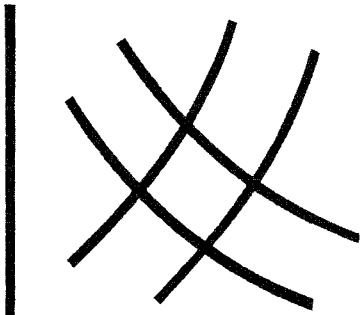

ECONOMIC ANALYSIS of U.S. TURKEY PRICES and PRODUCER INCOME

M.A. Soliman and C.R. Burbee

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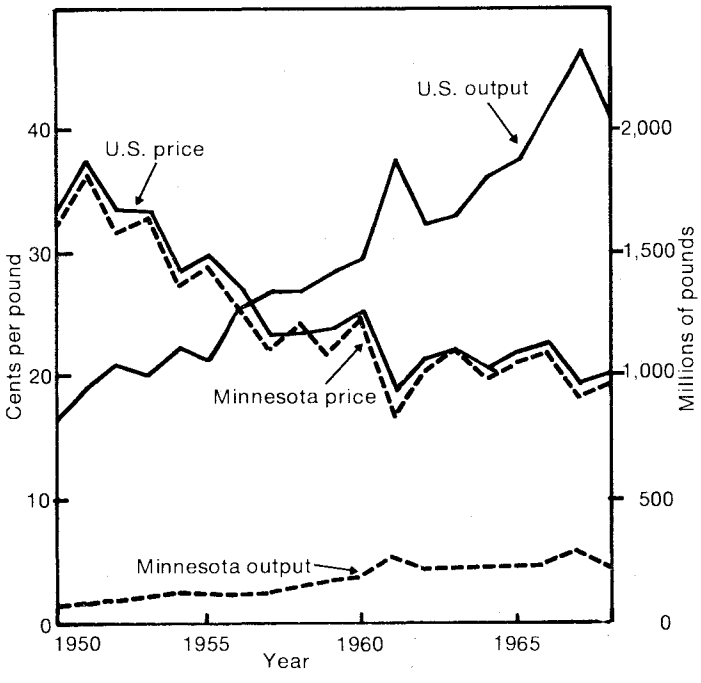
Economic Analysis of U.S. Turkey Prices and Producer Income

M. A. Soliman and C. R. Burbee

Turkey producers in the United States experienced declining prices for almost two decades. The downward trend began in 1952, with substantial decreases through the early sixties (figure 1). Although the trend moderated considerably during most of the sixties, the producer price averaged well below the average price of the previous decade. During the 1960-68 period, the average U.S. turkey price at the farm level was 21.8 cents a pound compared to 29.5 cents in the 1950-59 period. The price situation was more acute in the major turkey producing states. For example, Minnesota producers averaged 21.1 cents a pound in the 1960-68 period, well below the 28.6 cents a pound average of the fifties (figure 1).

Figure 1. Average farm price and output of turkey for the U.S. and Minnesota, 1950-68



Source: "Turkey Production, Disposition, and Gross Income Reports," Agricultural Marketing and Statistical Reporting Service, USDA.

The low price situation in the sixties prevailed in spite of industry efforts to alter the consumer image of turkeys. Historically, turkey had been marketed in a whole bird form primarily for consumption during the Thanksgiving-Christmas holiday period. The industry, aware of the inconvenience of cooking the whole bird, developed and promoted a new line of convenience foods. The purpose was to expand the demand for turkey during the non-holiday period as well as retaining the holiday market in order to increase prices and profits.

Producers, apparently optimistic about the prospects of an expanded market and higher prices, as well as being aware of cost reducing technological developments in production, proceeded to increase output. Between 1960 and the peak production year of 1967, production increased almost 862 million pounds, or 58 percent (figure 1).

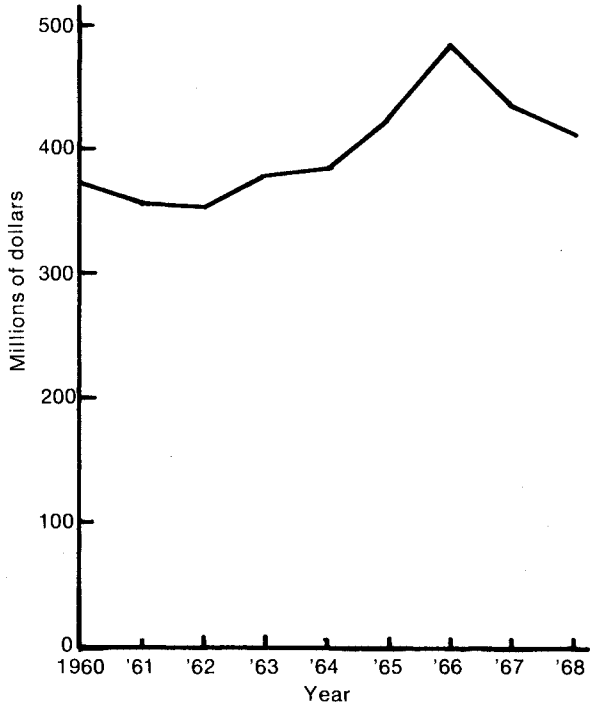
As a result of the divergent movements in prices and output, gross producer income remained relatively constant between 1960 and 1964, rose to 486 million dollars in 1966, and proceeded to decline in the next 2 years (figure 2). Although there is evidence of a positive trend in producer income, the positive trend in output is much greater.

The price situation appears to be a result of increased turkey production, but there was considerable effort on the part of the industry to expand consumer demand. Consequently, producers are uncertain whether these efforts to expand demand were successful or not considering the price and income situation. The industry's publicized efforts to expand demand probably influenced producer price and income expectations and contributed to the increase in supply.

The reduced price occurred for either of two reasons: efforts to expand demand were not significant at the farm level and the increased supply was the cause, or efforts to expand demand were successful at the farm level, but the increase in supply was greater, nullifying any beneficial effects to producers. Another question that still arouses curiosity on the part of producers is, "Would the market order proposal defeated by referendum in 1962 have alleviated the producer price and income problem?"[1]

[1] The USDA proposed a marketing order for turkey in October 1961 and a producer referendum in June 1962. The order was defeated in the referendum.

Figure 2. Gross turkey producer income in the U.S. 1960-68



Source: "Turkey Production, Disposition, and Gross Income Reports," Agricultural Marketing and Statistical Reporting Service, USDA.

Objectives and Procedure

The objectives of this study are to investigate (1) the shifts that occurred in the supply and demand of turkeys at the producer level, in order to explain producer price and income, and (2) the potential effects on producer price and income of a hypothetical market quota program, similar to the one defeated by referendum in 1962.

The first section consists of a brief theoretical discussion on price determination. The second section is a discussion on the supply and demand characteristics of turkeys. The third section is the statistical analysis of the first objective (above). The fourth section is an investigation of a market quota program and a comparison of the hypothetical results with actual prices and earnings during the 1964-68 period.

Supply and Demand Relationships

Turkey prices, like the prices of other commodities, are determined by the forces of supply and demand. Demand is "the schedule of quantities purchased by buyers at different prices during some time period." As price decreases, more is purchased, and as price increases, less is purchased. Such a schedule is illustrated in figure 3A as AA, and is considered to be the final or consumer demand schedule.

The quantity a consumer purchases depends not only on the commodity's price but on several other variables. These customarily are the consumer's disposable income, the prices of close substitutes, such as other meats in the case of turkey, and the consumer's tastes and preferences. In interpreting a demand function, all the variables except price and quantity are assumed to be held constant at some predetermined value.

Producers of most agricultural commodities do not face a consumer demand schedule, but a derived demand schedule. This function is shown in figure 3A as BB and is down and to the left of the consumer demand function. The vertical difference between the two represents the marketing margin, or the cost for processing, storage, transportation, and ownership transfer. If the marketing margin increases, the derived demand schedule would shift further down and to the left, increasing the distance between the two demand functions.

The supply schedule is "the quantity of a commodity a producer will supply at various prices during a given time period." The quantity supplied is considered to depend upon: the commodity's price, the prices of inputs to produce the commodity, such as feed and poults for turkeys, the prices of other commodities that could be produced with the same resources, the quantity of the commodity stored, and time. As the offered price increases, all other variables remaining constant, producers respond by supplying more of the commodity. A supply function is illustrated in figure 3A as SS.

The equilibrium price, the price that equates the quantity demanded and supplied, is P_F at the producer level in figure 3A. The quantity is Q_o and the equilibrium price at the consumer level is P_R.

Over time, the values of the other variables can and do change. These variables are known as "shifters of the schedules." For example, an increase in substitute prices and a general increase in consumer disposable income shift the consumer demand schedule to the right, such as position A'A' in figure 3B. And then, an increase in consumer demand with a constant marketing margin shifts the derived demand function to the right by the same distance to B'B' in figure 3B. With a fixed supply schedule, both the quantity sold and equilibrium price are increased.

Demand may also shift to the left as a result of lower substitute commodity prices and generally reduced disposable income. Such a shift is transmitted back through the marketing system and the derived demand is shifted to the left, resulting in a lower equilibrium price and reduced supplies.

Usually, consumer tastes and preferences do not change considerably in a short period of time. As the time period increases, tastes do change and will affect the demand for a commodity. In the case of changing the product form from whole bird to more convenient forms, the turkey industry was in part responding to a change in consumer preferences.

Aggregate demand for a commodity is the horizontal summation of the consumer demand schedules. Over time, other shifters remaining constant, population increases alone will tend to shift the demand schedule to the right.

Supply schedules also are shifted by changes in the values of the variables. For example, decreases in input

prices, prices of other commodities producers also produce with their resources, and decreases in the quantities of the commodity stored, will generally shift the supply schedule down and to the right. New methods of producing the commodity that cut costs and occur almost continually in agriculture, also will shift the schedule down and to the right. Such a shift is illustrated in figure 3C from SS to S'S'.

Figure 3. Supply and demand relationships

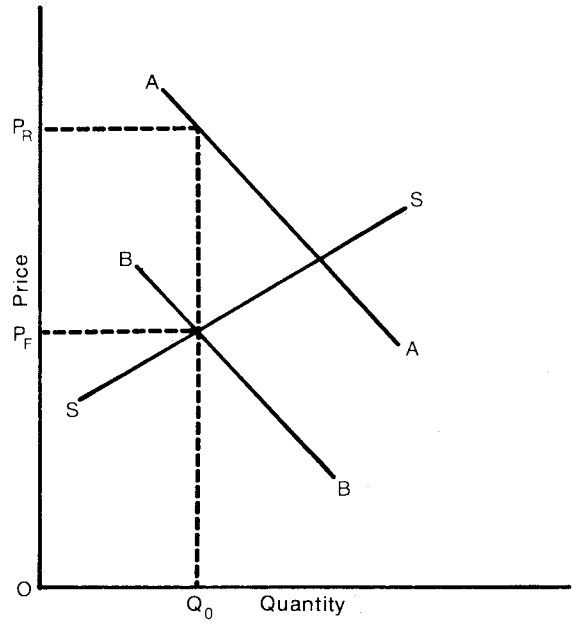


Figure 3A. Consumer and derived demand functions and the supply function with equilibrium prices and quantity

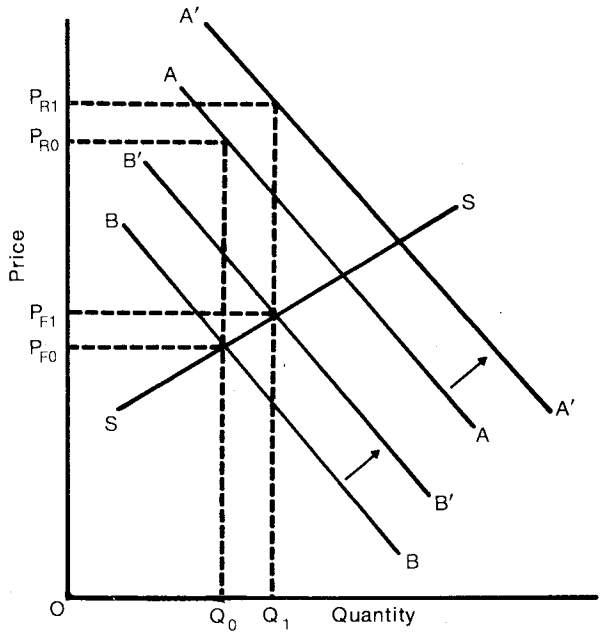


Figure 3B. Shift to the right of the consumer demand function, constant marketing margin with increases in equilibrium prices and quantity

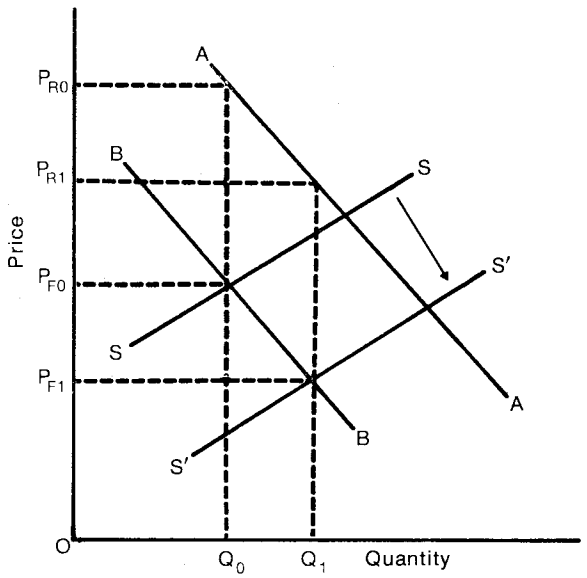


Figure 3C. Shift down to the right of the supply function with decreases in the equilibrium prices and increase in quantity

LEGEND

AA—consumer demand schedule
BB—derived demand schedule
SS—supply
P_F —equilibrium price at producer level
P_R —equilibrium price at consumer level
Q —quantity

Aggregate supply of a commodity is the horizontal summation of the supply schedules of all producers. The aggregate schedule will shift as the number of producers or their output increases. The schedule still can shift to the right even if the number of producers decrease, as long as the remaining producers increase their supplies enough to offset the supply lost by producers leaving the industry.

The ultimate effect of such shifts upon equilibrium prices and quantities depends on the price elasticity of supply and demand in the area of shift. Price elasticity is "the percentage change in quantity divided by the percentage change in price." Either supply or demand price elasticity is considered to be elastic when the percentage change in quantity is greater than the percentage change in price. An inelastic situation is just the opposite.

For supply and demand functions that are arithmetically linear, such as those in figure 3, the price elasticity is different at each point on the functions. The elasticity at any point on the function is the product of the price-quantity ratio and the value of the slope of the function (which is a constant). The price-quantity ratio decreases in value with movement down the demand function. The most elastic point is at the upper extremity and the most inelastic point is at the opposite end of the function.

The concept of price elasticity is very important in explaining changes in gross income. For example, as the supply function shifts out to the right with a fixed demand function, equilibrium price declines and quantity

increases. Gross income (price times quantity) increases until the price elasticity value becomes unitary. Further shifts in the supply function over the inelastic portion of the demand function reduce gross income.

For an industry characterized by a prolonged period of low prices, increasing output, and a moderate increase in money income, it is now possible to hypothesize the situations that would produce this situation. First, the supply function may have shifted to the right along the relatively elastic portion of the demand function. A second possibility is that the supply function shifted to the right, accompanied by a shift in a relatively inelastic demand function. Third and less probably, the demand function twisted so that it became more elastic over the lower price range, and the supply function also was twisted and shifted out and became more elastic over the lower price range. These three cases are illustrated in figure 4.

Figure 4. Supply and demand shifts that reduce price and increase quantity and income

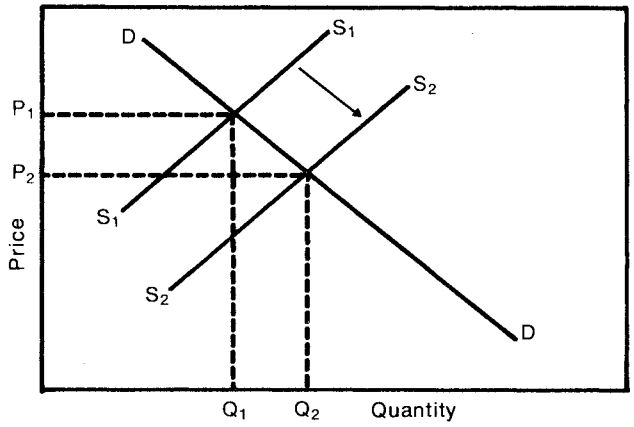


Figure 4A. Supply shifts to the right

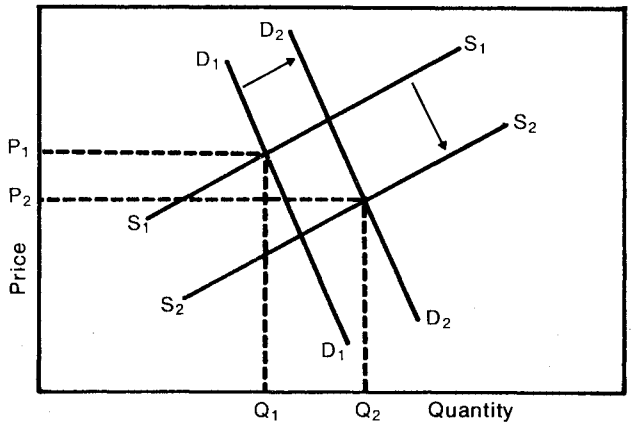


Figure 4B. Supply and demand shift to the right

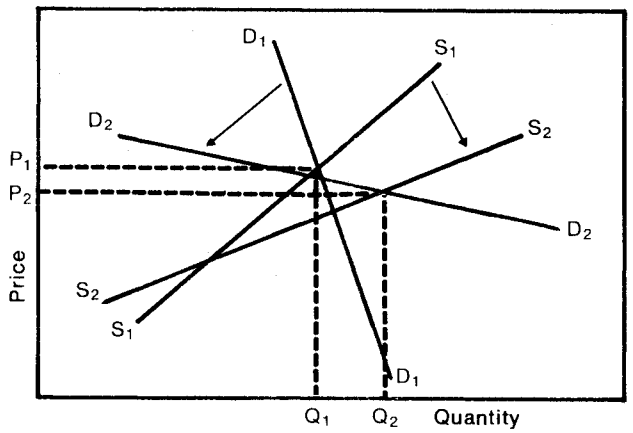


Figure 4C. A twist in the supply and demand functions

Characteristics of Turkey Supply and Demand

Demand

It is traditional to serve whole turkey in the United States on the Thanksgiving and Christmas holidays. During the rest of the year, consumption is very small in comparison. This highly seasonal demand for turkey is illustrated by consumption data from the *1965-66 Household Food Consumption Survey.*[2] A summary of the data by regions and seasons is presented in table 1.

Table 1. Per capita consumption of ready-to-cook turkey by seasons and regions in the United States, 1965-66*

Region	Season				Annual total
	Spring	Summer	Fall	Winter	
	pounds				
Northeast	1.144	0.793	3.627	1.612	7.176
North-central	0.572	0.364	2.873	0.676	4.485
South	0.351	0.247	2.561	0.585	3.744
West	0.793	1.222	3.172	0.949	6.136

* Source: "Food Consumption of Households in the U.S.," Agricultural Research Service, USDA.

During the fall months, per capita consumption as a percent of total annual consumption ranges from a low of 51 percent in the Northeastern States to a high of 68 percent in the Southern States. Per capita consumption was especially small during the spring and summer months. Annual per capita consumption by regions also varied considerably. Consumption was highest in the Northeastern States followed closely by the Western States. In the North Central and Southern States, consumption was substantially less. The differences in per capita consumption between regions undoubtedly is partly attributable to income and consumer preference.

[2] USDA, Agricultural Research Service, *Food Consumption of Households in the U.S.*, 1966, unpublished data.

The industry, aware of this seasonal demand characteristic, made several attempts to alter the consumption pattern of turkey. The purpose, of course, was to expand sales during the nonholiday season and maintain the high level of sales during the holiday period, all at favorable prices. These efforts have ranged from promotion to developing new products. Promotion was aimed in particular at the Easter market, long dominated by the pork industry.

The increasing emphasis by consumers on more convenient to prepare food forms has resulted in a variety of new turkey products including: a small whole bird called the "fryer-roaster," cut-up products such as legs, breasts, wings, and so on, and deboned or further processed items, such as rolls, roasts, pies, and frozen dinners. The industry developed and promoted the fryer-roaster with some success in the fifties. It developed other product groups during the sixties. Unfortunately, there is very little data available on the consumption of individual cut-up pieces and other processed turkey products.

Production of such product groups by processing plants under federal inspection is a matter of record.[3] By 1960, the output of fryer-roasters had reached 100 million pounds RTC (ready-to-cook). Per capita supply reached 0.5 pounds RTC annually and remained at that level during the 1960-68 period (figure 5).

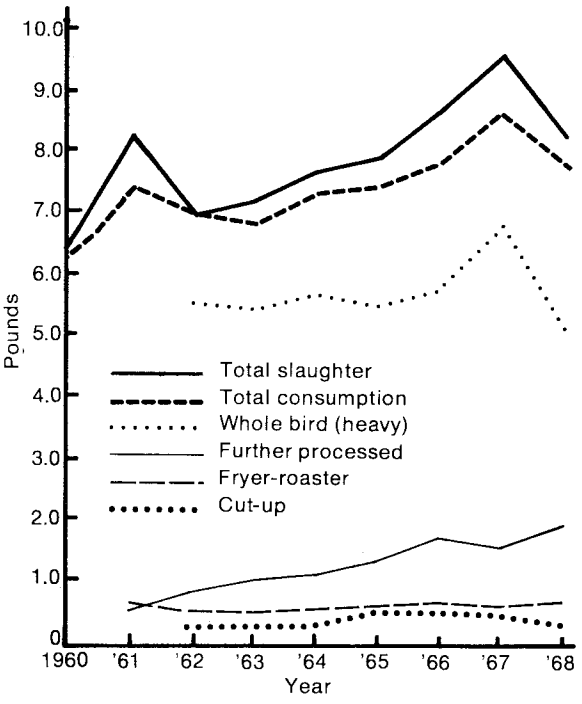
Inspection records on the quantity of turkey further processed were initiated in 1961. In that year, output was 105 million pounds RTC, equivalent to a per capita supply of 0.6 pounds RTC (figure 5). The processing industry increased the output of further processed items rapidly after that, and in 1968, processed 383 million pounds RTC, 1.9 pounds per capita, of further processed turkey items.

In 1962, record keeping began on the output of turkey cut up into parts by processing plants. Output increased from 37 million pounds RTC in 1962 to 135 million pounds RTC in 1968. In terms of annual per capita supply, output increased from 0.2 to 0.7 pounds (figure 5).

Only an approximation can be made of the quantity of heavy hens and toms processed for sale in whole bird form. Since federal inspection was not mandatory, only 87 percent of the RTC output was inspected during the 1962-68 period. For purposes of quantifying the maximum output of heavy whole turkey, it was assumed that this quantity is the difference between the total turkey slaughter and the quantity of inspected fryer-roasters, cut-up, and further processed turkey. The output of heavy whole turkey appears to have remained relatively constant, slightly in excess of one billion pounds RTC annually, except for larger quantities in 1966 and 1967. The per capita supply has remained at approximately 5.5 pounds annually (figure 5).

Trends during the 1962-68 period clearly illustrate the declining relative importance of heavy whole turkey as an accepted consumer product form. The share of total slaughter declined almost continuously from 78 percent in 1962 to 63 percent in 1968. Since the output of fryer-roasters remained relatively constant, the increase was principally in further processed forms, and to a lesser extent in cut-up items.

Figure 5. Per capita total, whole bird, further processed, cut-up, and fryer-roaster slaughter, and per capita consumption in pounds ready-to-cook, 1960-68



Source: "Poultry and Egg Situation Reports," Economic Research Service, USDA.

Domestic use of turkey parallels the increase in supply. Per capita consumption increased from 6.1 pounds RTC in 1960 to a peak of 8.6 pounds in 1967. Since exports were negligible, the increased domestic per capita consumption was entirely in the form of new convenience turkey food items.[4]

Supply

The supply of live turkeys for processing also is highly seasonal. Typically, producers purchase poults during the spring months and sell the mature birds for processing in the late summer and fall. Slaughter records indicate October is the peak processing month, followed by November and September.[5] In 1968, approximately half the slaughter occurred during these three months.

The seasonal supply pattern apparently is the result of the large demand for live turkeys by processors just prior to the important holiday market. Fortunately for

[3] USDA, Economic Research Service, *Poultry and Egg Situation*, PES-255, Feb. 1969.

[4] Turkey exports averaged 44 million pounds annually during the 1962-68 period.

[5] USDA, Economic Research Service, *Poultry and Egg Situation*, PES-258, Sept. 1969.

producers, the seasonal demand enables them to take advantage of the summer for growing-out turkeys on range. This production practice eliminates the need for a large investment and high operating costs for confinement rearing.

The highly seasonal production of turkeys, along with a less seasonal demand, require a large-scale storage operation to prevent extreme seasonal fluctuations in the farm and consumer price levels. Since processed turkey can be frozen and stored for a number of months with little quality loss, a substantial proportion of each year's output is marketed in this form. The quantity of turkey in cold storage is at a peak at the end of October and declines to a low the following June or July. At their peak, storage inventories often are equivalent to a large proportion of the total annual production, especially in those years of large supplies. During the 1960-68 period, the quantity in storage each November 1 ranged from a low of 282 million pounds RTC in 1960 to a high of 551 million pounds RTC in 1967, and averaged 391 million pounds annually.[6] The low point each July ranged from 67 million pounds RTC in 1960 to a high of 185 million pounds RTC in 1968. The average was 106 million pounds annually.

Poultry producers have been subject to numerous technological developments during the past decade and a half. Rapid adoption of new techniques has resulted in increased efficiency and reductions in unit costs, and provided a stimulus to increase production. For turkeys, advancements in genetics, nutrition, and disease control enable larger birds to be produced in a shorter period of time with less feed. Feed conversion, the pounds of feed required to produce a pound of meat, declined from an average of 4.85 pounds in 1950-54 period to 4.15 pounds in 1965-66 period.[7]

Input supplying industry advancements that lower input prices provide additional incentive to increase production. For example, poult prices on the average declined throughout the sixties, and the decrease amounted to about 4.5 cents a poult, or 7 percent between 1960 and 1968. There was also a slight downward trend in manufactured turkey grower feed prices nationally. The price decreases for the two primary production inputs probably reflect some improvement in the efficiency of producing and distributing feed and poults.

Processing firms also experienced a marked increase in coordinated production of turkeys. Contracts reduce the risks associated with future price changes and provide both a base price to producers and a guaranteed supply to processors. Gallimore estimated that between 60 and 70 percent of the turkeys produced in the 1961-62 period were grown under some form of contractual arrangement.[8]

Other advancements, including labor saving equipment, have encouraged producers to increase the size of their operations and further reduce unit production costs. A California study revealed that there are important economies to size in production.[9] The average annual total unit cost of a single brood, with a 9.75 percent mortality rate and moderate growth rate, declines from 24 cents a pound for a 5,000 bird flock to 22.5 cents a pound for a 100,000 bird flock produced on range. About 75 percent of the savings can be realized by an operation annually producing 25,000 birds in a single flock.

It should not come as any surprise that production has become increasingly specialized, with a substantial reduction in the number of producers. Between 1959 and 1964, when the last U.S. Agricultural Census was published, the number of producers declined from 87,000 to 42,000 and in 1964, only 4,500 producers produced 95 percent of the turkeys.[10] The next census should reveal further reductions in the number of producers.

Production is concentrated in a few geographically dispersed states. Typically, Minnesota and California together produce between 25 and 30 percent of the total (table 2). The top ten producing states generally account for 70 to 75 percent of the nation's turkey supply.

A significant shift in the geographic location of production occurred during the sixties. Production did not increase very rapidly in the northern producing states while output rose substantially in the South. By 1968, Arkansas, North Carolina, Texas, and Virginia produced 25 percent of the total.

Statistical Analysis

The Model

The purpose of the statistical analysis was to investigate the shifts in the supply and/or demand functions that would explain the price situation that occurred during the 1960-67 period. The 8-year period was divided into two 4-year periods, 1960-63 and 1964-67, and the quarterly supply and demand functions were determined for each. The respective function for each period was compared to another function for the same quarter, but quantified for the 8-year period. Appropriate tests were made to determine whether the 4-year period quarterly function differed significantly from the 8-year function.

Considering the possible results, demand was determined on both a per capita and aggregate basis. The rea-

[6] op. cit., PES-258.

[7] USDA, Economic Research Service, *Poultry and Egg Situation*, PES-244, Nov. 1966.

[8] Gallimore, W. W., *Contracting and Other Integrating Arrangements in the Turkey Industry*, USDA, Economic Research Service, MRR 734, Nov. 1965.

[9] Eidman, V. R., G. W. Dean, and H. D. Carter, *Economies to Scale in California Turkey Production*, Berkeley, University of California Agricultural Experiment Station Research Report 298, Aug. 1968.

[10] U.S. Dept. of Commerce, Bureau of the Census, *1964 U.S. Census of Agriculture, Livestock, Poultry, and Livestock and Poultry Products*, vol. 2, chapter 2, 1967.

Table 2. The ten major turkey producing states, 1960 and 1968

1960			1968		
Rank	State	Production in millions of pounds	Rank	State	Production in millions of pounds
1.	California	281.1	1.	California	283.4
2.	Minnesota	224.6	2.	Minnesota	261.0
3.	Iowa	138.1	3.	Missouri	180.9
4.	Missouri	80.1	4.	North Carolina	154.6
5.	Texas	74.2	5.	Texas	144.0
6.	Wisconsin	61.7	6.	Arkansas	134.0
7.	Indiana	58.4	7.	Iowa	116.3
8.	Utah	56.8	8.	Utah	74.7
9.	Ohio	52.2	9.	Ohio	73.7
10.	Virginia	49.8	10.	Wisconsin	71.4
Total for ten states		1,077.0			1,494.0
Total for U.S.		1,488.6			2,011.2
Percent ten states of U.S. total		72			74

Source: U.S. Department of Agriculture, "Production, Disposition, and Gross Income for Turkeys," SRS, S.B. 396, 1967 and POU 3-1 (69).

son was that a per capita demand function might be stable over the full period, while population growth might shift the aggregate function.

Per capita quantity demanded at the producer level was hypothesized to be a function of the farm price, price of red meat substitutes, and per capita consumer disposable income. The aggregate quantity demanded was assumed to be a function of the price of turkey at the farm, total disposable income, the consumer price index of red meats, and population.

Turkey production requires from 5 to 6 months to grow-out to the desired market weights. Consequently, producers must make their decisions about how many poults to purchase months in advance of the traditional late summer-early fall marketing season. Experience with production costs, prices, and net returns for the last flock produced is customarily the basis for making this decision. But predictions about these items and knowledge about cold storage inventory levels also are introduced into the decision-making process. Once the poults are purchased, producers cannot readily alter the number of head until the birds reach an acceptable weight, either as fryer-roasters or heavier market classes.

For the aggregate supply function, the quantity supplied in any calendar quarter is assumed to be a function of time and three variables: turkey output, the turkey feed-price ratio, and the quantity in storage, the values of which are for the same quarter of the preceding year.

Regression analysis was used to estimate the functions.[11] The stability problem of whether the quarterly per capita demand and aggregate supply functions belonged to the same demand and supply functions was resolved statistically by covariance analysis.

Results

The analytical results indicate that the quarterly per capita demand functions remained stable over the 8-year period at the producer level, despite industry efforts to expand consumer demand. Whether or not the turkey industry was successful in its efforts to expand demand is a matter of conjecture. The shift in processed output to more further processed and cut-up product forms probably increased marketing costs, especially processing, and therefore the marketing margin. Since the demand functions at the producer level were stable, and if the marketing margin did increase, it would be a reasonable conclusion that consumer demand did expand. But the larger margin negated the effect at the producer level. Unfortunately, the lack of price and margin data prevents an analysis.

Aggregate demand analysis for turkey at the farm level revealed that population was an insignificant variable in explaining the quantity demanded. This result was not unexpected since the increase in population between the midpoints of the two periods was relatively small, approximately 5 million or 2.7 percent.

Price elasticities of demand for the per capita and revised aggregate demand functions are presented in table 3. The values are slightly greater for the aggregate, as would be expected. The elasticities are very inelastic for the first and fourth quarters and about unitary for the other two. Consequently, increases in producer output and sales in the first and fourth quarters would result in a lower producer income and only a constant or slightly higher income in the other two.

Analysis of the aggregate supply revealed that there were significant quarterly shifts between periods. The supply functions shifted down and to the right in each quarter with the greatest shift in the third followed in order by the fourth, second, and first quarters.

Table 3. Price elasticities for per capita and aggregate demand functions by quarters

	Quarters			
Function	1	2	3	4
Per capita	— .36*	— .99	— .90	— .45
Aggregate	— .46	— 1.01	— 1.10	— .47

* For a one percent increase in price, per capita quantity demanded decreases .36 of a percent.

Figure 6 illustrates the aggregate supply and demand functions by quarters. The quantities demanded are

[11] See Appendix for a description of the model and results.

plotted as a function of price, while the quantities supplied are a function of the turkey feed-price ratio.[12] The demand function is for the 1960-67 period while there are supply functions for the 1960-63 and 1964-67 periods in each quarter.

The decrease in the already deflated producer price of turkey in the 1960-67 period was primarily a result of increasing supply. The industry's efforts to expand demand did not significantly alter the derived demand function at the producer level. The industry may have been successful in expanding consumer demand, but possible increased marketing costs for the new products prevented a shift in the derived demand function.

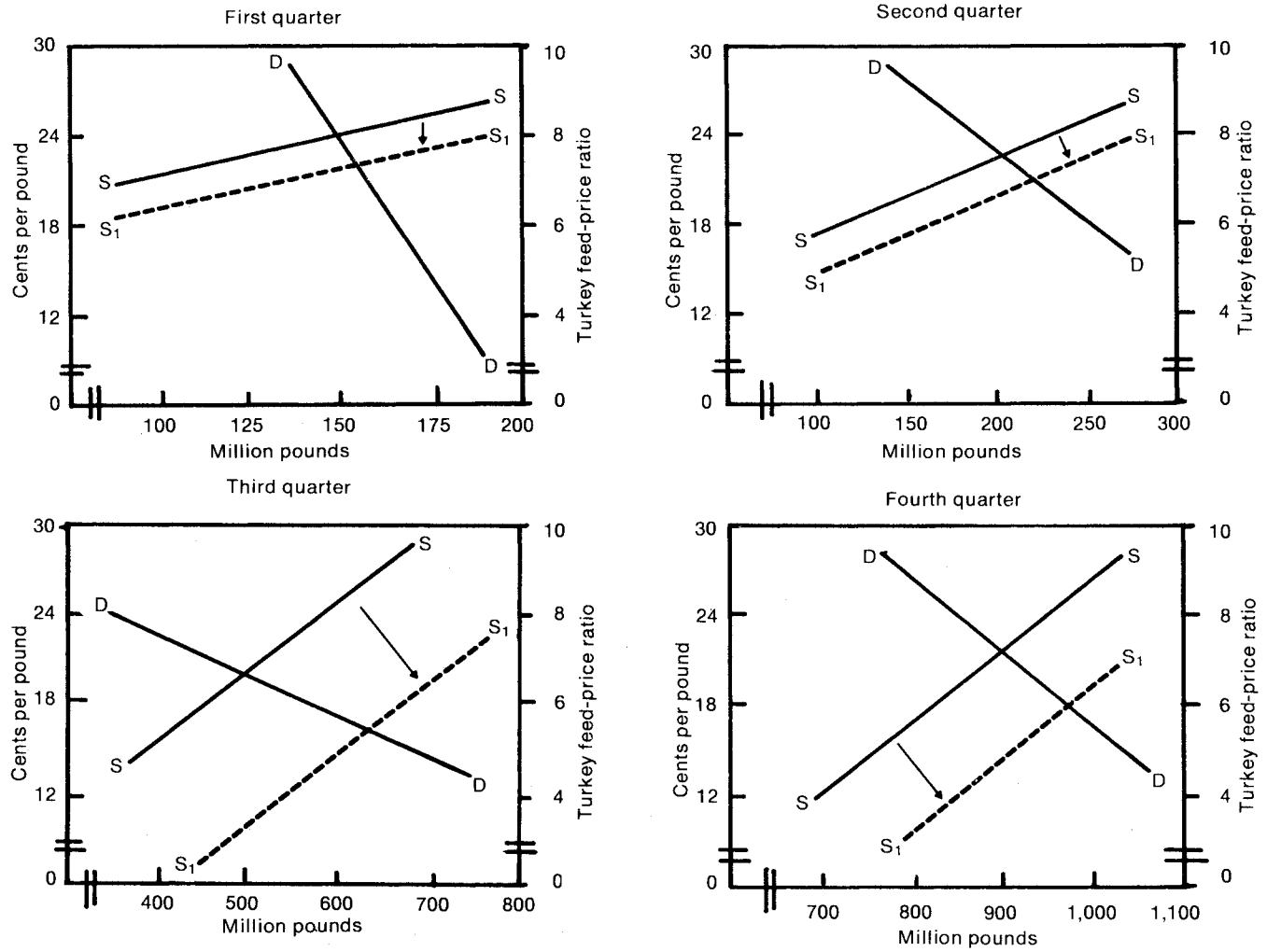
A Market Quota Program

The problem of increasing output, of declining and unstable prices, and of low income during the late fifties and very early sixties resulted in a proposal for a turkey market order in 1961. The purpose of the order was to implement controls on output in order to improve and stabilize producer prices and incomes. But the referendum for adoption held in 1962 was defeated, and output continued to increase while prices and income remained at low levels.

Producers are now well aware of the economic consequences and undoubtedly express some interest in what the economic benefits might have been with the order. To answer this question, a hypothetical supply control program was designed and estimated prices and incomes for the years 1964-68, using some of the data derived from the statistical analysis. The year 1963 was assumed as the base year with production of 1,686 million pounds. Inventory levels by quarters are the same as those for 1963: 153.4, 88.6, 251.4, and 217.5 million pounds RTC in the first through fourth quarters respectively.

The supply quota for each quarter of each year was

Figure 6. The aggregate demand and supply functions for turkey by quarters



[12] The price is deflated by the Consumer Price Index and the feed ratio is logged for one year. All other variables are fixed at their mean value.

estimated by the following procedure. The percentage increase in per capita real disposable income between two consecutive years is multiplied by the respective income elasticity of the demand coefficient estimated in the per capita demand analysis.[13] This product is added to 1 plus the percentage increase in population between the same 2 years. This figure is multiplied by the output in the same quarter of the previous year to obtain the output quota of the following year.[14]

The total quantity is assumed to be allotted to producers and this amount is produced. The results from 1964 to 1968 in terms of output, price, and gross income in both the hypothetical program and in reality are presented in table 4.

Table 4. A comparison of production, prices, and gross producer income under a hypothetical supply control program and actual results, 1964-68

Year	Supply Program			Actual		
	Production*	Price†	Gross income	Production	Price	Gross income‡
	million pounds	cents	million dollars	million pounds	cents	million dollars
1964	1,772	22.2	393.4	1,826	21.0	383.5
1965	1,856	24.1	447.3	1,915	22.2	425.1
1966	1,929	24.7	476.5	2,105	23.1	486.3
1967	1,986	23.8	472.7	2,351	19.5	458.5
1968	2,042	24.3	496.2	2,019	20.5	414.5

* Production is determined by the method outlined in footnote 13.
† Price is calculated from the demand equation for each quarter and the average price is weighted by quantity produced for each quarter.
‡ Gross income equals production multiplied by average price.

Under the hypothetical market order program, output was less than in reality in all years except 1968, and the average reduction was about 6 percent, or 125 million pounds annually. The hypothetically realized price averaged about 2.5 cents a pound higher, and was greater than in reality in all years by amounts ranging from 1.2 to 4.3 cents a pound. Gross producer income was higher under the program by an average of 10.5 percent and exceeded actual income in all years except 1966. Over the 5-year period, producers realized an additional 118 million dollars under the quota program, or an average of 23.6 million dollars annually. The greatest difference between actual and quota income was in 1968 when the program resulted in an additional 83 million dollars.

It is essential to note that for several reasons, producer increases in net revenue would not be equivalent to the increases in gross income. First, administration costs for such a program would be in addition to the routine production costs. Second, and more important, such programs tend to slow the adoption of new technology, especially technology that reduces cost with increased operating size. Producers cannot readily expand size unless they can purchase additional quotas or obtain them through administrative allocation. Consequently, the realized increase in net income could be substantially less than the increase in gross income over time.

Whether the proposed market order would have been administered in such a way to provide results similar to the hypothetical program will never be known. But, the program in all likelihood would have resulted in more stable and higher farm turkey prices, reduced output, and a higher aggregate producer income.

Summary and Conclusions

Turkey output continued to increase considerably during the decade of the sixties, and farm price and producer income remained low, compared to previous years. This situation prevailed despite industry efforts to expand consumer demand by developing and promoting new products. Consumption of the new products has increased and total consumption increased from 6.1 pounds in 1960 to 8.6 pounds per capita in 1967.

The price problem was considered to be caused by one of two possible situations. It was hypothesized that (1) the demand for turkey at the farm level did expand but supply also expanded, or (2) only supply expanded. Either situation would increase output but keep prices and incomes at depressed levels.

An analytical procedure was developed to test the hypotheses by comparing the functions in each of two periods, 1960-63 and 1964-67, by calendar quarters. The statistical analysis of both per capita and aggregate demand functions at the producer level revealed that there was not a significant shift or expansion, indicating that the demand expansion efforts at the consumer level were not transmitted back to the producer level. However, supply had expanded significantly, particularly in the last two quarters of the year.

Price elasticities of demand were found to be very inelastic in the first and fourth quarters but near unity in the other two. Increases in supply would tend to reduce income in the first and fourth quarters and possibly increase producer income in the other two.

A second objective was to investigate the impact on

[13] For example, output needed in the first quarter of 1964 is equal to
$82.8\ [1 + ((.01586 \div (.0505 \times .8534))] = 87.69$ million lbs.

The computed income elasticity of demand for turkey is: .8534, .4534, 1.3102, and .2804 for the first, second, third, and fourth quarters respectively. Income elasticity of demand for turkey is the proportional change in quantity demanded in response to proportional change in real income. For example, income elasticity in the first quarter is .85; this means that the quantity of turkey demanded in the first quarter at a given price will increase by .85 percent for a 1 percent increase in real income. See Appendix Table 4.

[14] The authors recognize the effect of price changes of substitute meats on turkey consumption. However, these substitutes are omitted in the analysis because the estimated coefficients for the deflated consumer price index of red meats do not differ from zero at acceptable probability levels for the first three quarters of the year. The cross elasticity coefficient is .54 for the fourth quarter and is significant. This means a 5 percent increase in the deflated consumer price index of red meats will increase turkey consumption 2.7 percent or about 0.1 pound per capita. This is equivalent to a 1 percent increase in the aggregate. Consequently, changes in the red meat consumer price index are ignored because very large changes are required to significantly alter the quantity of turkey demanded.

price and income of a supply control program similar to the one defeated by producers in a national referendum in 1962. The hypothetical program indicated the farm price would have averaged 2.5 cents a pound higher than in reality, and annual gross producer income would have averaged 23.6 million dollars higher each year from 1964 through 1968. However, administrative costs and quota controls that would inhibit adoption of new cost-reducing technology would result in net income increases of less than the increases in gross incomes.

APPENDIX

Statistical Analysis

The Model

Quarterly turkey demand functions were estimated for the periods 1960-63 and 1964-67. It was hypothesized that turkey consumption is influenced by (1) the price of turkey at the farm level, (2) consumer disposable income, and (3) the price of substitute meats. The mathematical model is:

$C_{it} = a_o + b_o PT_{it} + b_1 PT_{2it} + b_2 PT_{3it} + b_3 PT_{4it} + b_4 Y_{it} + b_5 Y_{2it} + b_6 Y_{3it} + b_7 Y_{4it} + b_8 PS_{it} + b_9 PS_{2it} + b_{10} PS_{3it} + b_{11} PS_{4it} + b_{12} I_{it} + U_{it}$

where:

i = 1, 2, 3, 4 quarters
t = 1, 2, 3, 4 years
C is the per capita consumption of turkey
PT is farm price per pound of turkey, deflated by Bureau of Labor and Statistics Consumer Price Index (1957-59 = 100), CPI
$PT_{2it} = PT_{2t}$ when i = 2 and o otherwise
$PT_{3it} = PT_{3t}$ when i = 3 and o otherwise
$PT_{4it} = PT_{4t}$ when i = 4 and o otherwise
Y is per capita disposable income deflated by CPI
$Y_{2it} = Y_{2t}$ when i = 2 and o otherwise
$Y_{3it} = Y_{3t}$ when i = 3 and o otherwise
$Y_{4it} = Y_{4t}$ when i = 4 and o otherwise
PS is price of a substitute = consumer price index of red meats
$PS_{2it} = PS_{2t}$ when i = 2 and o otherwise
$PS_{3it} = PS_{3t}$ when i = 3 and o otherwise
$PS_{4it} = PS_{4t}$ when i = 4 and o otherwise
$I_i = 1$ when i = 4 and o otherwise
U is a random disturbance term

It was postulated that the current production of turkey is influenced by (1) production in a previous period, (2) the turkey-feed price ratio in the preceding year, pounds of feed equal in value to 1 pound of turkey, (3) time, and (4) cold storage holdings of turkey. The mathematical model is:

$S_{it} = c_o + d_1 LS_{it} + d_2 LR_{it} + d_3 T_{it} + d_4 LN_{it} + b_5 I_{2it} + b_6 I_{3it} + b_7 I_{4it} + U_{it}$

where:

i = 1, 2, 3, 4 quarters
t = 1, 2, 3, 4 years
S is production of turkey million pounds
LS is production lagged one year
LR is turkey-feed price ratio lagged one year
T is time
LN is cold storage holdings of turkey lagged one year
$I_{2it} = 1$ when i = 2 and o otherwise
$I_{3it} = 1$ when i = 3 and o otherwise
$I_{4it} = 1$ when i = 4 and o otherwise
U is a random disturbance term

This supply relation was estimated for the two periods 1960-63 and 1964-67. The question arises as to whether the demand and supply relations remain stable in the two periods. This question can be answered statistically by testing whether the observations for the two periods can be regarded as belonging to the same demand or supply equations. In order to accomplish this test, the data were pooled from 1960 to 1967 and estimated the hypothesized demand and supply functions. An F test was used, to test the hypothesis that both samples belong to the same regression.[15] To perform the analysis of covariance, the following sums of squares are needed:

A equals sum of squares of n + m deviations of the dependent variable from the regression estimated by n + m observations with n + m − p degrees of freedom.

B equals sum of squares of n deviations of the dependent variable from the regression estimated by the first n observations, with n − p degrees of freedom.

C equals sum of squares of m deviations of the dependent variable from the regression estimated by the second m observations, with m − p degrees of freedom. Then the ratio

$$F_{(p,\ n+m-2p)} = \frac{A - B - C/p}{(B + C) / (n + m - 2p)}$$

will be distributed as F (p, n + m − 2p) under the null hypothesis that both observation groups belong to the same regression model.

Results

The empirical results for supply and demand are summarized in tables 1 and 2. For testing the demand function, the sum of squares A is .079523, and B + C is .004826. The ratio F (14,4) is therefore 4.42. In order to interpret the 1964-67 observations as coming from a different structure at the 5 percent level of significance, F would have to be at least 5.88. The differences obtained in the coefficient estimates were due to chance. The hypothesis that there has been a significant shift in the demand function between the two periods is not accepted. In other words, it could be concluded that there has been no significant shift in demand for turkey between 1960-63 and 1964-67 periods.

[15] For further discussion of the test, see Chow, E. C., *Tests of Equality Between Sets of Coefficients in Two Linear Regressions*, Econometrica 28: 591-605; and Johnston, J., *Econometric Methods*, New York, McGraw-Hill Book Co., Inc., 1963.

Appendix table 1. Principal statistical estimates of quarterly demand for turkey from 1960 to 1963, and from 1964 to 1967, United States

Period	Dependent variable	R^2	Constant term	Regression coefficients and their standard errors*							
				PT_{1t}	PT_{2t}	PT_{3t}	PT_{4t}	Y_{1t}	Y_{2t}	Y_{3t}	Y_{4t}
1960-63	C_{1t}	.9999	5.9597	—.0265‡	.0007	—.0507‡	—.0560‡	—.0011	—.0006	.0005	.0026‡
				(.0077)	(.0078)	(.0084)	(.0062)	(.0005)	(.0003)	(.0003)	(.0004)
1964-67	C_{1t}	.9999	.4189	—.0120	—.0441	—.0477	—.0694	.0004	.0005	.0012†	.0007
				(.0357)	(.0260)	(.0332)	(.0438)	(.0004)	(.0004)	(.0005)	(.0007)
1960-67	C_{1t}	.9986	.6616	—.0113	—.0349‡	—.0681§	—.0765§	.00028	—.00007	.0008§	.00025
				(.0108)	(.0164)	(.0210)	(.0156)	(.00018)	(.00026)	(.0003)	(.00025)
Aggregate 1960-67	C_{1t} x population	.9997	114,754.88	—2,733.59†	—4,263.26†	—13,865.40§	—13,931.27§‖	31,480.86§‖	—16,525.34‖	76,908.83§‖	46,381.03§‖
				(1,522.25)	(2,241.05)	(2,703.78)	(2,023.24)	(8,333.54)	(11,923.09)	(12,723.61)	(12,131.60)

Period	PS_{1t}	PS_{2t}	PS_{3t}	PS_{4t}	I_{4t}	Sum squares of residuals	Degrees of freedom
1960-63	—.0293	.0137	.0092	.0615‡	—6.5713‡	.001021	2
	(.0118)	(.0064)	(.0065)	(.0092)	(1.2875)		
1964-67	—.0033	.0007	—.0057	.0179	1.4957	.003805	2
	(.0097)	(.0110)	(.0146)	(.0175)	(1.1359)		
1960-67	—.0033	.01196	.00694	.0256‡	1.8009†	.079523	18
	(.0056)	(.00800)	(.00904)	(.0111)	(.9144)		
Aggregate 1960-67	—546.83	2,070.92	1,594.12	4,965.37§	228,324.87†		18
	(703.31)	(1,310.83)	(1,286.29)	(1,319.67)	(141,201.36)		

* The estimated standard errors appear in parentheses below each coefficient.
† Significantly different from zero at the 10 percent probability level.
‡ Significantly different from zero at the 5 percent probability level.
§ Significantly different from zero at the 1 percent probability level.
‖ Y_{1t} is disposable income divided by CPI.

The same method was used for the supply function. A turns out to be 52,153.600 and B + C is 20,964.780; the ratio F (8,16) is 2.98. If the 1964-67 observations for the supply function are coming from a different structure at the 5 percent level of significance, F would have to be at least 2.60. Therefore, the null hypothesis that the supply function of turkey from 1964 to 1967 is not governed by the same relationship as it is from 1960 to 1963, was accepted. In other words, the supply function has shifted to the right while the demand curve has not changed.

The estimated relationship for the demand function for the period 1960 to 1967 by quarters are:

First quarter:

$.66157 - .01133\ PT_{1t} + .00028\ Y_{1t} - .0033\ PS_{1t}$

Second quarter:

$.66157 - .04623\ PT_{2t} + .00021\ Y_{2t} + .00866\ PS_{2t}$

Third quarter:

$.66157 - .07943\ PT_{3t} + .00108\ Y_{3t} + .00364\ PS_{3t}$

Fourth quarter:

$2.46247 - .08783\ PT_{4t} + .00053\ Y_{4t} + .02230\ PS_{4t}$

The supply function for 1960 to 1963 is different from that of 1964 to 1967. The first quarter supply is:

$-520.1032 - .4734\ LS_{1t} + 63.4230\ LR_{1t} + .5266\ T_{1t} + 1.5399\ LN_{1t}$

The same relation holds for the other quarters except for the intercept which is:

— 331.4132 for the second quarter, 58.5768 for the third quarter and 544.3968 for the fourth quarter.

The second period first quarter supply is:

$-373.6518 + 1.4042\ LS_{1t} + 57.6540\ LR_{1t} - 2.0924\ T_{1t} - .0489\ LN_{1t}$

The intercepts for the second, third, and fourth quarters are — 382.3883, — 509.7218, and — 685.8018 respectively.

Appendix table 3. Percentage increase in population and real income 1964-69*

Year	Percentage increase	
	Population	Real income
1964	1.586	5.05
1965	1.301	4.92
1966	1.182	3.80
1967	1.117	2.57
1968	1.055	2.46
1969†	1.000	2.30

* Real income means the purchasing power of consumer income. If consumer income remains constant while prices increased, the consumer's purchasing power declines. Real income is obtained by dividing per capita disposable income by the general price level, Consumer Price Index for all items.
† 1969 percentage increase in population and income are proposed according to the trend.

Appendix table 4. Computed elasticities of demand for turkey*

Elasticity with respect to:	Quarter			
	1	2	3	4
Price .....per capita	— .3566	— .9890	— .9048	— .4461
aggregate	— .4592	— 1.0147	— 1.1005	— .4699
Income ....per capita	.8534	.4534	1.3102	.2804
aggregate	1.0775	.4866	1.4129	.3142

* The point elasticity was calculated using the formula:

$$\frac{\text{Change in quantity demanded}}{\text{Change in price or income}} \times \frac{\text{Average of price or income}}{\text{Average of consumption}}$$

For example, demand elasticity in the first quarter =

$$-.0113 \times \frac{21.2452}{.6750} = -.3566$$

Appendix table 2. Principal statistical estimates of quarterly turkey supply, 1960-63, 1964-67, and 1960-67, United States

Period	Dependent variable	R^2	Constant term	Regression coefficients and their standard errors*							Sum squares of the residuals	Degrees of freedom
				LS_{it}	LR_{it}	T_{it}	LN_{it}	I_{2it}	I_{3it}	I_{4it}		
1960-63	S_{it}	.9906	— 520.1032	— .4734 (.3839)	63.4230‡ (27.2840)	.5266 (4.4392)	1.5399 (1.0000)	188.6900‡ (81.6800)	578.6800§ (117.8800)	1064.5000§ (262.5500)	15,279.000	8
1964-67	S_{it}	.9976	— 373.6518	1.4042§ (.3743)	57.6540 (46.8030)	— 2.0924 (4.2513)	— .0490 (.4981)	— 8.7365 (46.6380)	— 136.0700 (188.8800)	— 312.1500 (302.5100)	5,685.780	8
1960-67	S_{it}	.9872	— 413.4892	.6347§ (.2048)	54.6710‡ (22.0950)	3.9946§ (1.1912)	.1794 (.5180)	49.7050 (46.9990)	247.9200§ (80.5980)	297.5400† (146.5000)	52,153.600	24

* The estimated standard errors appear in parentheses below each coefficient.
† Significantly different from zero at the 10 percent probability level.
‡ Significantly different from zero at the 5 percent probability level.
§ Significantly different from zero at the 1 percent probability level.