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Factors Affecting the Price of Turkeys and Their Usefulness in Decision Making by Utah Turkey Producers

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FACTORS AFFECTING THE PRICE OF TURKEYS AND THEIR USEFULNESS IN DECISION MAKING BY UTAH TURKEY PRODUCERS

by

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INTRODUCTION

Production of turkeys in Utah has had a rapid growth since its beginning a few decades ago. In 1929 there were only 226,000 birds sold by Utah producers and in 1960 there were 2,798,000 birds sold. Over this 31 year period of time production has increased 12 times.

Gross income received in 1960 for Utah turkeys amounted to $13,787,000 and accounted for 8.35 percent of total farm income in Utah in 1960 (2).

In addition to the income direct to turkey producers, this industry contributes to the incomes of various other industries such as processors, feed handlers, hatcheries, transportation agencies, and financing agencies.

Purpose of the study

The turkey industry has developed into a large volume, highly competitive business with narrow margins of profit for even the more efficient operators. Depending on market conditions and efficiency of their operations, farmers receive varying net returns. Cost of production studies indicate that approximately 90 percent of the costs are variable, of which feed costs and poult costs are major items (1). Because of the high proportion of variable costs rapid adjustments in production can be made in response to changes in price.

An analysis of reasons prices vary would aid Utah turkey farmers in making more intelligent productions and marketing decisions and thereby increase their returns.

Objectives

The major problem was to determine what were the main factors which affect prices received for turkeys sold on the U.S. market? The specific objectives were:

a. to determine the factors affecting the demand for turkeys

b. to determine the factors affecting the supply of turkeys

c. to ascertain the effects of movements in turkey prices as determined by the interactions of supply and demand factors

d. to measure the effects of seasonal and secular changes that have taken place in the turkey industry.

REVIEW OF LITERATURE

There have been various studies conducted relative to factors affecting the price received for turkeys. Some of these studies are similar to this study and are helpful in understanding and analyzing this problem.

Of particular interest was a study made at Purdue University in 1949. Some conclusions derived from this study are as follows:

"The price of turkey fluctuated more from year to year than did most of the factors that were associated with the price of turkeys. The production of turkeys and nonagricultural incomes fluctuated about half as much as did the price of turkeys." (9, p. 20)

"The production of turkeys and the price of chickens was the most important single factor affecting turkey prices from year to year." (9, p. 21)

Another study published by the University of Wisconsin concerning turkey prices and pricing was concerned mainly with pricing accuracy and adequacy of price reporting data.

The general conclusion was that either the price reporting service slightly understated the true market value of the New York market prices in August and September and overstated them in November and December, or that the relationship between actual New York prices and those paid by processors in the North Central states changed during that five month period.

Another important conclusion was that there is a much greater week to week change in retail than in wholesale price (7).

A study at Ohio State University by R. H. MacDonald and R. F. Gray brings out some interesting and important facts on factors affecting turkey prices from 1929-1949.

The conclusion was that next to chicken, beef cattle and hogs were turkey's main competitors for the American consumer meat dollar. However, the price of chickens and the wage income of industrial workers were the two most important factors affecting the price of turkey during 1929-1949 (3).

The most recent was a study at Iowa State University in which the main problem was to determine the proper amount of turkeys to produce in order to give the farmers the greatest returns. This study indicated that the main factors in forecasting the size of the annual turkey crop were: (a) improvements in the feed conversion ratio; (b) turkey feed price ratio of previous year; (c) January 1 intentions to produce.

The independent variables used in determining the average farm price were: size of turkey crop, population, income, supply of red meats, marketing costs, and trends (6).

SOURCE OF DATA AND METHOD OF PROCEDURE

The majority of Utah's turkey crop is sold to eastern markets, approximately 10 percent is sold in Utah (5).

Utah farmers are concerned with the U.S. price which will in turn determine the price they will receive in Utah. Except for a certain section where specific reference is made to Utah, the data that were used applied to the U.S. turkey market.

The data were derived from secondary sources published by different U.S. Government and private agencies.

In most instances the period of time studied was 1940-1960. Some data were not available in some of the earlier years; as a result, this time period varied.

The study is presented in three sections. The first section is concerned with the general changes that have taken place in the industry over the past 21 years. Included are seasonal and secular changes. The graphic method is used in presenting the statistical data in the first section.

The second section is a statistical analysis of demand and supply variables. The conceptual solution is the theory of supply and demand in which theoretically the price of a commodity is determined by the interactions of these two forces. The problem is one of analyzing the variables that affect the supply and demand for turkeys.

Multiple and simple correlations analysis were the statistical tool used in the second section. This method assumes that the relationships

between the different variables used are linear, additive, and separate.

After considerable graphing of the data it was felt that the relationships tended to be linear and that this method would be superior to other alternative methods for analyzing these data.

The third and final section is an attempt to apply the results of the first two sections in a price analysis, using the same methods as in the demand and supply.

CHANGES IN THE TURKEY INDUSTRY

Many changes have taken place over the past three decades in the nation's turkey industry. Some of these are general secular trends or long term changes and others are changes which take place within shorter periods of time known as seasonal changes.

The first part of this section will consider the secular changes and the second part considers seasonal changes.

Production

United States turkey production increased from 34 million birds in 1940 to a high of 85 million birds in 1960 (Figure 1). This represents a 150 percent increase. In the early part of the 1940's there was actually a decline in production until the latter part of World War II. There was a small increase from 1943 to 1945 and a decrease to a low in 1948 of only 32 million birds. For the four years 1948 to 1952 there was an increase of 100 percent bringing production up to 62 million birds. Then from 1952 to 1960 it was still growing but at a less rapid rate, and in three of those eight years there was a decline in production. The overall increase for these eight years was a 50 percent increase from 1952.

Many advances in the control of disease, feeding and breeding improvements, management practices and marketing techniques were also made during this 21 year period of time. Undoubtedly these advances by science had their effects on the number of turkeys farmers could and did produce.

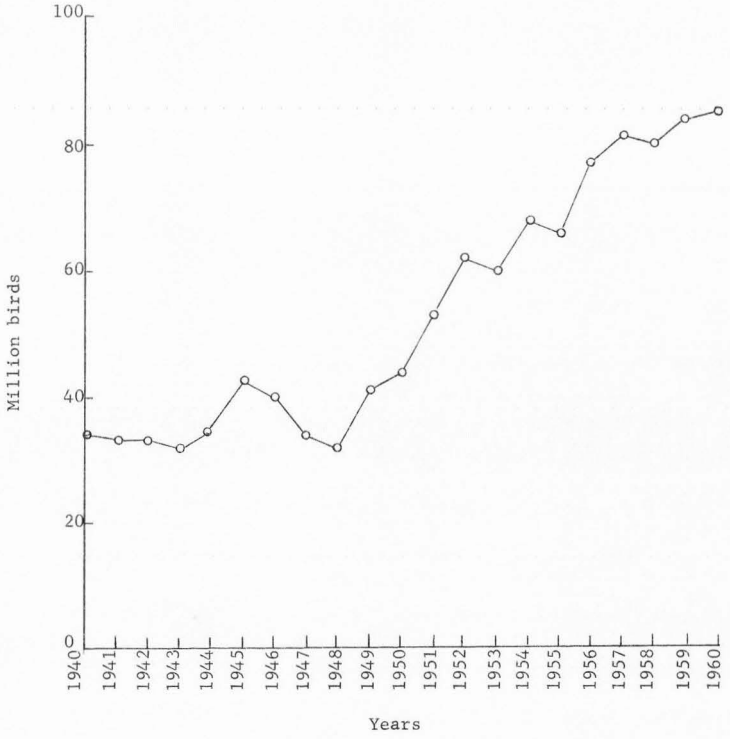


Figure 1. Number of turkeys produced in the United States, 1940-1960

During the last 21 years the turkey industry has become a highly specialized business with a decrease in the number of farms producing turkeys but with larger flock sizes. In 1929 there were 687,000 farms in the United States which were raising turkeys on a commercial basis. In 1959 there were only 86,000 farms producing turkeys or a 86.4 percent decrease.

There has been a change in the states and general areas where turkeys are produced. In 1929 the first 10 states producing turkey, measured in number of pounds, were Texas, California, North Dakota, Minnesota, Oklahoma, Oregon, Idaho, Colorado, Virginia, and Montana. By 1960 the concentration of turkeys raised in order by number of pounds were California, Minnesota, Iowa, Missouri, Texas, Wisconsin, Indiana, Utah, Ohio, and Virginia. Only four of the leading states in 1929 were still in the top 10 by 1960. Utah, which was not in the top 10 in 1929, was eighth from the top in 1960.

Since 1929 the general concentration by region has also changed from South Central states to the West North Central states (4).

Cold storage holdings

Not all turkeys produced each year are sold during that year's marketing season. Some are held in cold storage to be sold at a later date in hopes of better prices. Figure 2 shows that the percentage of each year's turkey crop placed in cold storage had a rather rapid increase right after the war, but in the 1950's it began to level off and in recent years has fluctuated around 9 to 14 percent of total production.

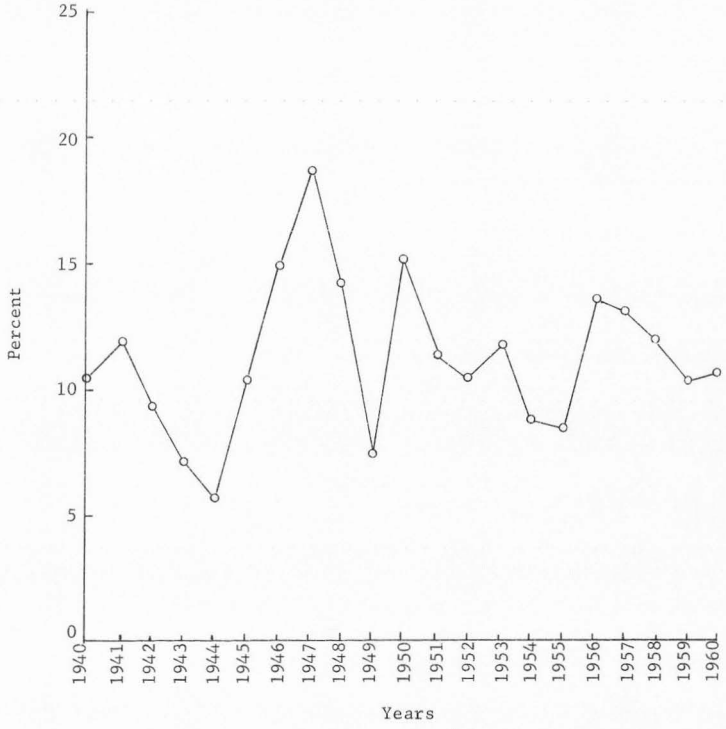


Figure 2. Percentage of each years United States turkey production placed in cold storage, January 1 1940-1960

Size and type

Together with the tremendous increase in the production of turkeys came a change in the size or weight at which turkeys were sold.

In 1929 the average size of turkeys was 13.2 pounds. Since that time the trend has been one of a gradual increase in the weight until 1949 when it leveled off at about 17 to 18 pounds. The hens increased from 12.0 pounds in 1940 to 14.0 pounds in 1948 and have varied little since. Toms averaged 18.1 pounds in 1940 and have increased to 25.2 pounds in 1960. The fryer size turkey, which have just recently become popular, started at 7.6 pounds in 1951 and are presently processed at 8.7 pounds average.

Some changes have taken place in types of birds produced. There has been a definite trend toward the larger birds being produced. In 1953 of the total birds hatched for production, 29 percent were of the light breed turkey and 71 percent were the heavy breed. Since 1953 the light breed turkeys have become less popular as compared with the heavy breeds. In analyzing the changes towards the heavy breed turkey still further, there has been a continuing shift to the heavy white breeds.

The white feathered heavy breeds may be sold as fryers in competition with the small Beltsville, a light breed, or may be carried to maturity, thus, giving the farmer an option as to when to market his birds.

Per capita consumption

In the early 40's there was very little change in per capita consumption of turkey and it stayed just under three pounds per person. In 1945 it began from 2.7 pounds per capita and climbed to 6.3 in 1960, an increase of 130 percent. In comparing turkey with other types of meat over this same period of time, turkey increased on a percentage basis

more rapidly than chicken or total meat (Figure 3). Chicken also had a rapid increase, whereas total meat tended to stay about the same until 1952, when it too began to increase, but at a much slower rate. Considering actual pounds of meat consumed turkey still tends to be small compared to some of the other types. In 1940 turkey was 2.5 percent of the total meat consumed, while in 1960 it accounted for 3 percent, a slight increase.

Chicken, which is normally thought of as turkey's main competitor, accounted for 8 percent of the total meat consumed in 1940 and 13 percent in 1960.

Price of turkey

The majority of turkey is sold during the fall months. The weighted average farm price of turkey published by the U.S.D.A., which was considered most representative, weights the fall months heaviest. Yearly prices gradually increased until 1948 when they hit an all time high of 46.8 cents per pound. Since then prices have been trending downward and in 1957 reached a low of 23.4 cents per pound.

In order to see the picture in terms of real prices, the weighted average price was divided by an index of all farm prices--the result is called "purchasing power of turkey prices." This purchasing power shows the ability of turkey to purchase other farm products, or the relationship of the price of turkeys relative to all other farm prices.

From 1940 to 1945 the real price of turkey or purchasing power of turkey was considerably higher than the weighted money price indicates (Figure 4). In 1945 this relationship reverses itself and from then until 1953 the purchasing power of turkey was less than the weighted money price. For these nine years the price received by the turkey

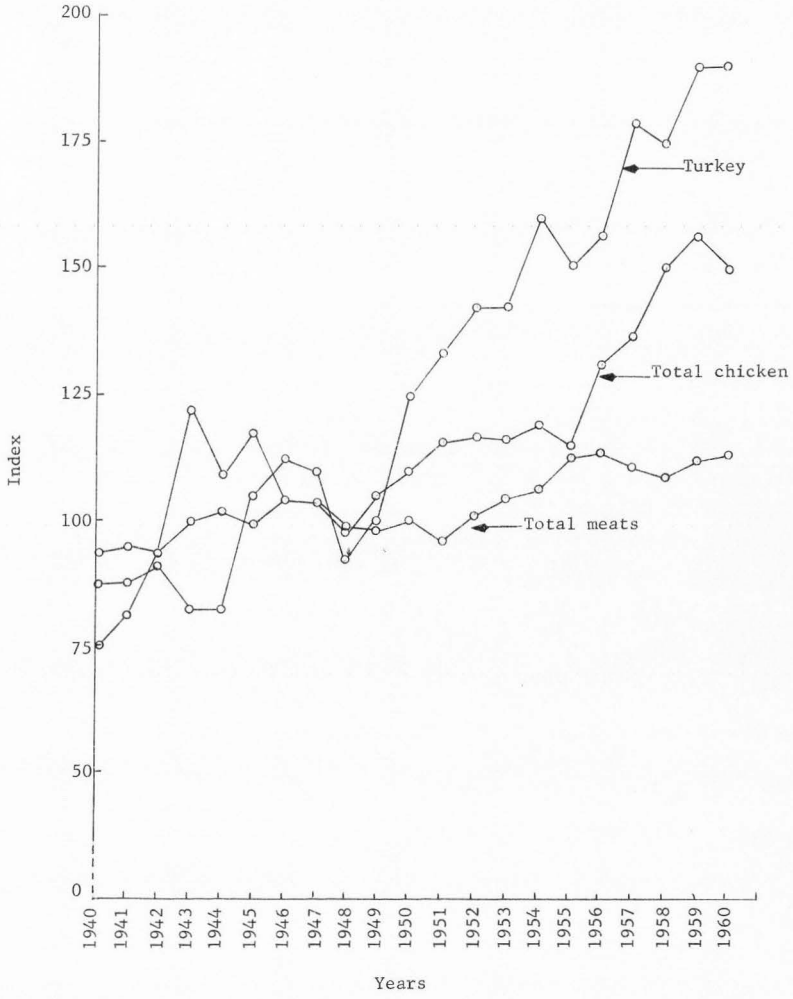


Figure 3. Index of United States per capita consumption of turkey compared with total United States meat consumption, 1940-1960 (1947-49 = 100)

Figure 4. Weighted annual average price and purchasing power of turkey in 1960 dollars, United States 1940-1960

farmers was low relative to prices of other farm products.

There were no definite cycles in purchasing power to indicate cyclical price movement; there was, however, an inverse relationship between the relative price and production of turkeys (Figure 5). In 14 of the 21 years purchasing power and turkey production moved in opposite directions. This suggests that farmers are making efforts to establish an equilibrium between purchasing power and production. This effort is thwarted due to the lag in time required to increase or decrease production. This inverse relationship was not evident during six of the 21 years; however, three of those six was during and right after the war when prices had been under government control.

Figure 5 also indicates trends of production and relative price. Since 1948 production has had a very upward rapid trend. There was no evidence of trend before then. The relative price, however, has tended downward since 1944. These two trends of lower relative prices and increasing production suggests a reduction in production costs as farmers are continuing to produce more and more turkeys even though the relative price of turkey has declined in relationship to prices of other farm products.

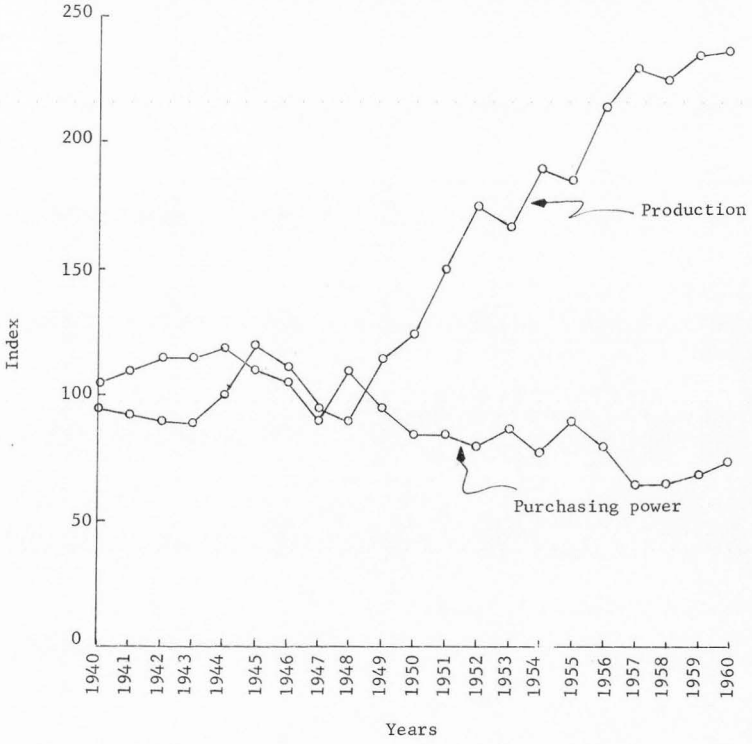


Figure 5. United States production of turkey compared with purchasing power of turkey (1947-1949 = 100)

SEASONAL CHANGES

Many agricultural products are affected by the seasons of the year and turkey is one of these products. The seasonal variation of demand affects the production of turkey as well as price and marketing movements. For this reason, this section will consider the seasonal influence on different aspects of the turkey industry.

Seasonal marketing

Turkey has traditionally been a holiday item on the housewife's list. The holidays in November and December being the time turkey consumption is the highest and the demand is greatest.

Data, however, were not available which gave the actual amount marketed each month. Thus, seasonality of turkeys marketed was estimated from the number of poults hatched each month lagged six months to represent the normal growing period for turkeys.

The marketing season starts in July and August and continues to climb through November after which it tapers off. The lowest months of marketing were from February to June (Figure 6).

Two changes have taken place in the marketing of turkeys over the period of time data were available. There was a change in the high month of marketing from November back to October, probably in anticipation of short storage holiday sales. The other change being a gradual increase in the level of the whole curve.

It is thus very evident that the marketing of turkey depends mainly on the traditional use of turkeys for the festive holidays of Thanksgiving

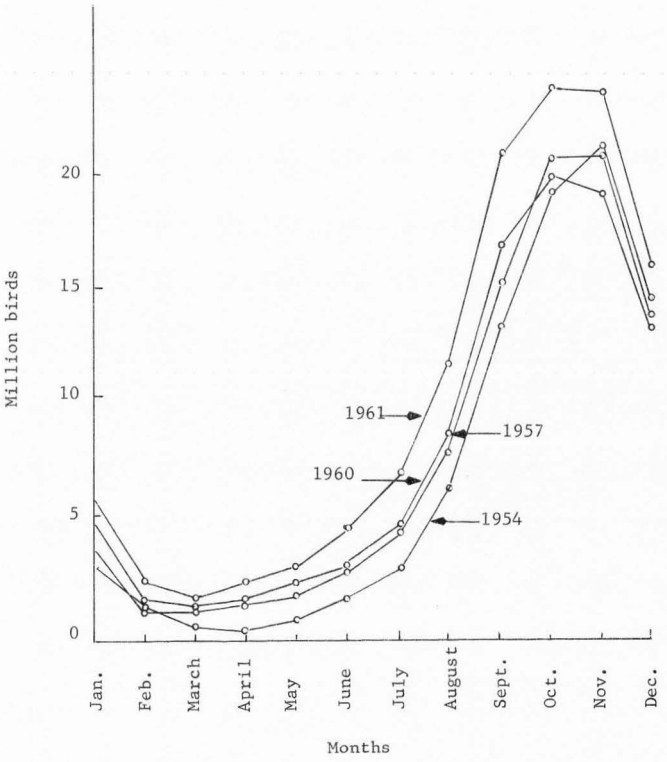


Figure 6. Seasonality of turkey marketings, selected years. (Estimated from poult hatchings lagged 6 months)

and Christmas. Only with considerable change in the consumer buying habits could there be much of a change in the seasonality of marketings.

Cold storage

The majority of turkeys sold off farms during the fall marketing season were consumed at that time. However, some of the turkeys were not consumed but were held to be marketed during the interval before the next year's turkey crop was marketed in the fall.

There have been some definite seasonal changes take place in cold storage holdings. In the early forties the low point in the cold storage holdings was in October and the high month was in February (Figure 7). In the fifties there was a shift from October back to September and August for the low month in cold storage holdings. At that same time there was a shifting of the high month of holdings from the first months of the year to the month of December. In the late fifties and 1960 the change has continued in the same direction. In 1960 the low month for storage was July and the high was in November.

During this same period of time there was a general shifting up of the whole curve, indicating more pounds of turkey being placed in storage. This was due to the larger crops being produced over this 21 year period of time. However, referring back to Figure 2 in the secular changes we find that the percentage of each years' turkey crop held in cold storage January 1 has leveled off at about 9 to 14 percent of the year's production. Even though there was more pounds being placed in cold storage the percentage of the crop that was stored tended to vary but without evidence of trend.

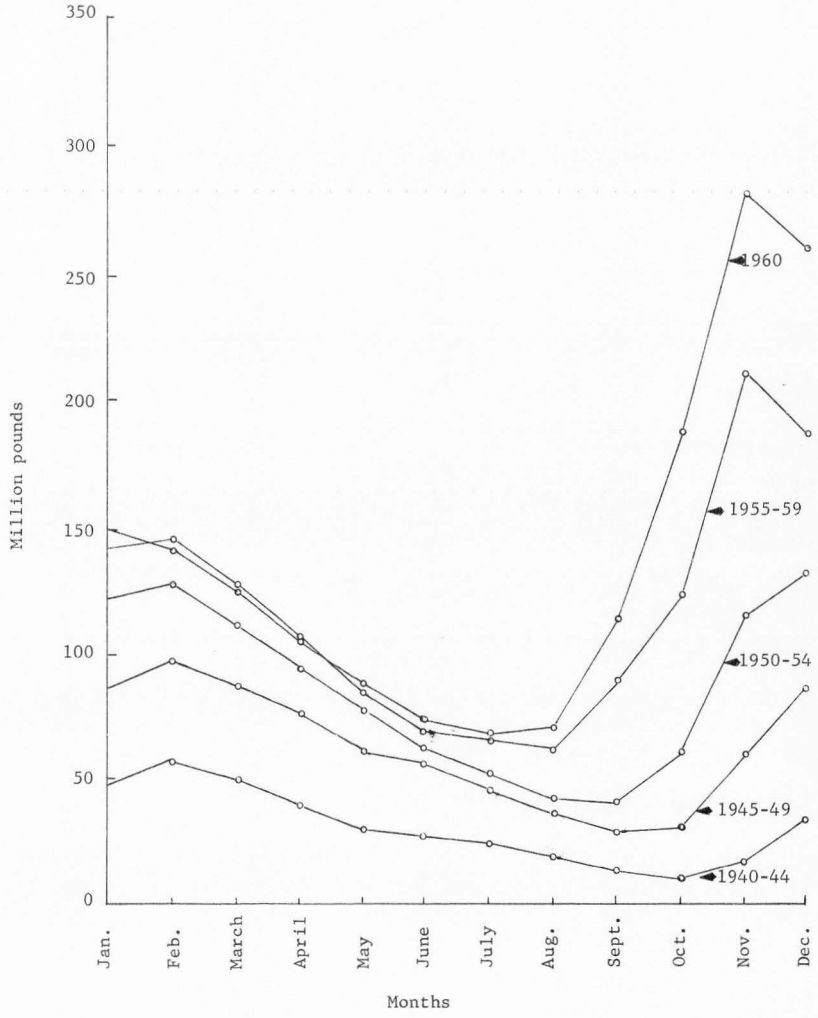


Figure 7. Turkey cold storage stocks first of month five year averages, 1940-1960

Percent used by season

Seasonal use of turkey was estimated by subtracting the cold storage held at the end of each month from total turkeys slaughtered each month. This gave the amount removed from the market and in this case it was assumed to have been consumed (Figure 8).

Past studies have indicated that the holiday seasons of Thanksgiving and Christmas are the traditional times of the year in which the housewife prepares turkey for the family.

This same tradition was substantiated in this study. Figure 8 indicates that the majority of turkeys were consumed during the fall months from September to December. The average for these four months for the five years 1955 to 1960 was 71.9 percent. This leaves 28.1 percent to be consumed during the remaining eight months of the year.

A recent study has shown that of a sample of housewives, only 25 percent served turkey for one or more regular family meals during the year (10).

There is, however, a trend for the larger restaurants to serve more turkey at times other than the holiday season and there is considerably more promotional activity to persuade the housewife to serve turkey more often.

Seasonal variations in turkey price

Due to the difference in use pattern of hens and toms it was hypothesized that the seasonal pattern of price would be somewhat different.

In order to examine this hypothesis it was necessary to build a price series from market quotations, as the U.S.D.A. does not publish price series for hens and toms separately. Wholesale prices published

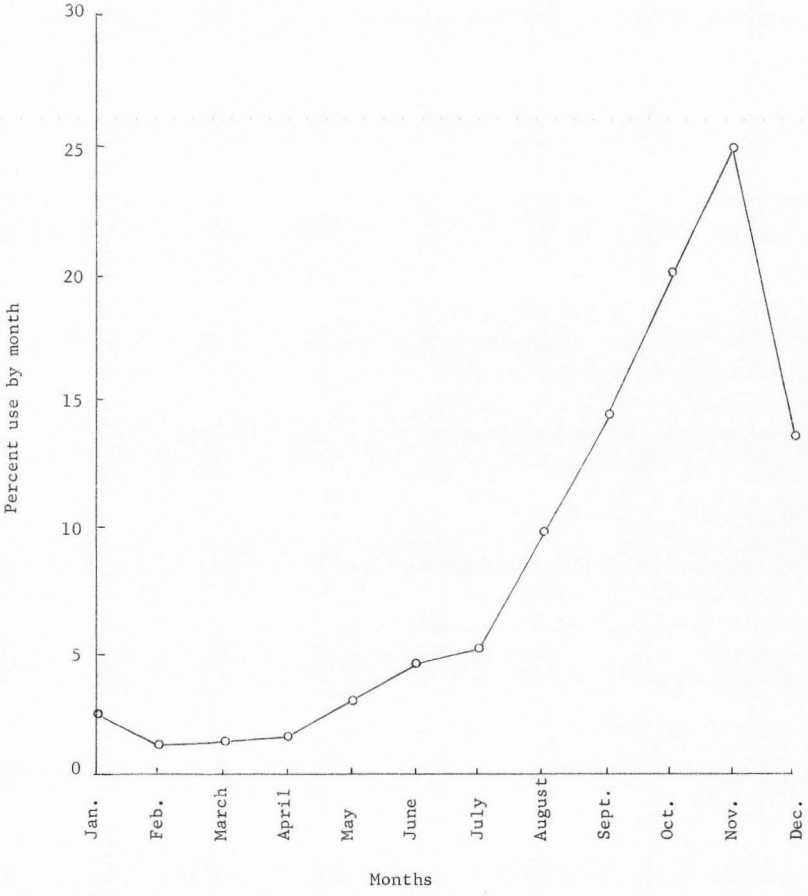


Figure 8. Seasonal use of turkey, United Stated average, 1955-1960

in the Producers Price Current for the period 1950 to 1960 were used for this series.

Prices of 10-12 pound hens and 24-26 pound toms were selected as representative of the two sexes. Had other sizes been selected the price patterns might have been different.

August was the month selected as the beginning of the marketing year; however, it was realized that some of the previous years turkeys were still coming out of cold storage, particularly in some years. It was also recognized that hens tend to mature faster than toms. It may be that the hen marketing year should begin one month earlier than toms. However, it is not likely that the seasonal pattern would have changed materially by doing so.

Hen turkeys, being lighter weight, are more popular with the housewife for family use and are consequently in greater demand, particularly in the fall. After the holiday season the housewife's demand for turkey is considerably lessened and the institutional users such as restaurants, cafeterias, hotels and caterers become the important turkey users. Institutional outlets tend to favor the use of the heavier birds, especially the heavy toms. An example of this is Utah where 91 percent of the total turkey used in Utah restaurants were toms (10). This is due mainly to advantages the larger toms have in relation of waste vs. meat. In other words, the bigger the bird the more meat there is to be sold in relationship to waste.

For the 10 production years beginning August 1950 and ending July 1960 hen prices were higher than tom prices from October to May; whereas the price of toms exceeded the hen prices from June to September (Figure 9).

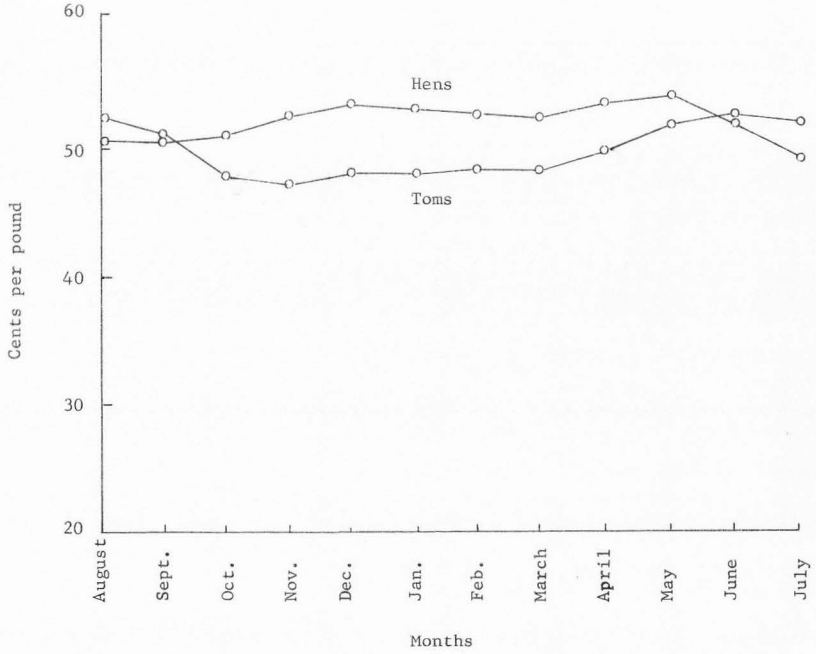


Figure 9. Seasonality of New York wholesale turkey prices by sex, 1950-1960 average

Hen prices tended to rise from the beginning of the marketing season in August until the end of the holiday season in December. This increase averaged about three cents per pound over this 10 year period of time. November to December was the time period when the price of hens was particularly high relative to tom prices. With an average spread of 5 to 6 cents, Hen prices started a little above 50 cents a pound and continued to increase until December after which they decreased slightly. This would suggest that on the average, early processed hens could be profitably stored for a short period. The rise from 50 cents in August to 54 cents in May would not consistently justify long term storage for hens.

Tom prices, on the other hand, started rather high and decreased in the fall months and then increased to their peak in June. This suggests that early processed toms can be more profitably sold at processing time. Toms processed from October through December increased an average of about 6 cents a pound by June for the 10-year period. This rise is about sufficient to cover storage and other costs for the period.

For the 10-year period as a whole it would appear profitable to sell the hens during the early months of the holiday season and store toms for later use.

In order to examine this problem further it was hypothesized that the seasonal price patterns might be different for years of relatively small and large production.

The 10 years of production were grouped into the high and low years of production by plotting production over time and then fitting a straight line trend to the data by the method of least squares. The years that fell above the trend line were considered as high production years and

those below the line were low production years.

The seasonal prices of these groups were plotted for both hens and toms.

The price pattern for hens was affected only slightly by the relative level of production; however, it was not sufficiently different to change the previous conclusions (Figure 10).

An analysis of the price patterns indicated a difference in the seasonal prices of toms for the high and low production years (Figure 11). Tom prices during the years of high production did not rise to the high that the price of toms did during the years of lower production. For high production years tom prices rose seasonally about three cents, whereas, for low production years they increased about 10 cents in seven months. The profitability of tom turkey storage can be materially improved by paying attention to the relative level of production as against storing year after year.

The level of prices for hens and toms in low and high production years as shown in Figures 10 and 11 has no significance since the price data were not corrected for trend.

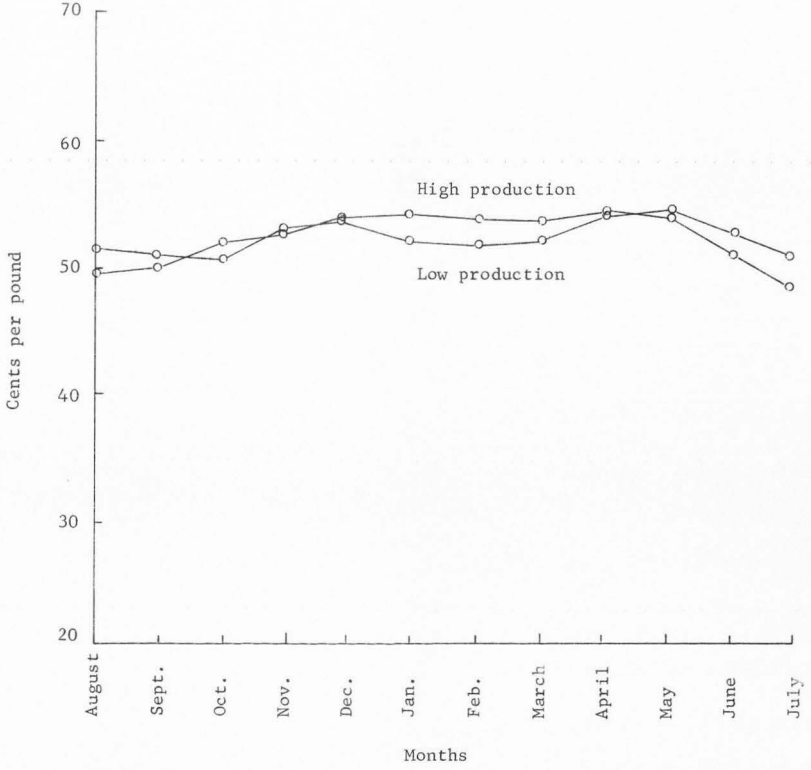


Figure 10. New York wholesale hen turkey prices, five high and five low production years, 1950-1960

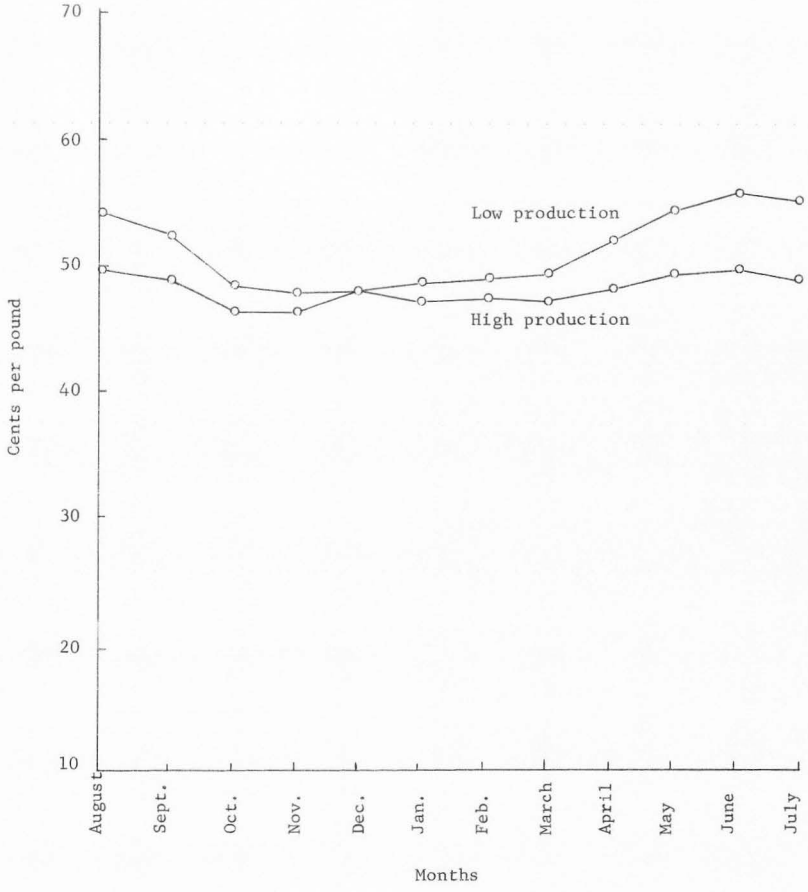


Figure 11. New York wholesale tom turkey prices, five high and five low production years, 1950-1960

INTRODUCTION SECOND SECTION

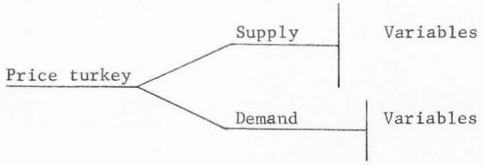
The well-known statement that "price depends upon supply and demand" is familiar to all. The analysis of prices is the determination of why prices have changed over time. In order to accomplish this analysis it is necessary to go back and consider what, if any, changes have taken place in the supply and demand. Then an explanation concerning price movements would be possible. Considering demand alone, it sums up the response of consumer demand for a given product to alternative prices of that product.

Demand is a function of many variables, whereas the demand curve deals only with two of these variables--price and quantity demanded. The distinction between a movement along and a shift in a demand curve may be summarized in terms of variables involved. Any change in quantity demanded which results only from a variation in price is a movement along the curve, whereas a change in the value of any other variable in the demand function is likely to shift the demand curve.

The supply side shows what quantities of a commodity will be offered for sale at different prices. It summarizes the sellers quantity reaction to various prices. A change in supply means a change in the location or position of the whole curve, but production is simply the quantity produced at a specific point on the supply curve.

By combining supply and demand on the same graph the intersection of these two curves determines the price at which a certain quantity of a good could be sold.

Over time the price of turkey has been continually decreasing and the quantity sold has been continually increasing. This analysis is concerned with these movements. The conceptual solution for the analysis started with the price of turkeys and determined measures of the demand and supply, and from these determining the important variables that have caused the movements in the supply and demand. In graphic form the analysis would look like this.



A close look at the theoretical analysis determined that in reality the amount of turkey demanded and the amount of turkey supplied (with a slight change due to cold storage holdings) would be basically the same figure. This proves to be no problem in the analysis; however, this does emphasize the importance of using proper logic in determining the variables that have caused the movements of the demand and supply curves.

THE MEASUREMENT OF DEMAND

The actual analysis was basically accomplished by the use of time series data, observing how prices, quantities, populations, incomes and various other factors related to demand and supply have changed over time.

Two methods were available for use in explaining or analyzing the relationships, tabulation and correlation. Tabular analysis would give no indication of how closely demand and supply are related to their respective independent variables; whereas, the correlation method does give a precise answer to this question. However, in using correlation methods certain relationships are assumed at the beginning such as: that the relationship of the data was linear rather than curvilinear and additive rather than joint.

After careful consideration of the data available and plotting of the variables with supply and demand it was decided that the relationships were linear and that the multiple correlation method of analysis would give more informative results than would the tabular method. Much data used in the multiple correlation problems for both supply and demand were not available before about 1940 which limited the number of observations that could be used to 21 years. The influence of the World War II could have distorted the relationship due to controls during the depression scare after the war. Therefore, the series used in the multiple correlation problems for both supply and demand were solved using two time periods. One was from 1940 to 1960 and the other was using

1947 to 1960. It was found that the correlation coefficient was slightly higher using the shorter time period. By using the shorter period of time several degrees of freedom are lost and statistically this is very important as the relationship between the variables must be greater in order to be statistically significant. After considering both alternatives it was decided that the 21 year time series was justified due to the limited number of observations and the evidence that the controls during the war years did not have as much affect as was thought.

The basic data used to measure the demand changes

There are various meanings used in connection with "demand" as has previously been discussed. In this case the term "demand" was used to represent the amount of turkey that was removed from the market at given prices in each of the 21 years. This is different from the theoretical demand curve in that each one of these prices and quantities is where demand and supply intersected determining price and quantity, but it is not the whole demand curve. In essence what this amounts to is the amount of turkey that disappeared off from the market and in this study it was assumed to have been consumed. Thus, it was a time series of the consumption of turkey over this 21 year period. In all statistical reports studied there were none that gave the actual amount of turkey that was consumed; therefore, this series had to be constructed. It was determined by taking the total pounds of turkey produced in each year plus the cold storage that was held over from last year's production (measured on December 31) minus the amount of turkey left in cold storage on December 31 of that year.

Table 1 shows the data that was used to determine this disappearance. The demand for any given year may be expressed in equation form as

Table 1. Estimated demand or disappearance for turkey, 1940-1960

	Turkeys sold from farms (mil. pounds)	+	January 1 cold storage (mil. pounds)	-	December 31 cold storage (mil. pounds)	=	Disappearance
1940	506		52		61		497
1941	491		61		50		502
1942	523		50		36		537
1943	485		36		37		484
1944	577		37		73		541
1945	715		73		108		680
1946	740		108		128		720
1947	634		128		83		679
1948	549		83		51		581
1949	748		51		127		672
1950	808		127		110		825
1951	927		110		107		930
1952	1049		107		147		1009
1953	999		147		122		1024
1954	1149		122		121		1150
1955	1079		121		95		1105
1956	1247		95		162		1180
1957	1348		162		177		1333
1958	1338		177		162		1353
1959	1432		162		149		1445
1960	1488		149		160		1477

Source: Poultry and Egg Situation, January 1962.

$$D_t = P_t + (S_{t-1} - S_t)^*$$

where

D = demand

P = production

S = cold storage

Once the consumption of turkey was determined the next problem was to determine which of many possible factors to use as independent variables. The important condition to consider in selecting the variables was to select those which were responsible for or related to the change in demand.

Various types and sources of data were carefully considered in order to obtain the best possible factors. By best, meaning those that were considered to have had the greatest affect on the variation in demand. After considerable trial and elimination process five independent variables were finally decided upon. These were:

Population. When using any time-series data, one of the most disturbing factors is the population changes that have taken place over the period of time that is being studied. The desire of consumers for meat is based on a solid background of preferences, habits, and prejudices. This is passed on from generation to generation and as the population continues to increase its effect is felt on the demand for turkey. This is evident by the increase in per capita consumption of all meat and espeically turkey as compared with the change in the per capita consumption of other items which have been decreasing such as potatoes.

Therefore, there is good reason to think that as the population

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*This may be read as the demand in time periods t equals to the production in time periods t plus the cold storage in time period t minus one year, minus the cold storage in time period t.

increases by a certain amount, that the quantity of turkey demanded will increase by that same amount.

Disposable income. Over this 21 year period of time there has been a marked increase in the disposable incomes that people have had available to spend. This increase has an effect on all food items and especially items such as meats. As people's material welfare increases, they tend to turn from cheaper food items to meat. Turkey is affected because as disposable incomes increase people will purchase more turkey.

However, when talking about prices or incomes of any kind over a period of time, money is used as the measure of value. The value of money tends to change and over the period of time being considered it has greatly decreased in value. Thus, the disposable income had to be adjusted or converted into what is termed "real income." This was accomplished by dividing disposable income by consumer price index, which is a measure of the changes that have taken place in the purchasing power of the dollar (Table 2).

Price of turkey. In discussing the theory of demand in the short run it is common to think of price of turkey as the cause and the quantity consumed as the result. In other words, in the meat market the general consumer is in no condition to influence price; given a price he will decide how much to purchase. Thus, the price of turkey within the short run affects the amount of turkey disappearance.

The majority of turkey was marketed during the four months of October-January. Therefore, the price series that was used to represent the price of turkey was the weighted average farm price of these four months.

In this series of prices and as was stated above, wherever prices

Table 2. Per capita disposable income deflated by consumer price index, 1940-1960

	Per capita disposable income[a]	Consumer price index[b]	Real incomes
1940	576	59.9	9.62
1941	697	62.9	11.08
1942	871	69.7	12.50
1943	977	74.0	13.20
1944	1060	75.2	14.09
1945	1075	76.9	13.97
1946	1136	83.4	13.62
1947	1181	95.5	12.36
1948	1291	102.8	12.56
1949	1272	101.8	12.59
1950	1369	102.8	13.32
1951	1474	111.0	13.28
1952	1520	113.5	13.39
1953	1582	114.4	13.83
1954	1582	114.8	13.78
1955	1660	114.5	14.50
1956	1742	116.2	14.99
1957	1804	120.2	15.01
1958	1826	123.5	14.79
1959	1906	124.7	15.28
1960	1947	126.6	15.38

[a]Source: Poultry and Egg Situation, November 1961, p. 11.
[b]Source: Statistical Abstract of U.S.

are used in time series, they must be deflated in order to see them in the proper perspective. Therefore, the turkey price series as well as the next two factors had to be deflated and put in terms of a base value of the dollar. The deflating process was accomplished by dividing all of the price series by the price index of all farm products, which was first adjusted so that its base was 1960 = 100 putting everything in 1960 dollar terms.

The price index of all farm products was used as the deflator as it was felt that it was the most satisfactory measure of the average price changes that occurred in the series that were used (Table 3).

Price of broilers. When considering the basic theory of demand, it is impossible to ignore what is termed as competitive goods or goods that are close substitutes. Broiler prices were considered as a factor in this light. For example, a higher price for broilers will increase the demand for turkey, and as the price of turkey increases, people would substitute broilers for turkey (Table 4).

Price of cattle. The price of cattle was included as a factor in that it was also considered to be a competitor of turkey. Any change in the price level in cattle prices would affect the demand for turkey. There was no average retail price available so the price per 100 pounds received by the farmer was used as the time series (Table 5).

Multiple correlation analysis of the demand

Using the five variables previously discussed as the independent variables and using pounds of turkey consumed as the dependent variable resulted in a multiple-correlation coefficient of .983 indicating a very high degree of association between the five independent variables and the dependent variable.

Table 3. Price of turkey deflated by index of prices received for all farm products, 1940-1960. (1960 = 100)

	Turkey price Oct.-Jan. (cents)	Index price received for all farm products	Deflated price turkey Oct.-Jan.
1940	15.4	42.0	36.7
1941	20.1	52.1	38.6
1942	27.4	66.8	41.0
1943	32.1	80.7	39.8
1944	33.6	81.9	41.0
1945	32.9	87.0	37.8
1946	35.6	97.9	36.4
1947	37.2	115.5	32.2
1948	47.4	119.7	39.6
1949	34.0	104.6	32.5
1950	33.1	108.4	30.5
1951	37.6	126.9	29.6
1952	33.7	121.0	27.9
1953	33.7	108.4	31.0
1954	28.1	104.6	26.9
1955	30.5	97.5	31.2
1956	26.6	96.6	27.5
1957	23.1	98.7	23.4
1958	23.5	105.0	22.4
1959	26.2	100.8	25.9
1960	25.9	100.0	25.9

Source: Egg and Poultry Statistics, Statistical Bulletin 305, March 1962.

Table 4. Price of broilers deflated by the index of prices received for all farm products, 1940-1960. (1960 = 100)

	Broiler prices (cents)	Index of prices received for all farm products 1960=100	Deflated broiler prices
1940	17.3	42.0	41.2
1941	18.4	52.1	35.3
1942	22.9	66.8	34.2
1943	28.6	80.7	35.4
1944	28.6	81.9	34.9
1945	29.5	81.0	33.9
1946	32.7	97.9	33.4
1947	32.3	115.5	27.9
1948	36.0	119.7	30.1
1949	28.2	104.6	26.9
1950	27.4	108.4	25.3
1951	28.5	126.9	22.5
1952	28.8	121.0	23.8
1953	27.1	108.4	25.0
1954	23.1	104.6	22.1
1955	25.2	97.5	25.8
1956	19.6	96.6	20.3
1957	18.9	98.7	19.1
1958	18.5	105.0	17.6
1959	16.1	100.8	15.9
1960	16.9	100.0	16.9

Source: Egg and Poultry Statistics, Statistical Bulletin 305, March 1962.

Table 5. Price of cattle deflated by index of prices received for all farm products, 1940-1960. (1960 = 100)

	Farm price of cattle per 100 pounds	Index of prices received by farmers for all products	Deflated price of cattle
1940	7.60	42.0	18.10
1941	8.80	52.1	16.89
1942	10.70	66.8	16.01
1943	11.90	80.7	14.74
1944	10.80	81.9	13.18
1945	12.10	87.0	13.90
1946	14.50	97.9	14.81
1947	18.40	115.5	15.93
1948	22.20	119.7	18.55
1949	19.80	104.6	18.93
1950	23.30	108.4	21.49
1951	28.70	126.9	22.62
1952	23.40	121.0	20.08
1953	16.30	108.4	15.04
1954	16.00	104.6	15.30
1955	15.60	97.5	16.00
1956	14.90	96.6	15.42
1957	17.20	98.7	17.42
1958	21.90	105.0	20.86
1959	22.60	100.8	22.42
1960	20.80	100.0	20.80

Source: Agriculture Prices.

x_1 = per capita disposable income

x_2 = deflated broiler prices

x_3 = deflated cattle prices

x_4 = deflated price turkey

x_5 = population

Y = pounds of turkey consumed

The coefficient of determination or R^2 was .964, meaning that of the total squared variability about the line of regression these five variables accounted for 96 percent of it.

Considering the influence of each of the independent variables separately, population alone accounted for 96.4 percent of the squared variability in the pounds of turkey consumed. Or in other words, the influence of population on the demand for turkey was so great it dominated the other four variables and their true relationship could not be determined. It is possible to make direct adjustments for population changes thereby giving the other four variables a chance to indicate their relationship to the demand. This was accomplished by reducing total pounds of turkey consumed each year to a per capita basis. Changing demand to a per capita consumption basis eliminates the possibility of a change in demand due to a change in population.

Pounds consumed were calculated on a per capita basis and the other variables were unchanged. This eliminated the population variable leaving only four independent variables.

x_1 = deflated price broilers

x_2 = deflated price cattle

x_3 = deflated price turkey

x_4 = per capita disposable income

Y = per capita consumption turkey

This set of variables resulted in a multiple-correlation coefficient of R^2 = .936 (Table 6), meaning that after the increase in demand due to the increase in population had been adjusted for, of the remaining squared variability these four variables accounted for 93.6 percent of it. The correlation coefficient indicated the degree of relationship between the variables and the per capita demand for turkey. A perfect correlation is 1.0 and the correlation in this case was .967, indicating a very high degree of relationship.

Before drawing any definite conclusions, however, it would be better to examine the partial coefficients and the regression coefficients (Table 6).

The first variable in the analysis was that of the deflated price of broilers. It is normally expected that as the price of broilers increases the demand for turkey would increase and as the price of broilers decreases the demand for turkey would decrease due to the competitive nature of the two. The examination of the regression coefficient indicates a negative sign, meaning that as the price of broilers increases the consumption of turkey decreases and as the price of broilers decreases the consumption of turkey increases.

This unexpected sign may be due to two factors. One, it may be due to an "inter-correlation," meaning that the independent variables are themselves interrelated. In this case the partial coefficients of correlation indicates that there is inter-correlation between the price of turkey and the price of broilers. The coefficient for broilers alone ($r_{12.345}$) was .926. The coefficient of correlation for the price of turkey ($r_{14.235}$) was .925. The combined affect of these two variables ($r_{124.35}$) = .946 shows a slight decrease from the coefficient of

Table 6. Multiple, partial and regression coefficients for per capita consumption of turkey and related independent variables

Types of relationships	Coefficients of determination	Coefficients of correlation	Regression coefficients	Probability level at which B becomes significant D.F. = N-K-1 = 16
Multiple	R^2 = 1.2345 = .936	R = 1.2345 = .967		Between
Partials	$r^2$12.345 = .857	r12.345 = -.926	b12.345 = -.079	.10 to .20
	$r^2$13.245 = .267	r13.245 = -.516	b13.245 = -.0435	.05 to .10
	$r^2$14.235 = .855	r14.235 = -.925	b14.325 = -.106	.01 to .02
	$r^2$15.234 = .571	r15.234 = +.756	b15.234 = .150	.10 to .20
	$r^2$145.23 = .919	r145.23 = .959		
	$r^2$134.25 = .858	r134.25 = .926		
	$r^2$135.24 = .625	r135.24 = .791		
	$r^2$1345.2 = .924	r1345.2 = .961		
	$r^2$123.45 = .904	r123.45 = .951		
	$r^2$124.35 = .894	r124.35 = .946		
	$r^2$125.34 = .863	r125.34 = .927		
	$r^2$1245.3 = .921	r1245.3 = .960		
	$r^2$1234.5 = .927	r1234.5 = .963		
	$r^2$1235.4 = .904	r1235.4 = .951		

x^1 = per capita consumption
x^2 = price broiler
x^3 = price cattle
x^4 = price turkey
x^5 = disposable income

correlation of broilers prices and a slight increase from the coefficient of turkey prices. For the very reason that the combination of these two did not better the correlation coefficient of broilers is enough to say that there was a degree of inter-correlation. The result was a minus sign.

Another factor which may cause a unexpected sign may be due to the influence of another variable which was not included or adjusted for in the correlation problem.

The next factor that was considered was the deflated price of cattle. The coefficient of determination indicated that it was the least important of the four variables in explaining the squared variability around the line of regression of per capita consumption of turkey ($r^2 13.245$) = .267. The corresponding correlation coefficient (r13.245) was .516 indicating some relationship, however, not as high as the other three variables.

Here again the problem of the unexpected sign was encountered. In examining the partial coefficients (Table 6) it was evident that there was again a high degree of inter-correlation between the deflated price of turkey and the deflated price of cattle. The coefficient of correlation for the price of turkey was (r14.235) .925 and the coefficient of correlation for the price of cattle was (r13.245) .516. When both are combined the net affect was (r134.25) .926 indicating the inter-correlation.

The third factor considered was the deflated price of turkey. In this case the sign was negative as was expected. The regression coefficient was -.106 indicating that as the price of turkey decreased by one cent that the per capita consumption would increase by .106 pounds. In other words with a 10 cent change in the price of turkey there was 1.06

pound change in the per capita consumption of turkey. The coefficient of correlation indicated a high degree of relationship between the price and per capita consumption of turkey ($r14.235$) = .925. This corresponded to a coefficient of determination of ($r^2 14.235$) = .855, indicating that the price of turkey was quite high in explaining the variations about the line of regression. The T test of the regression coefficient indicated that the turkey prices were highly significant ($b14.235$) = .01 to .02.

Real per capita disposable income was the fourth factor used. The coefficient of correlation ($r15.234$) was .756, indicating a fairly high degree of relationship between the per capita disposable income and turkey disappearance. The coefficient of determination ($r^2 15.234$) amounted to .571. The regression coefficient had a positive sign and was ($b15.234$) .150 meaning that with a one dollar increase in the per capita real expendible income that the per capita consumption of turkey would increase by .150 pounds. With a 10 dollar increase this would mean a 1.5 pound increase in the per capita consumption of turkey. This regression coefficient became significant near the .10 percent probability level.

In examining the combinations of the partials many of the same conclusions are arrived at. By leaving out the price of cattle, which had the least affect, the coefficient of determination ($r^2 134.5.2$) was .924 indicating that the price of cattle did not have a great deal of affect on the per capita consumption of turkey.

By considering the price of turkey and the real income and holding the affects of the other two variables at their average, the coefficient of determination ($r^2 145.23$) was .919 with the r value being .959. In other words these two variables alone accounted for all but a very little amount of the variation in the per capita consumption of turkey.

The affects of the other combinations are found in Table 6; it was felt that they say essentially the same thing as has already been said and will not be discussed.

Multiple correlation analysis of demand (trend removed)

A logical question asked at this point in the demand analysis was, to what extent were the independent variables just explaining trend in per capita consumption? There has been definite trend up in the per capita consumption from 1947-1960. Associated with this same trend was a trend down in the relative price of turkey.

Therefore, the per capita consumption was adjusted by dividing through by its trend leaving only the variations about the trend to be explained by the independent variables.

Again the same independent variables were used in the multiple correlation problem with one change. The price of broilers was deflated by an index of the price of turkey. This then put the price of broilers in terms of the price of turkey, removing the trend in this price series. The other variables were unchanged.

The result of this regression indicated that of the squared variations left, after trend is removed, that these four variables accounted for ($R^2 1.2345$) = 45.2 percent of it (Table 7). This gave a correlation coefficient of ($r1.2345$) .672, indicating a fair degree of relationship. The least important of the variables was the per capita income with the coefficient of determination ($r^2 15.234$) equal to .007 or very low. Price of broilers ($r^2 14.235$) and price of beef ($r^2 13.245$) both accounted for about 9 percent each of the variability.

The price of turkey accounted for ($r^2 12.345$) 5 percent of the squared

Table 7. Multiple, partial and regression coefficients for per capita consumption (trend removed) and related independent variables

Types of relationships	Coefficients of determination	Coefficients of correlation	Regression coefficients
Multiple	$R^2 1.2345 = .452$	$r1.2345 = .672$	
Partials	$r^2 12.345 = .055$	$r12.345 = -.224$	$b12.345 = -.044$
	$r^2 13.245 = .090$	$r13.245 = -.300$	$b13.245 = -.349$
	$r^2 14.235 = .092$	$r13.245 = +.304$	$b14.235 = +.436$
	$r^2 15.234 = .007$	$r15.234 = -.084$	$b15.234 = -.0132$
	$r^2 123.45 = .375$	$r123.45 = .613$	
	$r^2 124.35 = .301$	$r124.35 = .55$	
	$r^2 145.23 = .168$	$r145.23 = .41$	
	$r^2 125.34 = .126$	$r125.34 = .355$	
	$r^2 134.25 = .112$	$r134.25 = .334$	
	$r^2 135.24 = .091$	$r135.24 = .303$	
	$r^2 1234.5 = .452$	$r1234.5 = .672$	
	$r^2 1235.4 = .429$	$r1235.4 = .655$	
	$r^2 1245.3 = .320$	$r1245.3 = .566$	
	$r^2 1345.2 = .175$	$r1345.2 = .418$	

x^1 = per capita consumption
x^2 = price of turkey
x^3 = price of cattle
x^4 = price of broilers
x^5 = per capita income

variability. The regression coefficients indicate that the sign of broiler in this case was possitive. Evidently trend was the factor which was causing the minus sign in the first regression problem.

The combined affect of the price of turkey and the price of beef gave an r^2 value of .375, whereas, the combined affects of price of turkey, price of beef and the price of broilers was .452. The addition of the per capita disposable income did not increase the coefficient of determination.

These four variables accounted for about half of the squared variation around the line of regression after secular trend was removed.

Elasticity of demand estimated

By plotting per capita consumption and deflated price of turkeys on a graph and assuming this to be representative of what the demand has been for 21 years, it was possible to determine the demand elasticity.

Different goods vary in the degree to which their use responds to a reduction in price. "Elasticity" is the concept used when measuring this response. When the total revenue increases as a result of a reduction in price, the response is called "elastic." If the total revenue decreases by a reduction in price it is called "inelastic." If there is no change then it is called "unitary elastic." The formula used to measure this elasticity was:

$$\text{"E"} = \frac{\text{percent quantity increases}}{\text{percent price has decreased}}$$

In the demand for turkey the elasticity was different depending where on the line of least squares the elasticity was measured (Figure 12).

From 40 cents per pound on down to about 25 cents the demand indicated

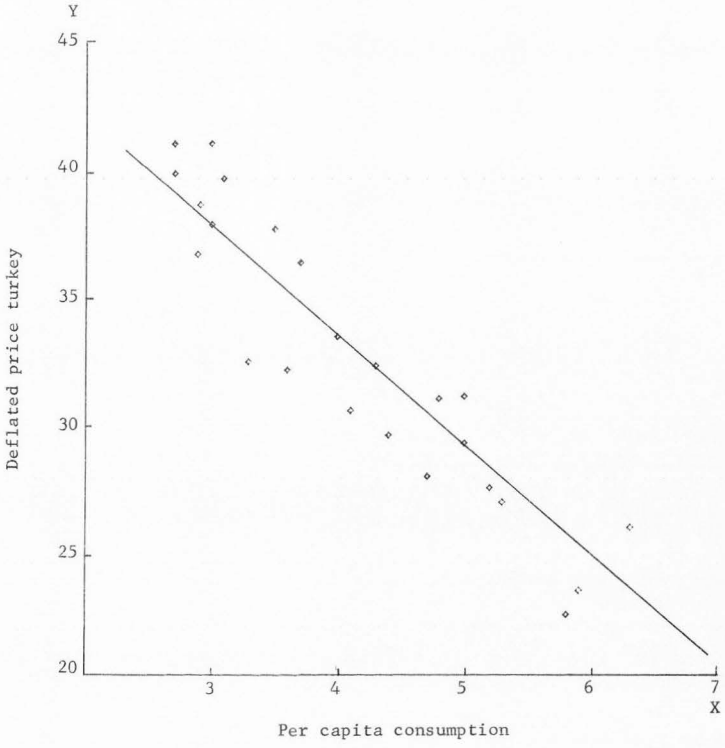

Figure 12. Scatter diagram of per capita consumption and deflated price of turkey with line of regression

an elastic situation. As price decreased total revenue increased. At the intersection of 25 cents and 6 pounds per capita the elasticity was unitary and from there on down the total revenue decreased as price decreased or it was inelastic.

At the mean of deflated price of turkey and per capita consumption the elasticity was 1.9 while at the price the 1960 turkeys sold for the elasticity was .98. This indicates that if the price goes any lower than the 1960 price, with per capita consumption increasing as a result of the lower price, that it would be to no advantage to the farmer, as the farmer's total revenue would not increase.

THE MEASUREMENT OF SUPPLY

The measurement of supply is subject to many of the same difficulties as the measurement of demand. In the short run the measurement of the supply side of the demand-supply relationship is the most important to the turkey farmer. In discussing the theory of demand and supply it is common to think of price as cause and the quantity demanded as result. In the short run situation of a given year and from the standpoint of the entire market, turkey supplies determine prices rather than the price determining supply. In the long run situation, supplies are generally responsive to changes in price.

The supply of turkey was considered to be the amount of turkey (measured in millions of pounds) that farmers were willing to produce and sell, plus the amount of turkey held in cold storage from last year's production to be marketed this year.

Supply for each of the 21 years may be generalized by:

$$S_t = P_t + CS_{t-1} - 1^*$$

where

S_t = supply

P_t = production

CS = cold storage

t = time

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*This may be read as the supply in time period t equals to production in time period t plus the cold storage in time period t minus one year.

This gives the amount of turkey that was available for sale on the open market for each year. At the end of each year there is a considerable amount of turkey that is left in cold storage that did not sell that year.

Had the price been right this turkey would have been sold before January 1; therefore, it was considered part of the supply.

There are two elements of supply--the production each year and the amount of turkey held in cold storage on January 1 of each year. Examination of each of these factors indicates that the production of turkey has been the factor which has varied the most over the past two decades. Cold storage holdings have varied some but for the past 10 years have tended to remain constant around 12 percent of each year's production (Figure 2).

The value of knowing what the production will be for the coming year is important to the turkey farmer because if he knows that the production will be larger than usual he may want to cut back his own production. If he knows that it is smaller than usual, he may want to increase his production.

The U.S.D.A. publishes many outlook reports among which is Farmers Intentions to produce turkeys which is a prediction of the number of turkeys to be produced next year. The accuracy of this report is important to the turkey farmers, as this would give him a good predictive tool to measure production.

Farmers intentions

In the fall of each year the U.S.D.A. takes a sample survey of turkey farmers in the United States to determine from them the amount of

increase or decrease they plan for turkey production the coming year.

Based on their study in the fall the U.S.D.A. publishes in January of each year the percentage increase or decrease expected in turkey production.

Relating Farmers Intentions expressed in millions of birds and actual numbers produced in a simple correlation problem it was determined that the coefficient of determination was .982 with the coefficient of correlation being .99 (Figure 13). The regression equation was $Y = 1.9 + .966x_1$. The value of this equation lies in its ability to estimate production in terms of Farmers Intentions.

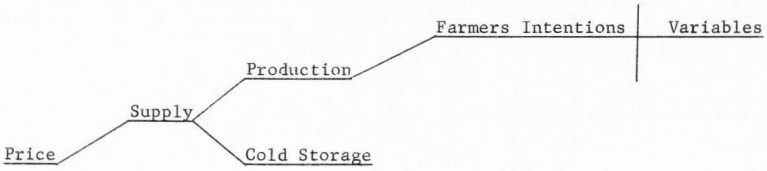
The statistical test to determine how accurate the estimate will be was accomplished by the use of the following formula.

$$S_{1.2} = \sqrt{\frac{\Sigma y^2 \ (1-B^2 1.2)}{N-M}}$$

where

M is the number of constants in the regression equation. This indicates that the chances would be 95 out of 100 that any one estimate would be correct to within 1.87 million birds; which is quite accurate. In other words this indicates that Farmers Intentions is a good estimate of what to expect for turkey production the next year (Figure 14).

The analysis thus far would look like this in graphic form.



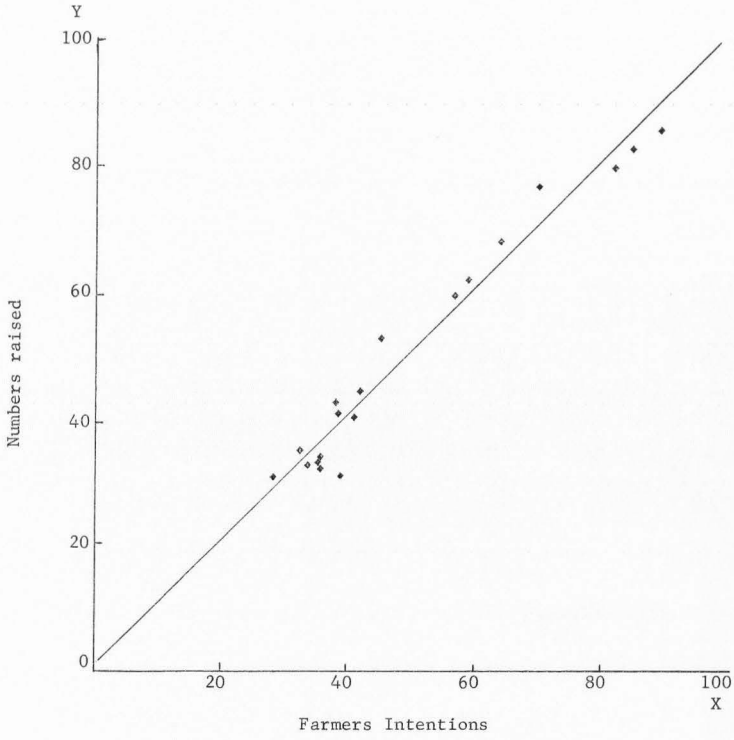


Figure 13. Scatter diagram of Farmers Intentions and actual numbers raised with the line of regression

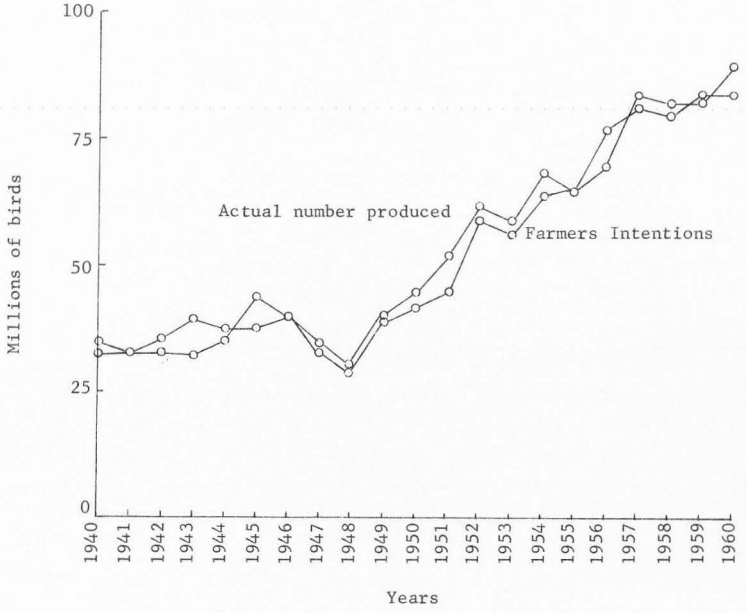


Figure 14. Actual numbers produced compared with Farmers Intentions, 1940-1960

Basic data used to measure supply changes

Using Farmers Intention as representative of production or supply, four variables were decided upon as being the most important influences to the farmer at the time he is making out his intentions report.

Average price poultry feed. The price of feed is the biggest cost factor the turkey farmer must consider. In past years in Utah it has amounted to about 67.7 percent of the total cost of production (8). Any change in this cost factor would certainly have an influence on the turkey farmers decisions as to how many turkeys to produce.

In the raising of turkeys the poults are started on a certain type of feed and after so many weeks a regular poultry ration is usually substituted. This poultry ration constitutes the majority of the feed that is required to produce a marketable turkey. Therefore, the price series that was used was the average price of the poultry ration. In order to adjust for any general price level changes or trends this price series was deflated by the index of all farm prices paid by farmers.

At the time the intentions report is made out the farmer has predictions as to what feed supplies will be next year and on this basis makes his judgment as to what he thinks the price of feed will be. Assuming he makes accurate judgments, the price of feed that was used in the correlation analysis was the average price for the year the intentions report was filled out (Table 8).

Cost of poults. Cost of poults is also an important item in the total cost of production the farmer must and does consider. Any change in the price of poults would certainly influence him as to the number of birds he would raise. Over the past 20 years adjusted average poult prices have tended to decrease from a high in 1941 of $1.10 each to a

Table 8. Average price poultry ration deflated by the prices paid by farmers for all farm products, 1940-1960. (1960 = 100)

	Average price poultry ration[a]	Prices paid by farmers 1960 = 100	Deflated price poultry ration
1940	1.54	41.5	3.71
1941	1.68	43.8	3.83
1942	1.83	50.8	3.60
1943	2.21	55.9	3.95
1944	2.66	58.9	4.51
1945	2.94	63.5	4.62
1946	2.91	67.9	4.28
1947	3.47	79.9	4.34
1948	4.17	86.6	4.81
1949	4.30	83.6	5.14
1950	3.47	85.6	4.05
1951	3.59	94.3	3.80
1952	4.02	95.0	4.23
1953	4.21	93.3	4.51
1954	3.87	94.0	4.11
1955	3.86	92.3	4.18
1956	3.54	93.0	3.80
1957	3.47	95.6	3.62
1958	3.42	98.0	3.48
1959	3.40	99.3	3.42
1960	3.33	100.0	3.33

[a]Source: Agriculture Prices, 1940-1960.

low of .568 cents in 1959. The price of poults was adjusted in order to account for any general price level changes or trends (Table 9).

Before any intentions reports are filled out the poult salesmen have contacted the farmers so that when the time comes to fill out the intentions report the farmer knows what the price of poults will cost him for next year's production.

The poult price used was the average price for the year the intentions report was filled out for.

Price of turkey. Undoubtedly the price the farmer received for his turkeys has an effect on the amount he will raise the next year. However, in this same concept a problem is raised as to the extent of influence each past year's price of turkey has on the next year's production.

As Mr. Nerlove expressed this problem:

> Surely farmers must base their decisions on some reasonable assessment of the supply and demand conditions for commodities they produce. Farmers react, not to last year's price, but rather to the price they expect, and this expected price depends only to a limited extent on what last year's price was. (8, p. 498)

After a considerable amount of work on this problem it was determined that the influence of turkey prices two and three years previous did not significantly affect the over-all result. Therefore, last years price of turkey was given the full weight and was used as the third variable.

Cold storage holdings. At the end of each year a considerable amount of turkey is left in cold storage to be sold during the next year. The farmers consider this amount or at least consider the percentage of the total production that was left in cold storage. If production was high this past year but cold storage was higher percentage wise, then this might cause the farmer to cut back on his intentions or production plans, or it could affect intentions in the other direction.

Table 9. Average price of turkey poults deflated by prices paid by farmers for all farm products, 1940-1960. (1960 = 100)

	Average price turkey poults[a]	Prices paid by farmers 1960 = 100	Deflated price turkey poults
1940	.406	41.5	.978
1941	.485	43.8	1.107
1942	.524	50.8	1.031
1943	.563	55.9	1.007
1944	.697	58.9	1.183
1945	.759	63.5	1.195
1946	.715	67.9	1.053
1947	.697	79.9	.872
1948	.841	86.6	.971
1949	.855	83.6	1.022
1950	.751	85.6	.877
1951	.698	94.3	.740
1952	.667	95.0	.702
1953	.663	93.3	.710
1954	.620	94.0	.659
1955	.618	92.3	.669
1956	.638	93.0	.686
1957	.611	95.6	.639
1958	.594	98.0	.606
1959	.566	99.3	.568
1960	.591	100	.591

[a]Source: Agriculture Prices, U.S.D.A., 1940-1960.

Cold storage holdings were expressed as a percentage of last year's production (Table 10).

Multiple correlation analysis of supply changes

Using the Farmers Intentions reports as the dependent variable and (a) price poultry ration, (b) price poults, (c) price turkey weighted average, (d) percentage last year's crop in cold storage as the independent variables resulted in the following information.

The multiple coefficient of correlation between these variables and Farmers Intention was (R1.2345) .905 with the coefficient of determination of ($R^2$1.2345) .819 (Table 11).

This gives reason to believe that the four variables that were used were quite closely correlated to Farmers Intentions and did an accurate job of explaining the variations in Farmers Intentions. All of the signs associated with the regression coefficients indicated the expected relationships between the variables and Farmers Intentions. A look at the partials will tell which of the variables was the most important in explaining the variations.

The first variable was the price of poultry ration. In this situation the coefficient of correlation was (r12.345) .582 with a corresponding coefficient of determination of ($r^2$12.345) .339. This was not a high degree of association but it does account for some of the variations in Farmers Intentions. The regression coefficient was (b12.345) -8.13, meaning that with a one dollar decrease in the price of ration that Farmers Intentions would increase by 8.13 million birds. The t test indicated that the regression coefficient became significant between the .10 and .20 probability level.

Table 10. Percentage of cold storage holdings on December 31 of each year, 1939-1960

	Turkey sold (million pounds)	December 31 cold storage holdings	Percentage in cold storage
1939	444	52	11.7
1940	506	61	12.0
1941	491	50	10.2
1942	523	36	7.0
1943	485	37	8.0
1944	577	73	12.7
1945	715	108	15.1
1946	740	128	17.2
1947	634	83	13.1
1948	549	51	9.3
1949	748	127	16.9
1950	808	110	13.6
1951	927	107	11.5
1952	1049	147	14.0
1953	999	122	12.2
1954	1149	121	10.5
1955	1079	95	8.8
1956	1247	162	13.0
1957	1348	177	13.1
1958	1338	162	12.1
1959	1432	149	10.4
1960	1488	160	10.7

Source: Poultry and Egg Situation, January 1962, p. 23.

Table 11. Multiple, partial and regression coefficients for Farmers Intentions and related independent variables

Types of relationships	Coefficients of determination	Coefficients of correlation	Regression coefficients	Probability level at which B becomes significant D.F. = N-K-1 = 16
Multiple	R^2 1.2345 = .819	R 1.2345 = .905		Between
Partials	$r^2$12.345 = .339	r12.345 = -.582	b12.345 = -8.13	.20 to .10
	$r^2$13.245 = .766	r13.245 = -.875	b13.245 = -82.50	.02 to .01
	$r^2$14.235 = .394	r14.235 = +.628	b14.235 = + .65	.20 to .10
	$r^2$145.23 = .465	r145.23 = .682		
	$r^2$134.25 = .766	r134.25 = .875		
	$r^2$135.24 = .800	r135.24 = .895		
	$r^2$1345.2 = .804	r135.24 = .897		
	$r^2$123.45 = .790	r123.45 = .889		
	$r^2$124.35 = .428	r124.35 = .654		
	$r^2$125.34 = .341	r125.34 = .584		
	$r^2$1245.3 = .473	r1245.3 = .688		
	$r^2$1234.5 = .802	r1234.5 = .895		
	$r^2$1235.4 = .817	r1235.4 = .904		

x^1 = Farmers Intentions
x^2 = Price poultry ration
x^3 = Price turkey poults
x^4 = Price turkey lagged
x^5 = Percentage last years crop in cold storage

The second variable used was the average price of poults. This was from all indications the most important influence in explaining the variations in the Farmers Intentions report. It alone accounted for ($r^2$13.245) 76.6 percent of the variation and the coefficient of correlation was (r13.245) .875 indicating a high degree of relationship. This may indicate that the hatcheries have a considerable influence as to the amount of turkeys that are produced. They certainly wouldn't throw poults away if they weren't bought, but would lower their price and put them on the market. The regression coefficient was (b13.245) -82.5, meaning that as the price of poults decreased by 10 cents that the Farmers Intentions to produce would increase by 8.25 million birds. This regression coefficient was highly significant at the .02 to .01 probability level.

The third variable was the price of turkey lagged one year. As was previously explained, an expectations model was used to determine what weight to give past years price of turkeys. The correlation results indicated that last year's price should be given the full 100 percent weight. This price of turkeys resulted in a coefficient of correlation of (r14.235) .628 indicating a fairly high degree of relationship. This amounted to a coefficient of determination of ($r^2$14.235) .394 or in other words, price of turkey accounted for 39.4 percent of the variations in the Farmers Intentions. The regression coefficient was (b14.235) .65, meaning that as the price of turkey increased by one cent that Farmers Intentions would increase by .65 million birds. It became significant around the 50 percent probability level, not particularly high.

The price of turkey was expected to explain more of the variation in Farmers Intentions than it did; however, costs are a big factor to

the turkey farmers and these results tend to substantiate this.

The fourth and last factor was the percentage of cold storage held at the end of each year.

The correlation problem indicated that this was the least important of the four variables considered. The correlation coefficient was (r15.234) .223 and the corresponding coefficient of determination was ($r^2$15.234) .05. Cold storage holdings accounted for only 5 percent of the variation in Farmers Intentions. The regression coefficient was (b15.234) -1.14 or in other words, with a 10 percent increase in cold storage holdings there would be a 1.14 million decrease in birds produced by turkey farmers. This was significant at the 10 to 20 percent probability level.

The combination of these variables indicated some inter-relationships between some of the variables. The combination of price of feed and price of poults accounted for 79 percent ($r^2$123.45) of the variations in Farmers Intentions. Even though this was high, the price of poults alone accounted for 76 percent of the variation alone, meaning that the price of feed added only 3 percent to the 76 percent. This would indicate a degree of inter-relationship between these two variables.

The price of turkey and the price of poults also indicated to some degree inter-relationship. Together ($r^2$134.25) these two explained 76 percent of the variations in Farmers Intentions. A look at the price poults itself indicates that it alone accounted for 76 percent, thus price of turkey added nothing.

The other relationship resulted in much the same picture as has already been explained and will not be discussed further.

The regression equation that resulted from the analysis was

$$Y = 160.56 - 8.13X - 82.50X_2 + .65X_3 - 1.14X_4$$

The value of a regression equation lies in its ability to estimate. In this case, however, the variables used are not available before the Farmers Intentions report comes out. Thus, the predictive value of this equation was substantially lessened.

Multiple correlation analysis of price changes

Many questions regarding turkey prices were explained in the section on seasonal and secular changes; however, all of the variations were not accounted for.

This section attempts to determine some of the more important factors which accounted for the changes that have taken place in turkey prices.

Referring to the economic theory on supply and demand it is the intersection of the supply and demand that determines price. Therefore, in order to explain the movements of these intersections a combination of both supply and demand factors were used as independent variables.

Again the multiple correlation method was used for the analysis. The majority of turkeys are sold from October to January; therefore, the price that was used as the dependent variable, was the deflated average farm price of turkeys from October to January.

The independent variables taken from the demand side were the price of broilers deflated and per capita real income. From the supply side of the analysis the production of turkey and cold storage were used. All were measured in absolute changes from year to year, not percentage changes.

The results indicated that of all the squared variations in the

deflated price of turkey, these four variables accounted for 93.7 percent of it ($r^2$1.2345) (Table 12). The coefficient of correlation was also high at .968 (r1.2345).

Looking at the effects of the individual factors, production of turkey and the price of broilers were the most important single factors explaining variations in turkey prices from year to year (Table 12). Production alone accounted for 84.5 percent of the squared variability in turkey prices. The regression coefficient indicated a negative relationship and was (b12.345) -.012, meaning that with one million pound increase in turkey production the price of turkey could be expected to decrease by 1.2 cents per pound.

The price of broilers was also very high in explaining the variability of turkey prices. It explained 83.8 percent of the variation and was positive in its relationship. The regression coefficient indicated that with one cent increase in the price of broilers that the price of turkey would increase by 3.6 cents. This relationship was expected as these two products are considered to be good substitutes.

The next most important variable was the cold storage holdings. It accounted for 73.1 percent of the variability and the relationship with the price was a negative one. As the amount of turkey held in cold storage increased by one million pounds, the price would decrease by .22 cents.

Real income was the lowest factor in explaining price variations with a coefficient of determination of .356 ($r^2$14.235). This was a positive relationship and was expected. The regression coefficient was .0156 (b14.325). With an increase of one dollar in per capita real income turkey prices would be expected to increase by 1.6 cents per pound.

Table 12. Multiple, partial and regression coefficients for turkey prices and related independent variables

Types of relationships	Coefficients of determination	Coefficients of correlation	Regression coefficients	Probability level at which B becomes significant D.F. = N-K-1 = 16
Multiple	$R^2 = 1.2345 = 0.937$	$R = 1.2345 = 0.968$		Between
Partials	$r^2 12.345 = 0.838$	$r12.345 = +0.915$	$b12.345 = +.036$	.05 to .02
	$r^2 13.245 = 0.845$	$r13.245 = -0.92$	$b13.245 = -.0118$	.01-to .001
	$r^2 14.325 = 0.356$	$r14.235 = +0.597$	$b14.325 = +.0156$	.01-to .001
	$r^2 15.234 = 0.731$	$r15.234 = -0.855$	$b15.234 = -.0022$	.20 to .10
	$r^2 145.23 = 0.741$	$r145.23 = 0.861$		
	$r^2 134.52 = 0.892$	$r134.25 = 0.944$		
	$r^2 135.24 = 0.875$	$r135.24 = 0.935$		
	$r^2 1345.2 = 0.914$	$r1345.2 = 0.955$		
	$r^2 123.45 = 0.87$	$r123.45 = 0.94$		
	$r^2 124.35 = 0.86$	$r124.35 = 0.93$		
	$r^2 125.34 = 0.87$	$r125.34 = 0.93$		
	$r^2 1245.3 = 0.89$	$r1245.3 = 0.94$		
	$r^2 1234.5 = 0.93$	$r1234.5 = 0.94$		
	$r^2 1235.4 = 0.89$	$r1235.4 = 0.97$		

x^1 = price turkey
x^2 = price broilers
x^3 = turkey production
x^4 = cold storage holdings

The regression equation that resulted was $Y_c = 14.37 + .36X_1 - .012X_2 + .016X_3 - .022X_4$. Making the test to determine how reliable the estimate would be, it was found that in 95 out of 100 chances that the estimate price would be correct to within 3.7 cents per pound.

To get a visual picture of this predictive reliability, prices were estimated for the year 1940-1961 based on the regression equation. These estimates were compared with actual price changes (Figure 15). Only in one year was the difference greater than two cents.

Using this equation to predict the 1961 October-January deflated average farm price of turkey resulted in a figure of 18.9 cents per pound. The actual for this period after the price adjustment was made was 18.2 cents per pound.

Attempting this same thing on the 1962 price assuming that real income and the price of broilers did not change as these figures were not available the regression equation predicted a 18.3 cents per pound before being deflated. The price adjuster was not available and this could either raise or lower this prediction figure.

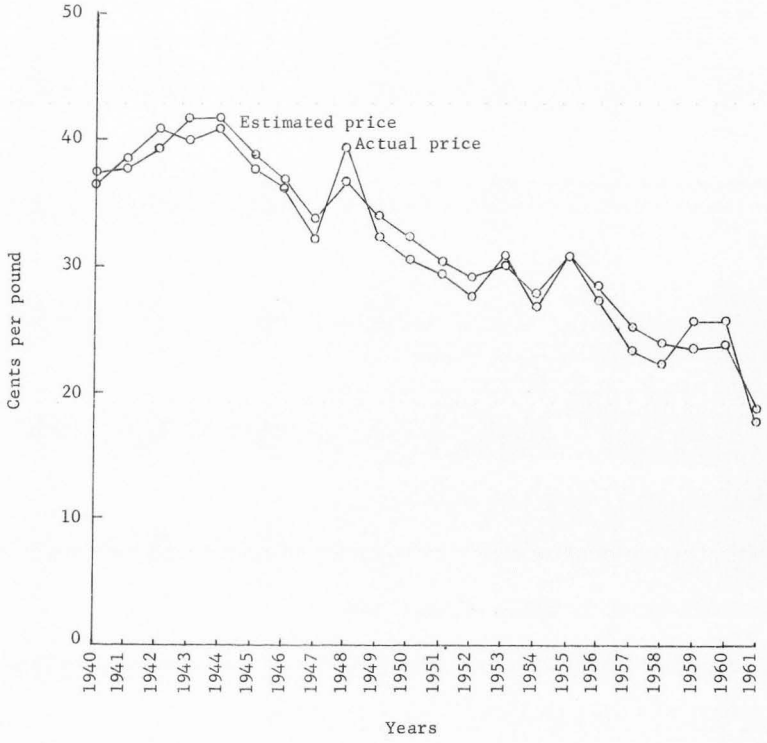


Figure 15. Actual farm price of turkey (October - January) and estimated price

SUMMARY AND CONCLUSIONS

Seasonal and secular trends

1. From 1940 to 1960 total United States production of turkey increased 150 percent. Measured on the basis of per capita consumption the increase was 130 percent. Utah ranks eighth in the nation in production of turkeys.

2. Prices received for turkey by farmers relative to all farm prices has trended downward, particularly since 1944. From an adjusted price of about 40 cents per pound in 1944 prices declined to about 25 cents by 1960.

3. From 1955 to 1960 more than 70 percent of annual turkey used was in the four months September through December. The long term trend is toward more equal distribution throughout the year.

4. Cold storage holdings in percentage of production fluctuated from 5 to 19 percent in the last 20 years without noticeable trend. The peak month of cold storage holdings has changed from February back to November and the low month from October to July.

5. From 1950-1960 seasonal patterns of prices were different for hen and tom turkeys. Hen prices were high beginning in October and on an average exceeded tom prices by 5 or 6 cents per pound in November and December when demand for family size birds was particularly strong. Tom prices actually exceeded hens from June to August for the period studied.

6. Seasonal price changes suggest the advisability of short time (2 to 3 months) storage of early processed hens to, but not through, the

holiday season. Seasonal price rise of tom turkeys on the average was sufficient to cover long time (6 to 8 months) storage costs. For five years of low turkey production relative to secular trend tom prices advanced about 10 cents per pound seasonally, suggesting the advisability of long time storage in years of relatively low production and sale at processing time in years of relatively high production. Hen prices did not show significant differences in seasonal trend relative to production level.

Demand considerations

1. Population accounted for 96.4 percent of the squared variation in pounds of turkey consumed when real income, price turkey, price broilers were held constant at their average. When population was eliminated by measuring consumption on a per capita basis, the deflated price of broilers accounted for 92.6 percent of the squared variations when other factors were held constant. The regression coefficient, however, indicated a negative sign, which was not expected. The price of turkey accounted for 85.5 percent of the variation in per capita consumption and the regression coefficient was negative, as expected. Prices of broilers and turkeys were highly interrelated.

2. Adjusting per capita consumption for trend it was found that, the price of turkey, price of broilers, price beef and per capita real income explained 45.2 percent of the remaining squared variability about the line of regression. The regression coefficient of broilers was positive as expected and indicated that presence of secular trend was the cause of the incorrect sign in the previous problem.

3. A demand curve constructed by use of the deflated turkey price and per capita consumption of turkey was less elastic as prices declined.

Recent supply-price relationships indicated, demand elasticity is near unity, based on this curve.

Supply considerations

1. A simple correlation between the Farmers Intentions to produce turkeys and actual production indicated a very high correlation r = .99. The Farmers Intention report published about January 20 of each year is highly reliable as an indicator of supply and is available soon enough to be valuable in decision making.

2. Using Farmers Intentions as the dependent variable, it was found that the price of poults was most important in explaining the variations. Other independent variables in order of importance were price of turkey the previous year, price of feed, and cold storage holdings. These four variables together explained 82 percent of the squared variability in Farmers Intentions.

Price considerations

1. Using weighted price of turkey as the independent variable with dependent variables from both the supply and the demand analysis resulted in a multiple correlation of 96.8. Production of turkeys and the price of broilers were the two most important independent variables explaining the variations in the price of turkey. Cold storage holdings and real income were the other two variables used in the analysis but they were less important.

2. Prediction of the price of turkey may be obtained by the use of the regression equation $Y_c = 14.37 + .36X_1 - .012X_2 + .016X_3 - .022X_4$.

In order to obtain an early prediction the price of broilers and real income must be assumed, as estimates are not available in January

when production, in the form of Farmers Intentions, and cold storage holdings on January 1 are.

The assumed demand curve obtained in the demand analysis may also be used to predict price, where per capita consumption is obtained from Farmers Intentions and the demand curve indicates the price relative to that level of per capita consumption.

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