 customers. The desire in a sample of this type would be to observe the largest number of customer units possible. The data collected in the present study showed that customer units were distributed among the types of stores with fifty-one percent in chain stores, thirty-three percent in large independent stores, and sixteen percent in small independent stores. This analysis indicated that the rate of purchase of apples per person was about the same in large independent, small independent, and chain stores. However, some smaller stores should be included in the sample as smaller stores would serve as a check against the larger stores and indicate if the rate of movement remained the same in large and small stores. Also, since customers in all three types were not always subject to the same influences, a sample with some stores of each type would be needed to indicate changes in the conditions under which apples are purchased that would affect the rate of sales. A sample with some stores of each type, but weighted by stores with the most customers, appears to be more desirable for an observation study of the rate of movement of apples only.

In designing a sample to be used in an uncontrolled study of merchandising practices, stores of all types and sizes should be included. Stores of the various classifications are needed to observe the sales responses resulting from various merchandising policies. This study indicated the need to have wide variation in merchandising practices with a small sample to detect the effects of more of these factors on sales. A sample designed to study the effects of retailing practices would need to be weighted in favor of small independent stores as these are less homogeneous than either

large independent or chain stores. A sample weighted in this manner would tend not only to equalize the number of customers observed in each store type but also to increase the confidence which could be placed in the data obtained in the small independent stores which are more heterogeneous.

In summary, a study of the rate at which apples move at retail needs to be primarily concerned with sampling customers. Even though the result of the study would depend on customer reaction, an observation study of merchandising factors appears to require sampling of stores as well as customers. In a sample suited for the latter type of study, stores with contrast in merchandising policies are needed to determine sales effects of different policies. Still, when a sample is being used to provide both types of information, it should be designed to sample both customers and stores, as was done in the sample used in this study.

# BIBLIOGRAPHY

Cravens, M. E., Jr., et. al., Studies in Midwest Apple Marketing, Michigan Agricultural Experiment Station Special Bulletin 378, East Lansing, Michigan, June, 1952.

Cravens, M. E., Retail and Wholesale Distribution of Apples in Upstate New York, Cornell University Agricultural Experiment Station Bulletin 794, Ithaca, New York, 1943.

Dominick, Bennett Avery, Jr., "Merchandising McIntosh Apples Under Controlled Conditions - Customer Reaction and the Effect on Sales", Unpublished Doctorate Thesis, Cornell University, Ithaca, New York, 1952.

Dougherty, L. A. and Yeager, A. F., Marketing New Hampshire McIntosh Apples, New Hampshire Experiment Station Bulletin 347, June, 1943.

Grayson, P. E., "A Technique for Analyzing Causally Related Factors Affecting Price", Unpublished Master's Thesis, Cornell University, Ithaca, New York, June, 1940.

Henderson, Peter L.,"Influence of Selected Marketing Services on Apple Sales", Unpublished Doctorate Thesis, Cornell University, Ithaca, New York, 1952.

Kramer, Clyde Y., "Simplified Computations for Multiple Regression", Paper prepared for mimeographed distribution (undated and unnumbered), Virginia Agricultural Experiment Station, Virginia Polytechnic Institute.

Snedecor, George W., Statistical Methods, Iowa State College Press, Ames, Iowa, 4th ed., 1946.

The vita has been removed from the scanned document

# APPENDIX A

## Per Capita Consumption of Apples in the United States, Farm Weight, By Five Year Periods, 1909-1953

## Sample Data Sheet

## Plan for Visitation of Stores

# APPENDIX A

## Table 1

Per Capita Consumption of Apples in the United States, Farm Weight, by Five Year Periods, 1909-1953

| Period | Average Per Capita Consumption (Pounds) | Period* | Average Per Capita Consumption (Pounds) |
|---|---|---|---|
| 1909-1913 | 67.5 | 1934-1938 | 31.8 |
| 1914-1918 | 66.8 | 1939-1943 | 31.8 |
| 1919-1923 | 54.4 | 1944-1948 | 28.6 |
| 1924-1928 | 51.7 | 1949-1953 | 28.5 |
| 1929-1933 | 44.4 | | |

* Beginning in 1934 only apples sold or consumed on the farms in commercial areas are included.

Source: Consumption of Food in the United States, 1909-1953, (Agricultural Handbook Number 62), Bureau of Agricultural Economics, United States Department of Agriculture, Washington, 1953, and its supplement, The National Food Situation, NFS-69, Agricultural Marketing Service, United States Department of Agriculture, Washington, 1954.

# NORTHEASTERN REGIONAL FRUIT MARKETING PROJECT

Cooperator: .....

Enumerator Brown City Richmond Day Sat Date 12/5/53

Store Name No. 18 (Large Independent) Street Address Lakeview Avenue

Observation Begin 10:47 (a. m.) p. m. End 11:47 (a. m.) p. m. Customer count 98

| Apple Variety | Quality | Price Unit | Display Long Wide | Kind Package | Sale | Pounds purchased by customer | Total |
|---|---|---|---|---|---|---|---|
| Winesaps | 1 2 (3) 4 5 | 5# 63 | 44-25 | 5# Poly | Bulk<br>(Pack) | 5 5 5 | 15 |
| Golden Delicious | 1 2 (3) 4 5 | 2# 29 | 38-17 | None | (Bulk)<br>Pack | 2 2 1 2 | 7 |
| McIntosh | 1 2 (3) 4 5 | 2# 33 | 38-23 | None | (Bulk)<br>Pack | 3 1 2 | 6 |
| Eastern Delicious | 1 2 (3) 4 5 | 2# 29 | 38-18 | None | (Bulk)<br>Pack | 2 2 1 2 3 1 3 2 2 2 | 20 |
| (A) Mixed | 1 2 3 (4) 5 | 2# 29 | 38-22 | None | (Bulk)<br>Pack | 2 | 2 |
| Stayman | 1 2 3 (4) 5 | 3# 29 | 41-115 | Cello | (Bulk)<br>(Pack) | 2 1<br>3 3 3 | 3<br>9 |
| Golden Delicious | (1) 2 3 4 5 | (B) EA 10 | 38-16 | None | (Bulk)<br>Pack | 1 1 | 2 |
| | 1 2 3 4 5 | | | | Bulk<br>Pack | | |

## Displays of Other Fruit

| Item | Bananas | Fla. Oranges | Cal. Oranges | Grapefruit | Grapes | Tangerines | Pears |
|---|---|---|---|---|---|---|---|
| Pricing Unit | 2# 3# | 5# | | 5# 2 | 2# | Doz Doz | 2# |
| Weight of Pricing Unit | X X | X | | X 2# | X | 3# 3# | X |
| Price | 29 25 | 29 | | 45 25 | 33 | 45 45 | 29 |
| Long | 32 25 | 44 | | 44 38 | 38 | 44 38 | 38 |
| Wide | 36 15 | 40 | | 33 12 | 19 | 32 13 | 20 |
| Quality | 3 5 | 3 | | 1 3 | 3 | 3 3 | 2 |

Remarks: A - Rome and York

B - Weight of Unit = ½ pound

| Time Period | Atlanta T | W | Th | F | S | Philadelphia T | W | Th | F | S | Knoxville T | W | Th | F | S | Ithaca-Elmira T | W | Th | F | S |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Day | | | | | Day | | | | | Day | | | | | Day | | | | |
| 1 | $C_1$ | $L_5$ | $S_9$ | $C_{13}$ | $L_{18}$ | $S_1$ | $C_5$ | $L_9$ | $S_{13}$ | $C_{18}$ | $L_1$ | $C_5$ | $S_9$ | $L_{13}$ | $C_{18}$ | $C_1$ | $S_5$ | $L_9$ | $C_{13}$ | $S_{18}$ |
| 2 | $L_2$ | $S_6$ | $C_{10}$ | $L_{14}$ | $S_{19}$ | $C_2$ | $L_6$ | $S_{10}$ | $C_{14}$ | $L_{19}$ | $C_2$ | $S_6$ | $L_{10}$ | $C_{14}$ | $S_{19}$ | $S_2$ | $L_6$ | $C_{10}$ | $S_{14}$ | $L_{19}$ |
| 3 | $S_3$ | $C_7$ | $L_{11}$ | $S_{15}$ | $C_{20}$ | $L_3$ | $S_7$ | $C_{11}$ | $L_{15}$ | $S_{20}$ | $S_3$ | $L_7$ | $C_{11}$ | $S_{15}$ | $L_{20}$ | $L_3$ | $C_7$ | $S_{11}$ | $L_{15}$ | $C_{20}$ |
| 4 | $C_4$ | $L_8$ | $S_{12}$ | $C_{16}$ | $L_{21}$ | $S_4$ | $C_8$ | $L_{12}$ | $S_{16}$ | $C_{21}$ | $L_4$ | $C_8$ | $S_{12}$ | $L_{16}$ | $C_{21}$ | $C_4$ | $S_8$ | $L_{12}$ | $C_{16}$ | $S_{21}$ |
| 5 | | | | $S_{17}$ | | | | | $L_{17}$ | | | | | $S_{17}$ | | | | | $L_{17}$ | |
| | Richmond | | | | | Boston | | | | | Rochester | | | | | Pittsburgh | | | | |
| 1 | $S_1$ | $L_5$ | $C_9$ | $S_{13}$ | $L_{18}$ | $S_1$ | $L_5$ | $C_9$ | $S_{13}$ | $L_{18}$ | $L_1$ | $S_5$ | $C_9$ | $L_{13}$ | $S_{18}$ | $S_1$ | $C_5$ | $L_9$ | $S_{13}$ | $C_{18}$ |
| 2 | $L_2$ | $C_6$ | $S_{10}$ | $L_{14}$ | $C_{19}$ | $L_2$ | $C_6$ | $S_{10}$ | $L_{14}$ | $C_{19}$ | $S_2$ | $C_6$ | $L_{10}$ | $S_{14}$ | $C_{19}$ | $C_2$ | $L_6$ | $S_{10}$ | $C_{14}$ | $L_{19}$ |
| 3 | $C_3$ | $S_7$ | $L_{11}$ | $C_{15}$ | $S_{20}$ | $C_3$ | $S_7$ | $L_{11}$ | $C_{15}$ | $S_{20}$ | $C_3$ | $L_7$ | $S_{11}$ | $C_{15}$ | $L_{20}$ | $L_3$ | $S_7$ | $C_{11}$ | $L_{15}$ | $S_{20}$ |
| 4 | $S_4$ | $L_8$ | $C_{12}$ | $S_{16}$ | $L_{21}$ | $S_4$ | $L_8$ | $C_{12}$ | $S_{16}$ | $L_{21}$ | $L_4$ | $S_8$ | $C_{12}$ | $L_{16}$ | $S_{21}$ | $S_4$ | $C_8$ | $L_{12}$ | $S_{16}$ | $C_{21}$ |
| 5 | | | | $C_{17}$ | | | | | $C_{17}$ | | | | | $C_{17}$ | | | | | $L_{17}$ | |

**Figure 1: DESIGN FOR VISITATION OF STORES IN EIGHT CITIES**

C = Chain Store
L = Large Independent Store
S = Small Independent Store

**Time Periods**
1 = 10:00-12:00
2 = 12:30-2:30
3 = 2:30-4:00
4 = 4:00-6:00
5 = 6:30-8:30

# APPENDIX B

## Figures Showing Weekly Sales by Cities

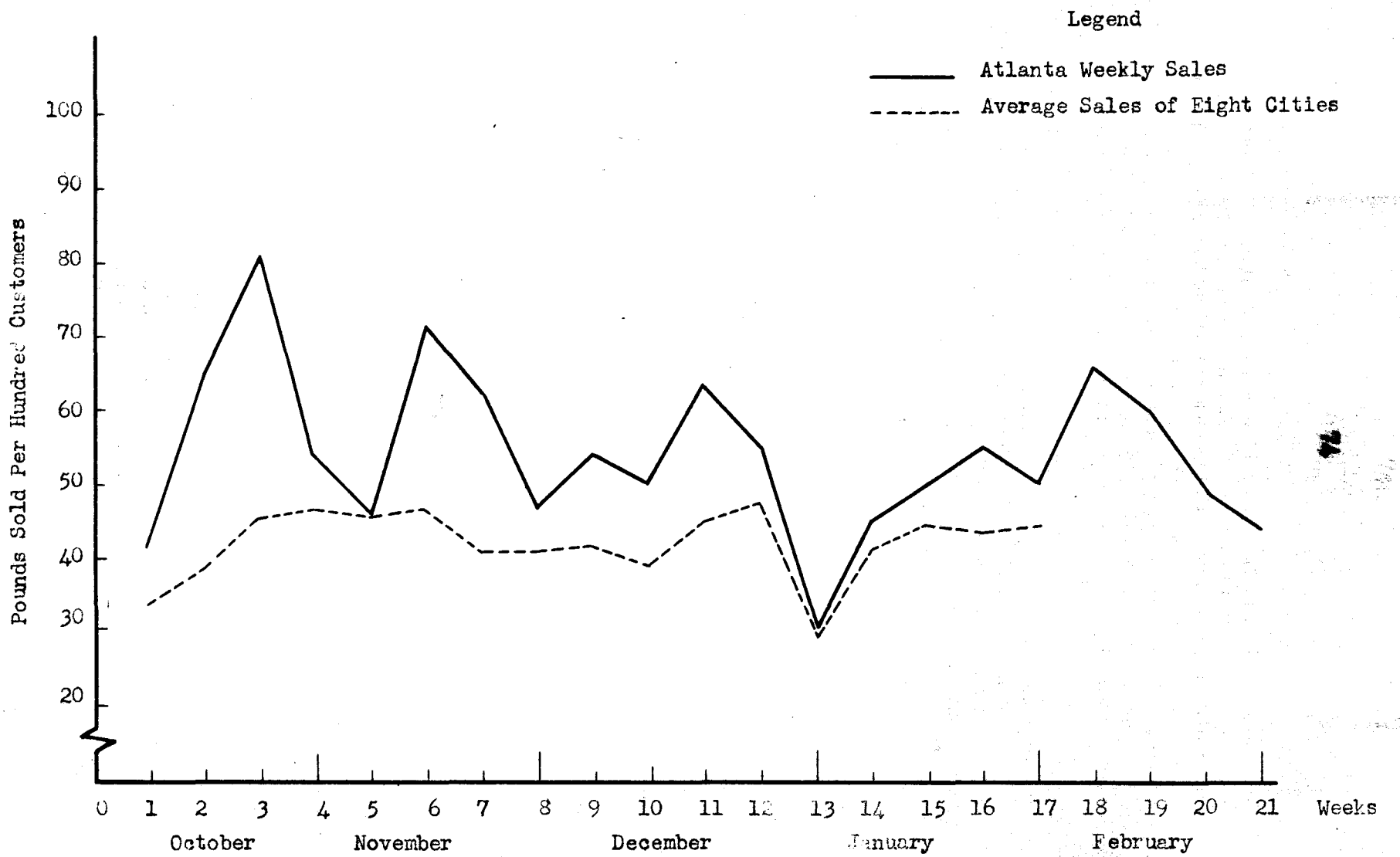


FIGURE 1: OBSERVED APPLE SALES IN ATLANTA, 1953-1954.

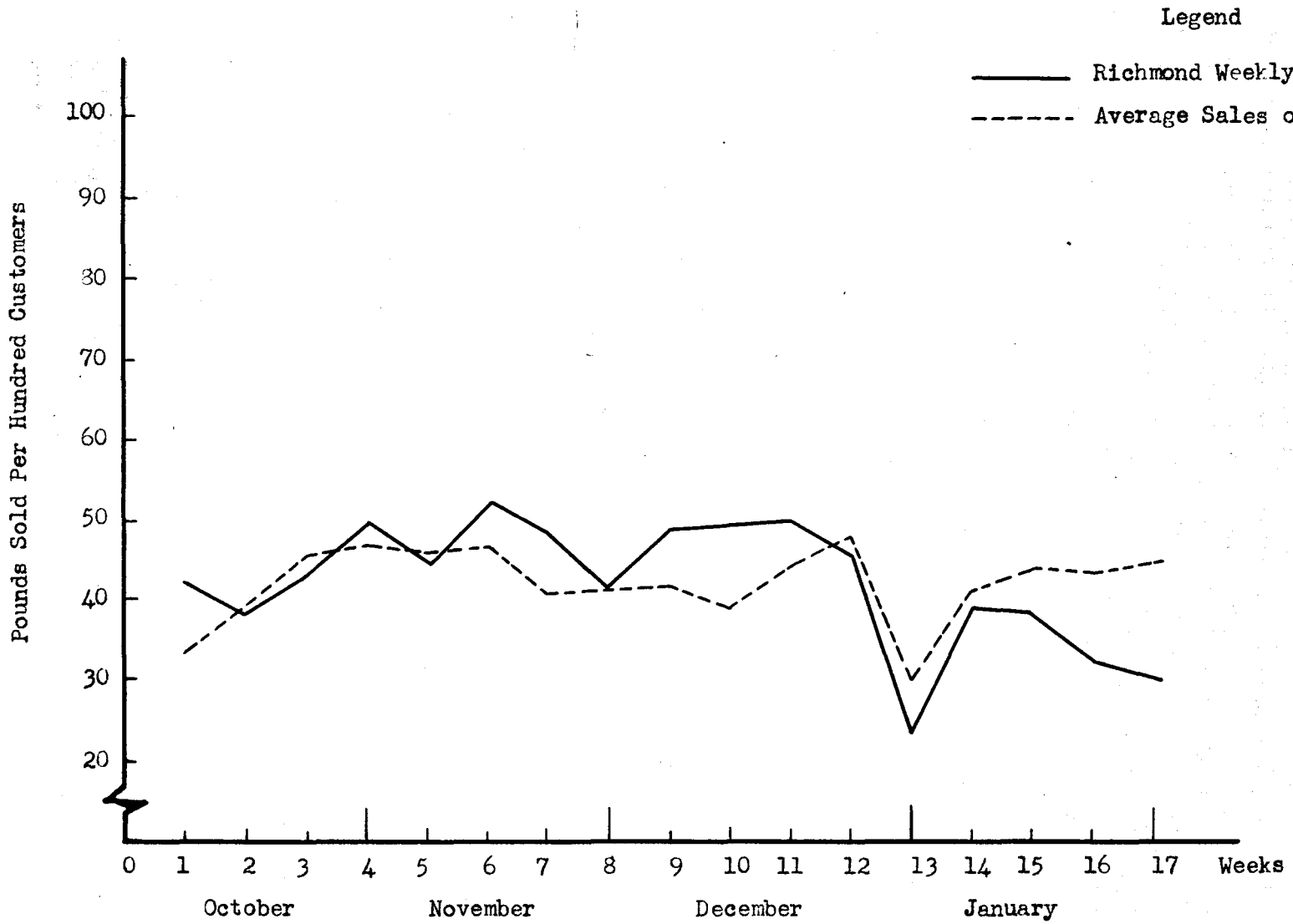


FIGURE 2: OBSERVED APPLE SALES IN RICHMOND, 1953-1954.

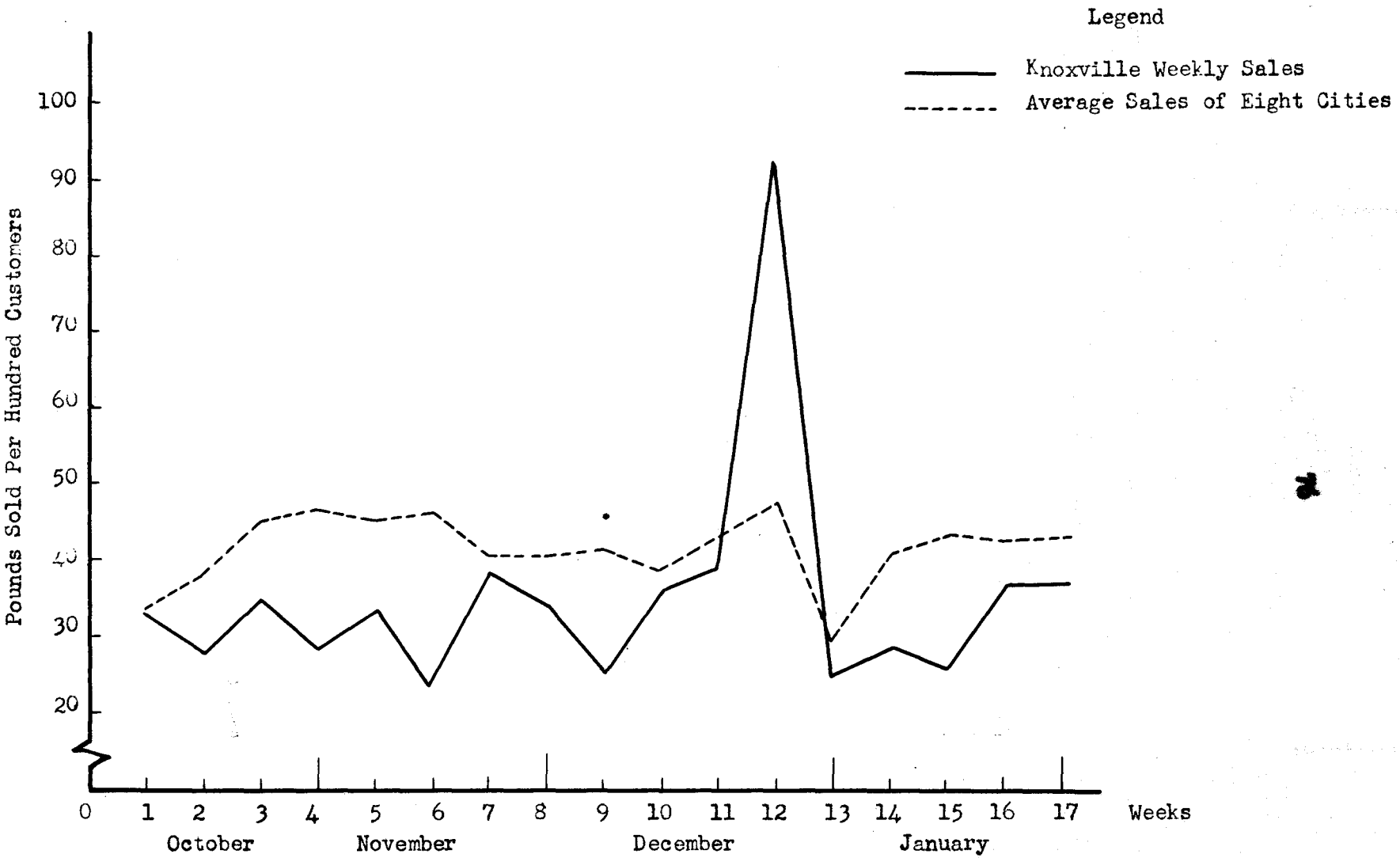


FIGURE 3: OBSERVED APPLE SALES IN KNOXVILLE, 1953-1954

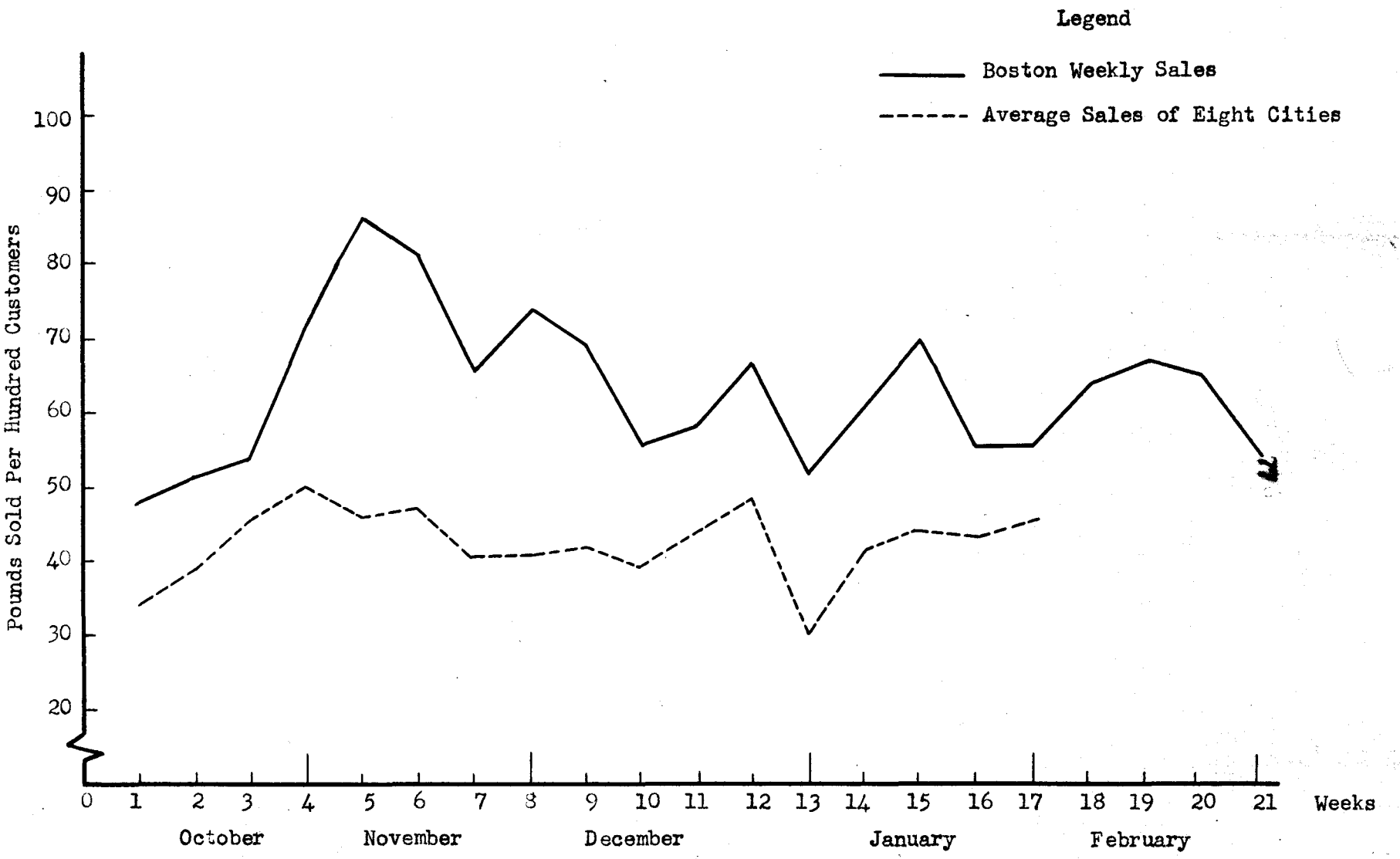


FIGURE 4: OBSERVED APPLE SALES IN BOSTON, 1953-1954

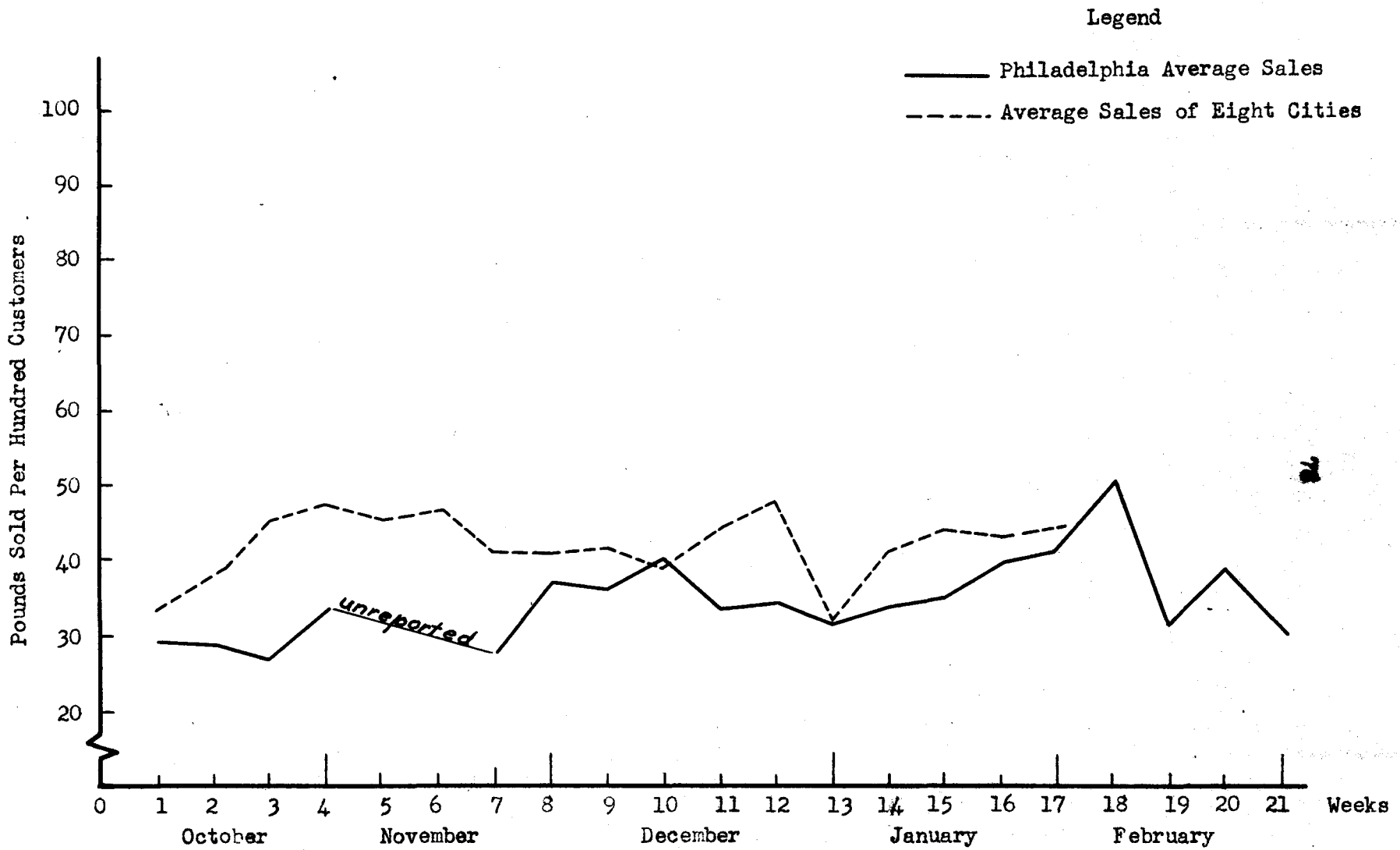


FIGURE 5: OBSERVED APPLE SALES IN PHILADELPHIA, 1953-1954.

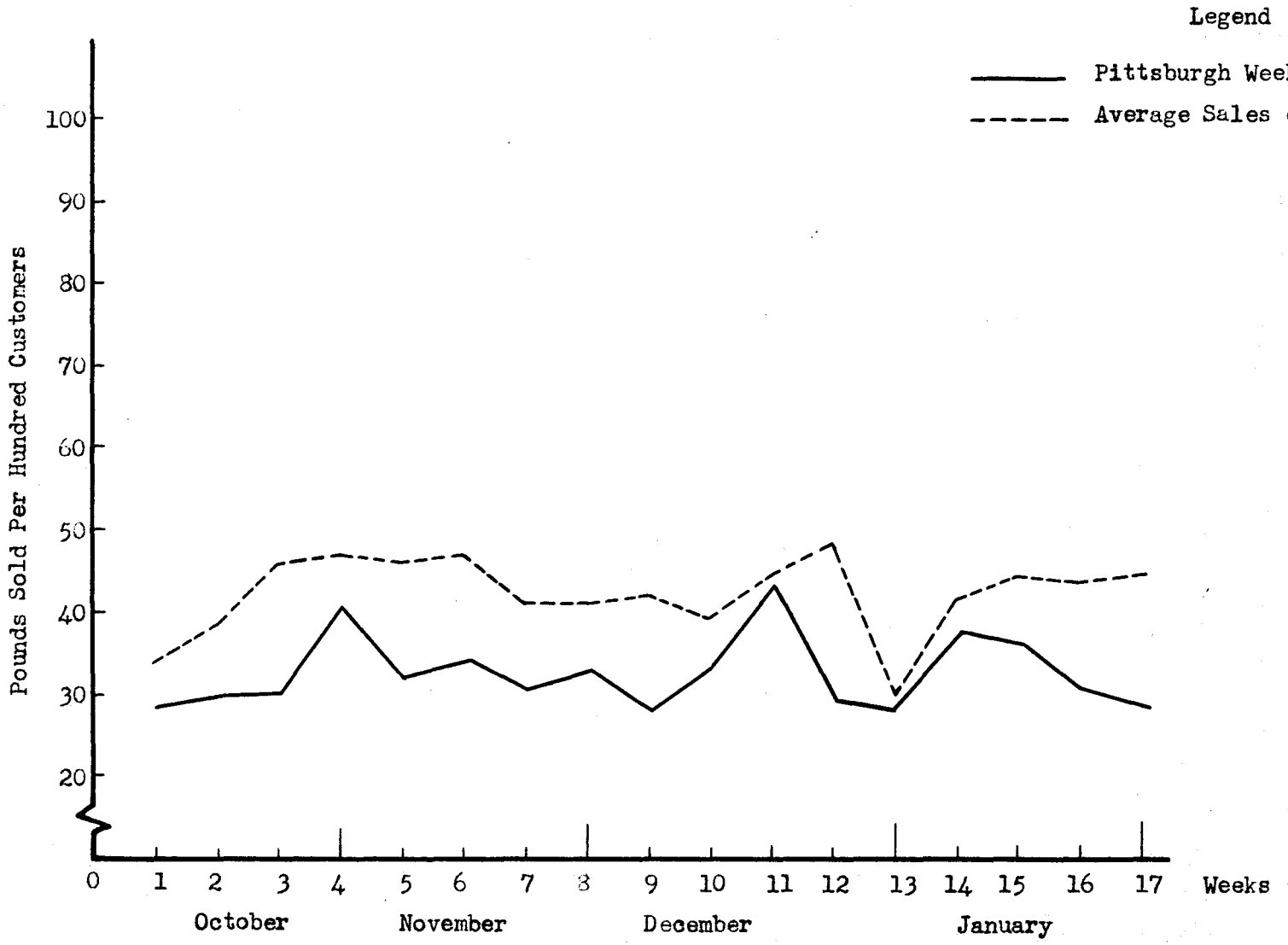


FIGURE 6: OBSERVED APPLE SALES IN PITTSBURGH, 1953-1954.

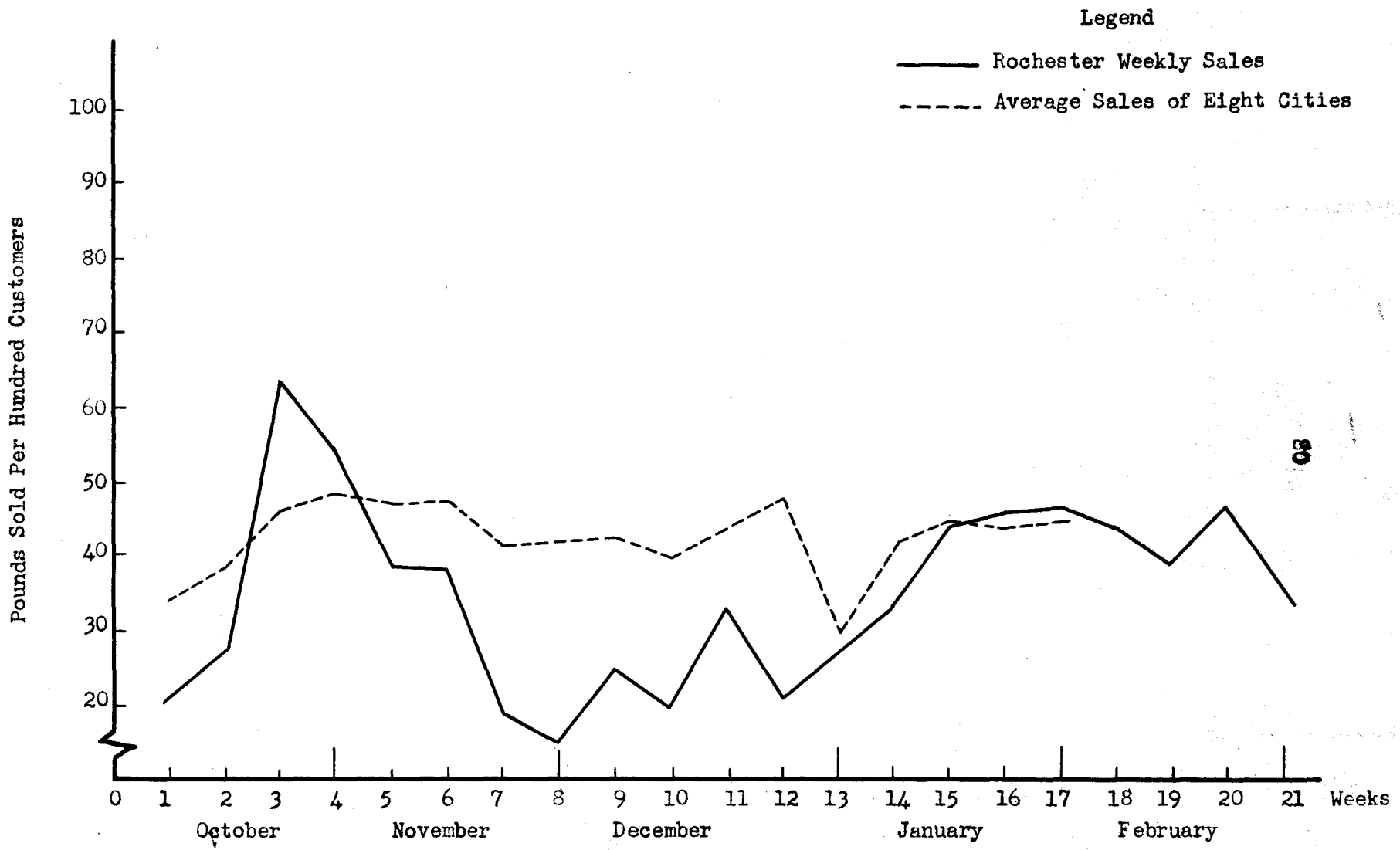


FIGURE 7: OBSERVED APPLE SALES IN ROCHESTER, 1953-1954.

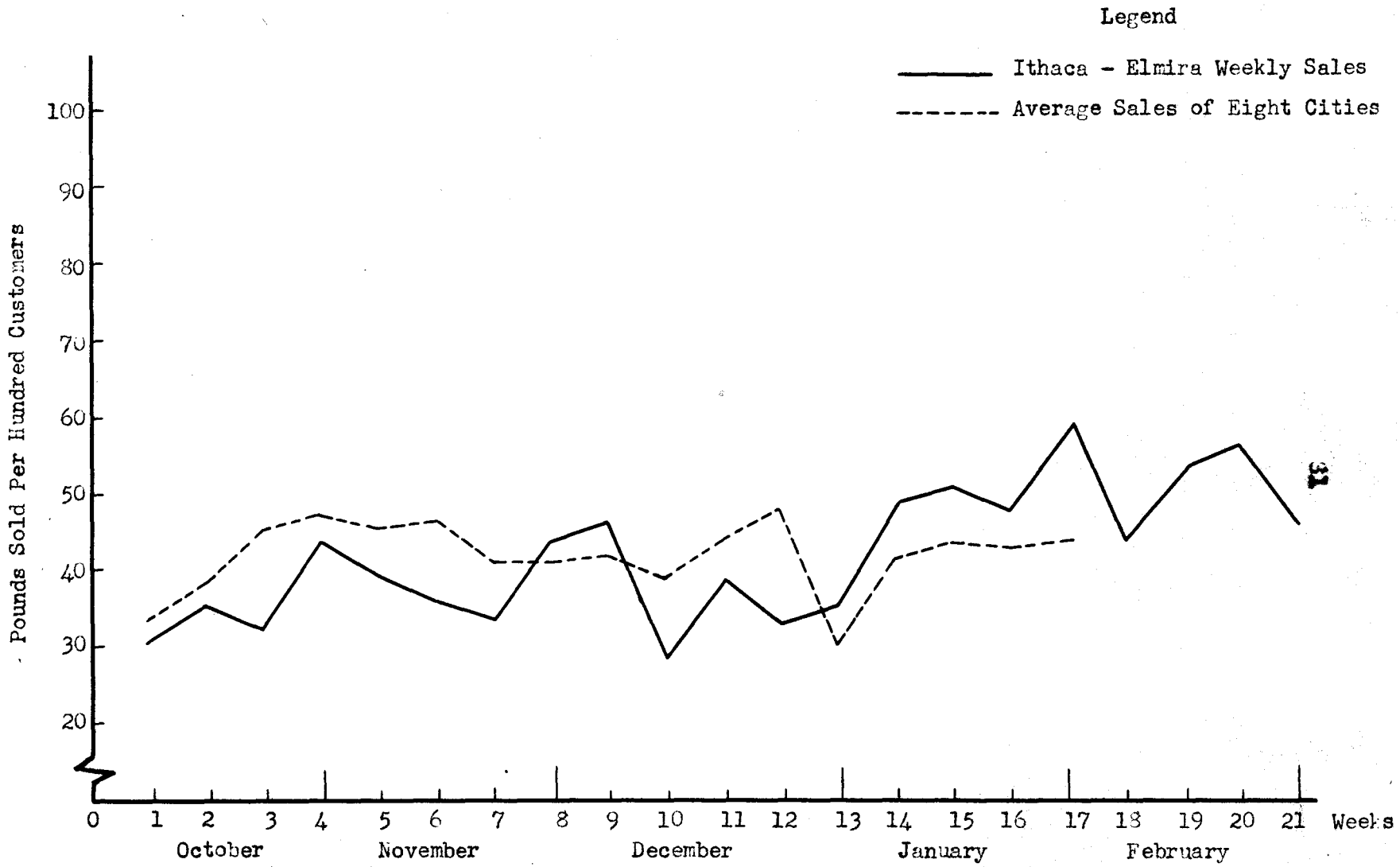


FIGURE 8: OBSERVED APPLE SALES IN ITHACA - ELMIRA, 1953-1954.

# APPENDIX C

## Example of Analysis of Variance - Sales

## Analysis of Variance Tables

## Analysis of Covariance Tables

## Explanation of Contents

The analysis of variance was made of the total pounds of apples sold during the seventeen-week period in 126 stores in six cities. The following example shows the way apple sales were adjusted for each of the variables balanced in the design. The fifth time period was omitted from the treatments of days and time periods because observations were made during the fifth time period only one day per week. Data collected during the last period were not readily comparable with data collected during other periods as a result of unequal observations. The data for the number of customer units (seasonal total), relative display space in apples (percent), number of kinds of other fruits (seasonal total), number of apple varieties (seasonal total), and price of apples (seasonal average) were adjusted in the same manner. The analysis of variance tables, but not the calculations, are shown for each of the five independent variables (customer units, price, et cetera) as well as the analysis of variance table for apple sales.

The covariance tables show the result of the adjustment of apple sales for the sampling variables jointly with each of the five independent variables listed above.

## EXAMPLE OF ANALYSIS OF VARIANCE

### APPLE SALES IN POUNDS

**Table I**

| Store No. | Atl. | Knox. | Bos. | Pitts. | Roch. | Ith. | Total |
|---|---|---|---|---|---|---|---|
| 1 | 99 | 7 | 15 | 69 | 484 | 158 | 832 |
| 2 | 34 | 26 | 351 | 241 | 65 | 50 | 767 |
| 3 | 99 | 13 | 243 | 53 | 57 | 253 | 718 |
| 4 | 247 | 90 | 166 | 19 | 76 | 310 | 908 |
| 5 | 1 | 68 | 165 | 44 | 24 | 11 | 313 |
| 6 | 373 | 15 | 564 | 88 | 200 | 100 | 1340 |
| 7 | 86 | 16 | 27 | 372 | 51 | 252 | 804 |
| 8 | 99 | 726 | 152 | 70 | 84 | 111 | 1242 |
| 9 | 44 | 9 | 168 | 301 | 288 | 379 | 1189 |
| 10 | 43 | 114 | 36 | 0 | 24 | 207 | 424 |
| 11 | 816 | 393 | 1238 | 227 | 91 | 201 | 2966 |
| 12 | 191 | 15 | 737 | 143 | 197 | 222 | 1505 |
| 13 | 865 | 218 | 86 | 20 | 96 | 182 | 1467 |
| 14 | 378 | 441 | 102 | 481 | 127 | 89 | 1618 |
| 15 | 344 | 20 | 825 | 29 | 646 | 430 | 2294 |
| 16 | 544 | 128 | 254 | 23 | 142 | 933 | 2024 |
| 17 | 79 | 29 | 1464 | 232 | 1116 | 668 | 3588 |
| 18 | 103 | 116 | 355 | 615 | 94 | 21 | 1304 |
| 19 | 26 | 22 | 689 | 78 | 406 | 682 | 1903 |
| 20 | 1027 | 136 | 94 | 199 | 167 | 649 | 2272 |
| 21 | 319 | 563 | 120 | 383 | 125 | 114 | 1624 |
| All Total | 5817 | 3165 | 7851 | 3687 | 4560 | 6022 | 31102 |
| Total Minus Nights | 5738 | 3136 | 6387 | 3455 | 3444 | 5354 | 27514 |

$CT = \frac{GT^2}{N} = \frac{GT^2}{126}$ (CT = Correction Term)

$= \frac{31102^2}{126}$

$= 7,677,257$

$SST = Sy_1^2 - CT$

$= (99)^2 + \ldots\ldots + (114)^2 - CT$

$= 17,541,350 - CT$

$= 9,864,093$

$SSe = \frac{Soi^2}{21} - CT$

$= \frac{(5817)^2 + \ldots\ldots + (6022)^2}{21} - CT$

$= \frac{176,144,968}{21} - CT$

$= 710,599$

Table II

| | Cities | | | | | | |
|---|---|---|---|---|---|---|---|
| Type | 1 | 3 | 4 | 6 | 7 | 8 | Total |
| Chain | 3971 | 2333 | 4690 | 2389 | 2910 | 2691 | 18984 |
| Large | 1155 | 709 | 2483 | 880 | 1040 | 2734 | 9001 |
| Small | 691 | 123 | 678 | 418 | 610 | 597 | 3117 |
| Total | 5817 | 3165 | 7851 | 3687 | 4560 | 6022 | 31102 |

$SSty = \frac{Syri^2}{42} - CT$

$= \frac{(18984)^2 + (9001)^2 + (3117)^2}{42} - CT$

$= \frac{451,125,946}{42} - CT$

$= 3,063,837$

$$SSt = \frac{Sy_1^2}{7} - CT$$

$$= \frac{(3971)^2 + ..... + (597)^2}{7} - CT$$

$$= \frac{83,813,010}{7} - CT$$

$$= 4,296,030$$

$$I_1 = SSt - SSty - SSe$$

$$= 4,296,030 - 3,063,837 - 710,599$$

$$= 521,594$$

Table III

Days x Cities (Minus Nights)

| Day | 1 | 3 | 4 | 6 | 7 | 8 | Total |
|---|---|---|---|---|---|---|---|
| Tues | 479 | 136 | 775 | 382 | 682 | 771 | 3225 |
| Wed | 1094 | 825 | 908 | 574 | 359 | 474 | 4234 |
| Thurs | 559 | 531 | 2179 | 671 | 600 | 1009 | 5549 |
| Fri | 2131 | 807 | 1267 | 553 | 1011 | 1634 | 7403 |
| Sat. | 1475 | 837 | 1258 | 1275 | 792 | 1466 | 7103 |
| Total | 5738 | 3136 | 6387 | 3455 | 3444 | 5354 | 27514 |

$$CT_1 = \frac{GT_1^2}{120}$$

$$= \frac{27514^2}{120}$$

$$= \frac{757,020,196}{120}$$

$$= 6,308,501$$

$$SSd = \frac{SI_{ri}^2}{24} - CT_1$$

$$= \frac{(3225)^2 + ..... + (7103)^2}{24} - CT_1$$

$$= \frac{164,375,800}{24} - CT_1$$

$$= 6,848,992 - CT_1$$

$$= 540,490$$

$$SSc_1 = \frac{Sc_i^2}{N} - CT_1$$

$$= \frac{(5738)^2 + .... + (5354)^2}{20} - CT_1$$

$$= \frac{136,016,386}{20} - CT_1$$

$$= 6,800,819 - CT_1$$

$$= 492,318$$

$$SSt_2 = \frac{SI_i^2}{4} - CT_1$$

$$= \frac{32,262,202}{4} - CT_1$$

$$= 8,066,550 - CT_1$$

$$= 1,758,048$$

Table IV

Day x Type (Minus Nights)

| Type | Tues | Wed | Thurs | Fri | Sat | Total |
|---|---|---|---|---|---|---|
| Chain | 1381 | 3068 | 2590 | 4917 | 4448 | 16404 |
| Large | 1348 | 763 | 2507 | 1523 | 1960 | 8101 |
| Small | 496 | 403 | 452 | 963 | 695 | 3009 |
| Total | 3225 | 4234 | 5549 | 7403 | 7103 | 27514 |

$$SSty_1 = \frac{Syeh^2 + Sylg^2 + Sysm^2}{40} - CT_1$$

$$= \frac{(16404)^2 + (8101)^2 + (3009)^2}{40} - CT_1$$

$$= 8,594,287 - CT_1$$

$$= 2,285,785$$

$$SSt_3 = \frac{SY_1^2}{8} - CT_1$$

$$= \frac{(1381)^2 + \ldots\ldots + (695)^2}{8} - CT_1$$

$$= 9,857,257 - CT_1$$

$$= 3,548,755$$

$$I_5 = SSt_3 - SSd - SSty_1$$

$$= 9,857,257 - 540,490 - 2,285,785$$

$$= 722,480$$

Table V

Cities x Time Period (Minus Nights)

| Time Period | 1 | 3 | 4 | 6 | 7 | 8 | Total |
|---|---|---|---|---|---|---|---|
| 1 | 1112 | 418 | 789 | 1075 | 986 | 751 | 5131 |
| 2 | 854 | 618 | 1742 | 844 | 822 | 1128 | 6008 |
| 3 | 2372 | 578 | 2427 | 596 | 1012 | 1785 | 8770 |
| 4 | 1400 | 1522 | 1429 | 940 | 624 | 1690 | 7605 |
| Total | 5738 | 3136 | 6387 | 3455 | 3444 | 5354 | 27514 |

$$SStp = \frac{Sy_{ri}^2}{30} - CT_1$$

$$= \frac{(5131)^2 + (6008)^2 + (8770)^2 + (7605)^2}{30} - CT_1$$

$$= 6,572,405 - CT_1$$

$$= 263,903$$

$$SSt_4 = \frac{SI_1^2}{5} - CT_1$$

$$= \frac{(1112)^2 + \ldots\ldots + (1690)^2}{5} - CT_1$$

$$= 7,679,160 - CT_1$$

$$= 1,370,658$$

$$I_6 = SSt_4 - SStp - SSe_1$$

$$= 1,370,658 - 263,903 - 492,317$$

$$= 614,438$$

Table VI

Days x Time Period (Minus Nights)

| Time Period | Tues | Wed | Thurs | Fri | Sat | Total |
|---|---|---|---|---|---|---|
| 1 | 832 | 382 | 1146 | 1467 | 1304 | 5131 |
| 2 | 767 | 966 | 754 | 1618 | 1903 | 6008 |
| 3 | 718 | 1250 | 2236 | 2294 | 2272 | 8770 |
| 4 | 908 | 1636 | 1413 | 2024 | 1624 | 7605 |
| Total | 3225 | 4234 | 5549 | 7403 | 7103 | 27514 |

$$SSt_5 = \frac{SI_1^2}{6} - CT_1$$

$$= \frac{(832)^2 + \ldots\ldots + (1624)^2}{6} - CT_1$$

$$= 7,344,481 - CT_1$$

$$= 1,035,919$$

$$I_7 = SSt_5 - SSd - SStp$$

$$= 1,035,919 - 540,490 - 263,903$$

$$= 231,586$$

Table VII

Time Period x Type (Minus Nights)

| Type | 1 | 2 | 3 | 4 | Total |
|---|---|---|---|---|---|
| Chain | 2629 | 3628 | 5135 | 5012 | 16404 |
| Large | 2152 | 1907 | 2459 | 1583 | 8101 |
| Small | 350 | 473 | 1176 | 1010 | 3009 |
| Total | 5131 | 6008 | 8770 | 7605 | 27514 |

$$SSt_6 = \frac{SI_i^2}{10} - CT_1$$

$$= \frac{(2629)^2 + \ldots\ldots + (1010)^2}{10} - CT_1$$

$$= 9,113,202 - CT_1$$

$$= 2,804,700$$

$$I_8 = SSt_6 - SSty_1 - SStp$$

$$= 2,804,700 - 2,285,785 - 263,903$$

$$= 255,012$$

TABLE 1

ANALYSIS OF VARIANCE TABLE FOR SALES

| Source of Variation | Sum of Squares | Degrees of Freedom | Mean Squares | F-ratio |
|---|---|---|---|---|
| Total | 9,864,093 | 125 | | |
| Type | 3,063,837 | 2 | 1,531,918 | 27.67** |
| City | 710,599 | 5 | 142,119 | 2.57* |
| Interaction of City x Type | 521,593 | 10 | 52,159 | .94 |
| Days | 540,491 | 4 | 135,122 | 2.44 |
| Interaction of Days x Cities | 725,240 | 20 | 36,262 | .66 |
| Interaction of Days x Type | 722,478 | 8 | 90,310 | 1.63 |
| Time Period | 263,904 | 3 | 87,968 | 1.59 |
| Interaction of Time Period x Cities | 614,437 | 15 | 40,963 | .74 |
| Interaction of Time Period x Days | 231,584 | 12 | 19,299 | .35 |
| Interaction of Time Period x Type | 255,011 | 6 | 42,501 | .77 |
| Error | 2,214,913 | 40 | 55,372 | |

** Significant at the one percent level.
* Significant at the five percent level.

TABLE 2

ANALYSIS OF VARIANCE TABLE FOR CUSTOMERS

| Source of Variation | Sum of Squares | Degrees of Freedom | Mean Squares | F-ratio |
|---|---|---|---|---|
| Total | 27,107,668 | 125 | | |
| Type | 8,043,856 | 2 | 4,021,928 | 30.98** |
| City | 1,785,611 | 5 | 357,122 | 2.75* |
| Interaction of City x Type | 814,436 | 10 | 81,444 | .63 |
| Days | 1,031,443 | 4 | 257,861 | 1.99 |
| Interaction of Day x Cities | 1,978,789 | 20 | 98,939 | .76 |
| Interaction of Day x Type | 2,769,859 | 8 | 346,232 | 2.67* |
| Time Period | 1,075,352 | 3 | 358,450 | 2.76* |
| Interaction of Time Period x City | 2,525,836 | 15 | 168,389 | 1.30 |
| Interaction of Time Period x Days | 862,498 | 12 | 71,874 | .55 |
| Interaction of Time Period x Type | 1,026,956 | 6 | 171,159 | 1.32 |
| Error | 5,193,032 | 40 | 129,826 | |

** Significant at the one percent level.
* Significant at the five percent level.

TABLE 3

ANALYSIS OF VARIANCE TABLE FOR PRICE OF APPLES

| Source of Variation | Sum of Squares | Degrees of Freedom | Mean Squares | F-ratio |
|---|---|---|---|---|
| Total | 15.352 | 125 | | |
| Type | .148 | 2 | .074 | 1.72 |
| City | 9.263 | 5 | 1.853 | 43.09** |
| Interaction of City x Type | .770 | 10 | .077 | 1.79 |
| Days | .333 | 4 | .083 | 1.93 |
| Interaction of Days x Cities | 1.303 | 20 | .065 | 1.51 |
| Interaction of Days x Type | .395 | 8 | .049 | 1.14 |
| Time Period | .162 | 3 | .054 | 1.26 |
| Interaction of Time Period x Cities | .649 | 15 | .043 | 1.00 |
| Interaction of Time Period x Days | .235 | 12 | .019 | .44 |
| Interaction of Time Period x Type | .383 | 6 | .064 | 1.49 |
| Error | 1.711 | 40 | .043 | |

** Significant at the one percent level.

TABLE 4

ANALYSIS OF VARIANCE TABLE FOR APPLE VARIETIES

| Source of Variation | Sum of Squares | Degrees of Freedom | Mean Squares | F-ratio |
|---|---|---|---|---|
| Total | 34.251 | 125 | | |
| Type | 5.499 | 2 | 2.750 | 11.85** |
| City | 4.589 | 5 | 918 | 3.96** |
| Interaction of City x Type | 3.697 | 10 | 370 | 1.59 |
| Days | 1.309 | 4 | 327 | 1.41 |
| Interaction of Days x Cities | 2.719 | 20 | 136 | .59 |
| Interaction of Days x Type | 1.597 | 8 | 200 | .86 |
| Time Period | 37 | 3 | 12 | .05 |
| Interaction of Time Period x Cities | 2.848 | 15 | 190 | .82 |
| Interaction of Time Period x Days | 1.443 | 12 | 120 | .52 |
| Interaction of Time Period x Type | 1.216 | 6 | 203 | .88 |
| Error | 9.297 | 40 | 232 | |

** Significant at the one percent level.

TABLE 5

ANALYSIS OF VARIANCE TABLE FOR KINDS OF OTHER FRUIT

| Source of Variation | Sum of Squares | Degrees of Freedom | Mean Squares | F-ratio |
|---|---|---|---|---|
| Total | 25.195 | 125 | | |
| Type | 4.832 | 2 | 2.416 | 32.65** |
| City | 9.467 | 5 | 1.893 | 25.58** |
| Interaction of City x Type | 1.056 | 10 | 106 | 1.43 |
| Days | 229 | 4 | 57 | .77 |
| Interaction of Days x Cities | 2.291 | 20 | 115 | 1.55 |
| Interaction of Days x Type | 1.493 | 8 | 187 | 2.53* |
| Time Period | 214 | 3 | 71 | .96 |
| Interaction of Time Period x Cities | 1.197 | 15 | 80 | 1.08 |
| Interaction of Time Period x Days | 1.311 | 12 | 109 | 1.47 |
| Interaction of Time Period x Type | 129 | 6 | 22 | .30 |
| Error | 2.976 | 40 | 74 | |

** Significant at the one percent level.
* Significant at the five percent level.

TABLE 6

ANALYSIS OF VARIANCE TABLE FOR DISPLAY SPACE

| Source of Variation | Sum of Squares | Degrees of Freedom | Mean Squares | F-ratio |
|---|---|---|---|---|
| Total | 2.501 | 125 | | |
| Type | .009 | 2 | .004 | .33 |
| City | .958 | 5 | .191 | 15.92** |
| Interaction of City x Type | .265 | 10 | .026 | 2.17* |
| Days | .027 | 4 | .007 | .58 |
| Interaction of Days x Cities | .303 | 20 | .015 | 1.25 |
| Interaction of Days x Type | .073 | 8 | .009 | .75 |
| Time Period | .005 | 3 | .002 | .17 |
| Interaction of Time Period x Cities | .210 | 15 | .014 | 1.17 |
| Interaction of Time Period x Days | .143 | 12 | .012 | 1.00 |
| Interaction of Time Period x Type | .038 | 6 | .006 | .50 |
| Error | .470 | 40 | .012 | |

** Significant at the one percent level.
* Significant at the five percent level.

TABLE 7

COVARIANCE OF SALES AND CUSTOMERS

| Source of Variation | Degrees of Freedom | Sums of Squares and Products | | | Errors of Estimate | | |
|---|---|---|---|---|---|---|---|
| | | $S_x^2$ | $S_{xy}$ | $S_y^2$ | Sum of Squares | Degrees of Freedom | Mean Squares |
| Total | 125 | 27,107,668 | 13,594,506 | 9,864,093 | | | |
| Type | 2 | 8,043,856 | 4,920,494 | 3,063,837 | | | |
| City | 5 | 1,785,611 | 445,405 | 710,599 | | | |
| Interaction of City x Type | 10 | 814,436 | 313,655 | 521,593 | | | |
| Days | 4 | 1,031,443 | 641,122 | 540,491 | | | |
| Interaction of Days x Cities | 20 | 1,978,789 | 939,970 | 725,240 | | | |
| Interaction of Days x Type | 8 | 2,769,859 | 1,244,351 | 722,478 | | | |
| Time Period | 3 | 1,075,352 | 482,900 | 263,904 | | | |
| Interaction of Time Period x Cities | 15 | 2,525,836 | 1,137,133 | 614,437 | | | |
| Interaction of Time Period x Days | 12 | 862,498 | 310,079 | 231,584 | | | |
| Interaction of Time Period x Type | 6 | 1,026,956 | 464,249 | 255,011 | | | |
| Error | 40 | 5,193,032 | 2,695,148 | 2,214,913 | 816,149 | 39 | 20,926 |

COVARIANCE OF SALES AND CUSTOMERS (Continued)

| Source of Variation | Degrees of Freedom | Sums of Squares and Products $S_x^2$ | $S_{xy}$ | $S_y^2$ | Errors of Estimate Sum of Squares | Degrees of Freedom | Mean Squares | F-ratio |
|---|---|---|---|---|---|---|---|---|
| Type + Error | 42 | 13,236,888 | 7,615,642 | 5,278,750 | 897,207 | 41 | | |
| Adjusted for Customers | | | | | 81,058 | 2 | 40,529 | 1.94 |
| City + Error | 46 | 6,978,643 | 3,140,553 | 2,925,512 | 1,512,190 | 44 | | |
| Adjusted for Customers | | | | | 696,041 | 5 | 139,208 | 6.65** |
| Interaction of City x Type + Error | 50 | 6,007,468 | 3,008,803 | 2,736,506 | 1,229,565 | 49 | | |
| Adjusted for Customers | | | | | 413,416 | 10 | 41,342 | 1.98 |
| Day + Error | 44 | 6,224,475 | 3,336,270 | 2,755,404 | 967,190 | 43 | | |
| Adjusted for Customers | | | | | 151,041 | 4 | 37,760 | 1.80 |
| Interaction of Day x City + Error | 60 | 7,171,821 | 3,635,118 | 2,940,153 | 1,097,653 | 59 | | |
| Adjusted for Customers | | | | | 281,504 | 20 | 14,075 | .67 |
| Interaction of Day x Type + Error | 48 | 7,962,891 | 3,939,499 | 2,937,391 | 988,394 | 47 | | |
| Adjusted for Customers | | | | | 172,245 | 8 | 21,530 | 1.03 |
| Time Period + Error | 43 | 6,268,384 | 3,178,048 | 2,478,817 | 867,559 | 42 | | |
| Adjusted for Customers | | | | | 51,410 | 3 | 17,136 | .82 |
| Interaction of City x Time Period + Error | 55 | 7,718,868 | 3,832,281 | 2,829,350 | 926,690 | 54 | | |
| Adjusted for Customers | | | | | 110,541 | 15 | 7,369 | .35 |
| Interaction of Day x Time Period + Error | 52 | 6,055,530 | 3,005,227 | 2,446,497 | 955,068 | 51 | | |
| Adjusted for Customers | | | | | 138,919 | 12 | 11,577 | .55 |
| Interaction of Type x Time Period + Error | 46 | 6,219,988 | 3,159,397 | 2,469,924 | 866,132 | 45 | | |
| Adjusted for Customers | | | | | 48,983 | 6 | 8,163 | .39 |

** Significant at the one percent level.

TABLE 8

COVARIANCE OF SALES AND PRICE OF APPLES

| Source of Variation | Degrees of Freedom | Sums of Squares and Products | | | Errors of Estimate | | |
|---|---|---|---|---|---|---|---|
| | | $Sx^2$ | Sxy | $Sy^2$ | Sum of Squares | Degrees of Freedom | Mean Squares |
| Total | 125 | 15,352 | -1,115,503 | 9,864,093 | | | |
| Type | 2 | ,148 | -10,547 | 3,063,837 | | | |
| City | 5 | 9,263 | -914,918 | 710,599 | | | |
| Interaction of City x Type | 10 | ,770 | -332,798 | 521,593 | | | |
| Days | 4 | ,333 | -32,448 | 540,491 | | | |
| Interaction of Days x Cities | 20 | 1,303 | 301,564 | 725,240 | | | |
| Interaction of Days x Type | 8 | ,395 | 50,545 | 722,478 | | | |
| Time Period | 3 | ,162 | -110,623 | 263,904 | | | |
| Interaction of Time Period x Cities | 15 | ,649 | -75,814 | 614,437 | | | |
| Interaction of Time Period x Days | 12 | ,235 | -39,452 | 231,584 | | | |
| Interaction of Time Period x Type | 6 | ,383 | 105,644 | 255,011 | | | |
| Error | 40 | 1,711 | -56,656 | 2,214,913 | 2,196,153 | 39 | 56,312 |

COVARIANCE OF SALES AND PRICE OF APPLES (Continued)

| Source of Variation | Degrees of Freedom | Sums of Squares and Products $Sx^2$ | Sxy | $Sy^2$ | Errors of Estimate Sum of Squares | Degrees of Freedom | Mean Squares | F-ratio |
|---|---|---|---|---|---|---|---|---|
| Type + Error | 42 | 1.859 | -67.203 | 5.278.750 | 5.276.321 | 41 | | |
| Adjusted for Price of Apples | | | | | 3.080.168 | 2 | 1.540.084 | 27.35** |
| City + Error | 45 | 10.976 | -971.574 | 2.925.512 | 2.839.495 | 44 | | |
| Adjusted for Price of Apples | | | | | 643.342 | 5 | 128.668 | 2.28 |
| Interaction of City x Type + Error | 50 | 2.481 | -389.454 | 2.736.506 | 2.675.372 | 49 | | |
| Adjusted for Price of Apples | | | | | 479.219 | 10 | 47.922 | .85 |
| Day + Error | 44 | 2.044 | 89.104 | 2.755.404 | 2.751.520 | 43 | | |
| Adjusted for Price of Apples | | | | | 555.367 | 4 | 138.842 | 2.47 |
| Interaction of Day x City + Error | 60 | 3.014 | 244.908 | 2.940.153 | 2.920.253 | 59 | | |
| Adjusted for Price of Apples | | | | | 724.100 | 20 | 36.205 | .64 |
| Interaction of Day x Type + Error | 48 | 2.106 | -6.111 | 2.937.391 | 2.937.374 | 47 | | |
| Adjusted for Price of Apples | | | | | 741.221 | 8 | 92.653 | 1.65 |
| Time Period + Error | 43 | 1.873 | -367.279 | 2.478.817 | 2.463.877 | 42 | | |
| Adjusted for Price of Apples | | | | | 267.724 | 3 | 89.241 | 1.58 |
| Interaction of Time Period x City + Error | 55 | 2.360 | -132.470 | 2.829.350 | 2.821.914 | 54 | | |
| Adjusted for Price of Apples | | | | | 625.761 | 15 | 41.718 | .74 |
| Interaction of Time Period x Day + Error | 52 | 1.946 | -96.108 | 2.446.497 | 2.441.751 | 51 | | |
| Adjusted for Price of Apples | | | | | 245.598 | 12 | 20.467 | .36 |
| Interaction of Time Period x Type + Error | 46 | 2.094 | 48.988 | 2.469.924 | 2.468.778 | 45 | | |
| Adjusted for Price of Apples | | | | | 272.625 | 6 | 45.438 | .81 |

** Significant at the one percent level.

TABLE 9

COVARIANCE OF SALES AND NUMBER OF APPLE VARIETIES

| Source of Variation | Degrees of Freedom | Sums of Squares and Products | | | Errors of Estimate | | |
|---|---|---|---|---|---|---|---|
| | | $Sx^2$ | Sxy | $Sy^2$ | Sumsof Squares | Degrees of Freedom | Mean Squares |
| Total | 125 | 34,251 | 167,887 | 9,864,093 | | | |
| Type | 2 | 5,499 | 108,020 | 3,063,837 | | | |
| City | 5 | 4,589 | -10,241 | 710,599 | | | |
| Interaction of City x Type | 10 | 3,697 | 22,080 | 521,594 | | | |
| Days | 4 | 1,309 | -23,179 | 540,490 | | | |
| Interaction of Days x Cities | 20 | 2,719 | 4,152 | 725,241 | | | |
| Interaction of Days x Type | 8 | 1,597 | 8,256 | 722,480 | | | |
| Time Period | 3 | 37 | 1,951 | 263,903 | | | |
| Interaction of Time Period x Cities | 15 | 2,848 | 19,637 | 614,438 | | | |
| Interaction of Time Period x Days | 12 | 1,443 | 10,149 | 231,586 | | | |
| Interaction of Time Period x Type | 6 | 1,216 | -23 | 255,012 | | | |
| Error | 40 | 9,297 | 27,085 | 2,214,913 | 2,136,007 | 39 | 54,769 |

COVARIANCE OF SALES AND NUMBER OF APPLE VARIETIES (Continued)

| Source of Variation | Degrees of Freedom | Sums of Squares and Products $S_x^2$ | $S_{xy}$ | $S_y^2$ | Errors of Estimate: Sum of Squares | Degrees of Freedom | Mean Squares | F-ratio |
|---|---|---|---|---|---|---|---|---|
| Type + Error | 42 | 14.796 | 135.105 | 5,278.750 | 4,045,081 | 41 | | |
| Adjusted for Apple Varieties | | | | | 1,909,074 | 2 | 954,537 | 17.43** |
| City + Error | 45 | 13.886 | 16.844 | 2,925,512 | 2,905,080 | 44 | | |
| Adjusted for Apple Varieties | | | | | 769,073 | 5 | 153,814 | 2.81* |
| Interaction of City x Type + Error | 50 | 12.994 | 49.165 | 2,736,506 | 2,550,481 | 49 | | |
| Adjusted for Apple Varieties | | | | | 414,474 | 10 | 41,447 | .76 |
| Day + Error | 44 | 10.606 | 3.906 | 2,755,404 | 2,753,965 | 43 | | |
| Adjusted for Apple Varieties | | | | | 617,958 | 4 | 154,489 | 2.82* |
| Interaction of Day x City + Error | 60 | 12.016 | 31.237 | 2,940,153 | 2,858,949 | 59 | | |
| Adjusted for Apple Varieties | | | | | 722,942 | 20 | 36,147 | .66 |
| Interaction of Day x Type + Error | 48 | 10.894 | 35.341 | 2,937,391 | 2,822,741 | 47 | | |
| Adjusted for Apple Varieties | | | | | 686,734 | 8 | 85,842 | 1.57 |
| Time Period + Error | 43 | 9.334 | 29.036 | 2,478,817 | 2,388,493 | 42 | | |
| Adjusted for Apple Varieties | | | | | 252,486 | 3 | 84,162 | 1.54 |
| Interaction of Time Period x City + Error | 55 | 12.145 | 46.722 | 2,829,350 | 2,649,610 | 54 | | |
| Adjusted for Apple Varieties | | | | | 513,603 | 15 | 34,240 | .63 |
| Interaction of Time Period x Day + Error | 52 | 10.740 | 37.234 | 2,446,497 | 2,317,412 | 51 | | |
| Adjusted for Apple Varieties | | | | | 181,405 | 12 | 15,117 | .28 |
| Interaction of Time Period x Type + Error | 46 | 10.513 | 27.062 | 2,469,924 | 2,400,263 | 45 | | |
| Adjusted for Apple Varieties | | | | | 264,256 | 6 | 44,042 | .80 |

** Significant at the one percent level.

* Significant at the five percent level.

TABLE 10

COVARIANCE OF SALES AND NUMBER OF KINDS OF OTHER FRUIT

| Source of Variation | Degrees of Freedom | Sum of Squares and Products | | | Errors of Estimate | | |
|---|---|---|---|---|---|---|---|
| | | $Sx^2$ | Sxy | $Sy^2$ | Sum of Squares | Degrees of Freedom | Mean Squares |
| Total | 125 | 25,195 | 175,785 | 9,864,093 | | | |
| Type | 2 | 4,832 | 102,378 | 3,063,837 | | | |
| City | 5 | 9,467 | 32,499 | 710,599 | | | |
| Interaction of City x Type | 10 | 1,056 | 767 | 521,594 | | | |
| Days | 4 | 229 | -4,711 | 540,490 | | | |
| Interaction of Days x Cities | 20 | 2,291 | 16,089 | 725,241 | | | |
| Interaction of Days x Type | 8 | 1,493 | 5,493 | 722,480 | | | |
| Time Period | 3 | 214 | 6,406 | 263,903 | | | |
| Interaction of Time Period x Cities | 15 | 1,197 | -1,874 | 614,438 | | | |
| Interaction of Time Period x Days | 12 | 1,311 | 10,058 | 231,586 | | | |
| Interaction of Time Period x Type | 6 | 129 | -1,345 | 255,012 | | | |
| Error | 40 | 2,976 | 10,025 | 2,214,913 | 2,181,143 | 39 | 55,927 |

COVARIANCE OF SALES AND NUMBER OF KINDS OF OTHER FRUIT (Continued)

| Source of Variation | Degrees of Freedom | Sums of Squares and Products $Sx^2$ | Sxy | $Sy^2$ | Errors of Estimate Sum of Squares | Degrees of Freedom | Mean Squares | F-ratio |
|---|---|---|---|---|---|---|---|---|
| Type + Error | 42 | 7,808 | 112,403 | 5,278,750 | 3,660,610 | 41 | | |
| Adjusted for Kinds of Other Fruit | | | | | 1,479,467 | 2 | 739,734 | 13.23** |
| City + Error | 45 | 12,443 | 42,524 | 2,925,513 | 2,780,186 | 44 | | |
| Adjusted for Kinds of Other Fruit | | | | | 599,043 | 5 | 119,809 | 2.14 |
| Interaction of City x Type + Error | 50 | 4,032 | 10,792 | 2,736,507 | 2,707,621 | 49 | | |
| Adjusted for Kinds of Other Fruit | | | | | 526,478 | 10 | 52,648 | .94 |
| Day + Error | 44 | 3,205 | 5,314 | 2,755,403 | 2,746,592 | 43 | | |
| Adjusted for Kinds of Other Fruit | | | | | 565,449 | 4 | 141,362 | 2.53 |
| Interaction of Day x City + Error | 60 | 5,267 | 26,114 | 2,940,154 | 2,810,680 | 59 | | |
| Adjusted for Kinds of Other Fruit | | | | | 629,537 | 20 | 31,477 | .56 |
| Interaction of Day x Type + Error | 48 | 4,469 | 15,518 | 2,937,393 | 2,883,509 | 47 | | |
| Adjusted for Kinds of Other Fruit | | | | | 702,366 | 8 | 87,796 | 1.57 |
| Time Period + Error | 43 | 3,190 | 16,431 | 2,478,816 | 2,394,183 | 42 | | |
| Adjusted for Kinds of Other Fruit | | | | | 213,040 | 3 | 71,013 | 1.27 |
| Interaction of Time Period x City + Error | 55 | 4,173 | 8,151 | 2,829,351 | 2,813,430 | 54 | | |
| Adjusted for Kinds of Other Fruit | | | | | 632,287 | 15 | 42,152 | .75 |
| Interaction of Time Period x Day + Error | 52 | 4,287 | 20,083 | 2,446,499 | 2,352,438 | 51 | | |
| Adjusted for Kinds of Other Fruit | | | | | 171,275 | 12 | 14,273 | .26 |
| Interaction of Time Period x Type + Error | 46 | 3,105 | 8,680 | 2,469,925 | 2,445,660 | 45 | | |
| Adjusted for Kinds of Other Fruit | | | | | 264,517 | 6 | 44,086 | .79 |

** Significant at the one percent level.

TABLE 11

COVARIANCE OF SALES AND RELATIVE DISPLAY SPACE

| Source of Variation | Degrees of Freedom | Sums of Squares and Products | | | Errors of Estimate | | |
|---|---|---|---|---|---|---|---|
| | | $Sx^2$ | Sxy | $Sy^2$ | Sum of Squares | Degrees of Freedom | Mean Squares |
| Total | 125 | 2.501 | 624.721 | 9,864.093 | | | |
| Type | 2 | .009 | 161.942 | 3,063.837 | | | |
| City | 5 | .958 | -68.889 | 710.599 | | | |
| Interaction of City x Type | 10 | .265 | 265.068 | 521.593 | | | |
| Days | 4 | .027 | -48.730 | 540.491 | | | |
| Interaction of Days x Cities | 20 | .303 | 165.644 | 725.240 | | | |
| Interaction of Days x Type | 8 | .073 | -72.549 | 722.478 | | | |
| Time Period | 3 | .005 | -4.993 | 263.904 | | | |
| Interaction of Time Period x Cities | 15 | .210 | 172.910 | 614.437 | | | |
| Interaction of Time Period x Days | 12 | .143 | 112.851 | 231.584 | | | |
| Interaction of Time Period x Type | 6 | .038 | -9.480 | 255.011 | | | |
| Error | 40 | .470 | -49.053 | 2,214.913 | 2,209.793 | 39 | 56.661 |

COVARIANCE OF SALES AND RELATIVE DISPLAY SPACE (Continued)

| Source of Variation | Degrees of Freedom | Sums of Squares and Products | | | Errors of Estimate | | | |
|---|---|---|---|---|---|---|---|---|
| | | $Sx^2$ | Sxy | $Sy^2$ | Sum of Squares | Degrees of Freedom | Mean Squares | F-ratio |
| Type + Error | 42 | .479 | 112.889 | 5,278.750 | 5,252.145 | 41 | | |
| Adjusted for Display Space | | | | | 3,882.352 | 2 | 1,521.176 | 26.85** |
| City + Error | 45 | 1.428 | -117.942 | 2,925.512 | 2,915.771 | 44 | | |
| Adjusted for Display Space | | | | | 705.978 | 5 | 141.195 | 2.49* |
| Interaction of City x Type + Error | 50 | .735 | 216.015 | 2,736.506 | 2,673.020 | 49 | | |
| Adjusted for Display Space | | | | | 463.227 | 10 | 46.323 | .82 |
| Day + Error | 44 | .497 | -97.783 | 2,755.404 | 2,736.166 | 43 | | |
| Adjusted for Display Space | | | | | 526.373 | 4 | 131.593 | 2.32 |
| Interaction of Day x City + Error | 60 | .773 | 116.591 | 2,940.153 | 2,922.568 | 59 | | |
| Adjusted for Display Space | | | | | 712.775 | 20 | 35.639 | .63 |
| Interaction of Day x Type + Error | 48 | .543 | -121.602 | 2,937.391 | 2,910.159 | 47 | | |
| Adjusted for Display Space | | | | | 700.366 | 8 | 87.546 | 1.55 |
| Time Period + Error | 43 | .475 | -54.046 | 2,478.817 | 2,472.668 | 42 | | |
| Adjusted for Display Space | | | | | 262.875 | 3 | 87.625 | 1.55 |
| Interaction of Time Period x City + Error | 55 | .680 | 123.857 | 2,829.350 | 2,806.790 | 54 | | |
| Adjusted for Display Space | | | | | 596.997 | 15 | 39.799 | .70 |
| Interaction of Time Period x Day + Error | 52 | .613 | 63.798 | 2,446.497 | 2,439.857 | 51 | | |
| Adjusted for Display Space | | | | | 230.064 | 12 | 19.172 | .34 |
| Interaction of Time Period x Type + Error | 46 | .508 | -58.533 | 2,469.924 | 2,463.180 | 45 | | |
| Adjusted for Display Space | | | | | 253.387 | 6 | 42.231 | .75 |

** Significant at the one percent level.

* Significant at the five percent level.