

# Factors Affecting Pecan Prices and Price Relationship in the United States

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# Factors Affecting Pecan Prices and Price Relationships in the United States

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Pecan production varies widely from year to year in the United States and the crop is marketed under highly uncertain conditions. These wide year-to-year production fluctuations, coupled with a relatively stable demand, cause sharp year-to-year changes in prices received by pecan growers.

This bulletin reports results of a study to analyze and define the major factors involved in pecan prices and price relationships in the United States and to outline methods to more accurately estimate yearly pecan prices from available information.

## Objectives and Procedures

The general hypothesis was that the characteristic variations in production, the uncertainty associated with demand and supply conditions, and the lapse of time between purchase of inshell pecans and sale of shelled pecans by shellers have a marked influence on prices and price relationships—and thus on price margins—in the pecan market.

This study had three specific objectives: (1) To present a model of price determination in the pecan market and discuss some specific hypotheses regarding factors affecting prices and price relationships implicit in the model; (2) To analyze the primary factors affecting the average annual farm price for pecans to ascertain the extent to which early-season monthly forecasts of production can be used to forecast the farm price and the effects of variations in the farm-wholesale price margin on the farm price; and (3) To analyze the relationship between farm and wholesale prices to estimate the effect of differences between forecasts and final production on the farm-wholesale price margin and on wholesale prices directly.

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## The Model and The Hypotheses

A model, or mental conception, was constructed of the price making mechanism in the pecan market to analyze its operating characteristics. The basic purpose of the model is to establish specific hypotheses to be tested regarding the strategic determinants of prices received by growers for pecans and the farm-wholesale price spread or margin. The hypotheses are then subjected to statistical test.

### EFFECT OF FORECAST ON FARM PRICE

Theoretically, prices received by growers for pecans are determined by the interaction of the demand for and supply of pecans at the farm level, *i.e.*, at the point of first sale. On the supply side, production in any given year is fixed and independent of price. Since growers do not typically store pecans from year to year in appreciable quantities, farm supply for any particular year is also fixed and independent of price. Although production (and farm supply) is fixed, there is nevertheless a great deal of uncertainty about the actual size of the crop at the time growers are harvesting and selling pecans. Presumably, however, the monthly production forecasts issued August through December by the Crop Reporting Board of the U. S. Department of Agriculture provide the best information available as to the probable size of the crop during the farm marketing season.

On the demand side, more than 80 percent of the pecans marketed annually in recent years usually have been shelled commercially. Therefore, the demand for pecans at the farm level is derived directly and primarily from the wholesale demand for shelled pecans facing pecan shellers.<sup>1</sup> Conceptually, the farm demand is derived from the wholesale demand for shelled pecans by subtracting unit marketing margins. The actual margin consists of charges for processing and distribution plus realized profits per unit of product moving through commercial shellers. Over the long run, and with reasonably effective competition, the margin would be expected to approximate actual costs including a "normal profit" per unit of product handled.

The model is illustrated in Figure 1 from which an explanation of price determination at the farm level emerges. In the diagram,  $P_w$  and  $P_f$  refer to the wholesale price per pound for shelled pecans and the

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<sup>1</sup>Actually only a relatively small proportion of the inshell pecans purchased by shellers are obtained directly from growers. However, in the following discussion the "accumulators margin" is considered a part of the farm-wholesale price spread, *i.e.*, it is assumed that shellers purchase all pecans directly from the grower. This does not affect the validity of the analysis.

farm price per pound for inshell pecans, respectively, with the wholesale price adjusted to an inshell basis. Also  $Q_f$  refers to the quantity of new crop pecans offered for sale (i.e., production). The wholesale demand function,  $D_w$ , represents the price per pound of shelled pecans, adjusted to a gross return per pound of inshell pecans, that shellers *expect* to receive for alternative quantities produced and marketed. For example, if the shell-out or conversion percentage is approximately constant, say 35 percent, the gross return per pound to the sheller at wholesale on an inshell basis would be equal to 35 percent of the wholesale price of shelled pecans. The demand curve is defined to be net of the influence of any quantities carried over from previous crops.

The farm demand curve,  $D_f$ , represents the price per pound that shellers would be willing to pay farmers for alternative quantities of inshell pecans. It is derived from the wholesale demand function by subtracting the average cost of processing and distributing a pound of inshell pecans, including a return to entrepreneurship. Thus the vertical difference between the wholesale and farm demand functions represents the "normal" price margin—the per unit costs of processing and distribution. Although the curves are drawn parallel in the diagram, indicating a constant cost per pound of inshell pecans, this is illustrative only. Actual unit costs probably vary with the quantity shelled and merchandized.

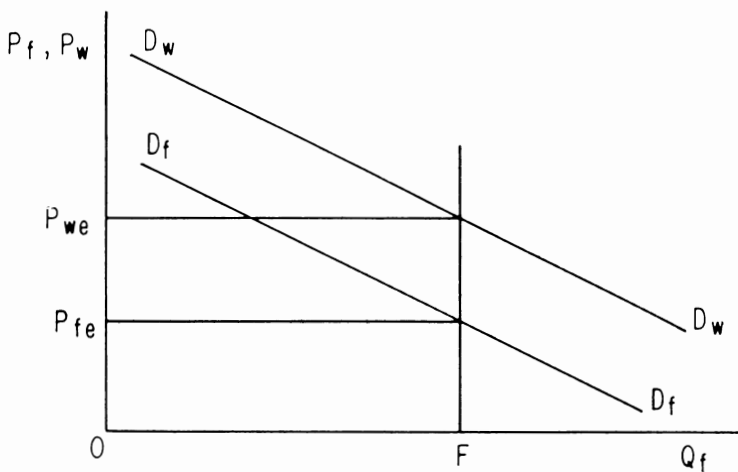


Figure 1. Illustrative model of farm price formations.

Given the model and *expected* production of F, shellers would expect the wholesale price to average  $P_{we}$  and would be willing to pay growers a price of  $P_{fe}$  per pound. Since the average annual farm price is established mainly during October, November and December, and the final estimate of production is not issued until the following July, it seems reasonable to assume that the monthly forecasts represent *expected* production and are thereby important determinants of the average annual farm price.

### EFFECT OF ERROR IN FORECAST ON FARM-WHOLESALE PRICE MARGIN

Since shellers market shelled pecans throughout the marketing year, the average annual wholesale price of shelled pecans is established, to a considerable extent, after the farm price of inshell pecans. Moreover, actual production differs frequently from the production forecasts. As a result, the actual wholesale price is likely to diverge from the expected price even if the expected wholesale demand function is realized. This is illustrated in Figure 2, which is identical to Figure 1 except that it shows two possible levels of actual production ( $Q_1$  and  $Q_2$ ) that differ from the forecast of production (F). The assumption that the expected wholesale demand schedule is realized is retained.

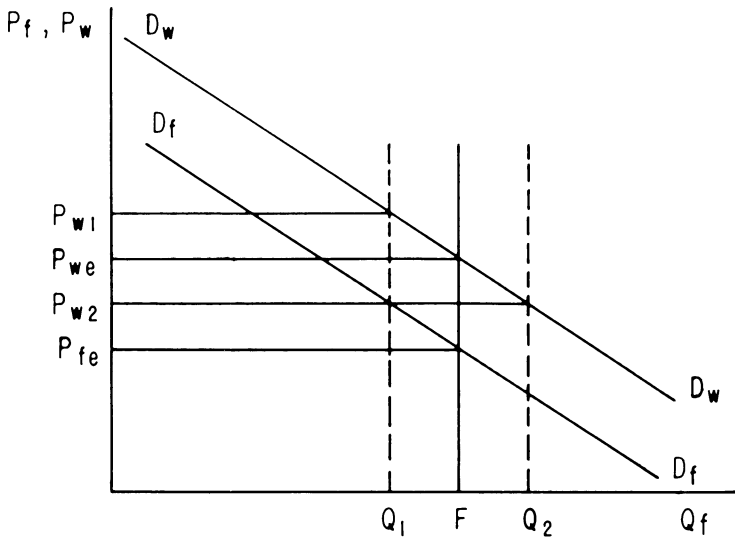


Figure 2. Illustrative model of the effect of forecast error on the farm-wholesale price margin.



Under the conditions assumed in figure 2, the farm price would be  $P_{fe}$ , as before, but the actual or realized wholesale price differs from the expected wholesale price ( $P_{we}$ ). If actual production is less than expected production, for example  $Q_1$ , then actual wholesale price ( $P_{w1}$ ) exceeds the expected price ( $P_{we}$ ), and the actual price spread ( $P_{w1} - P_{fe}$ ) exceeds the "normal" or expected spread ( $P_{we} - P_{fe}$ ). On the other hand, if actual production exceeds expected production, the actual wholesale price ( $P_{w2}$ ) will be less than expected price ( $P_{we}$ ), and the wholesale farm price spread ( $P_{w2} - P_{fe}$ ) is less than anticipated. Under these conditions, the wholesale-farm price spread in any year is, to a substantial extent, a residual and independent of actual costs.

The foregoing considerations suggest the hypothesis that annual variations in the price spread are closely related to the extent to which actual production differs from expected production (forecast).

### **EFFECT OF DIVERGENCE BETWEEN EXPECTED AND REALIZED WHOLESALE DEMAND ON FARM-WHOLESALE PRICE MARGIN**

Even when expected production and actual production are approximately equal, the realized wholesale price may differ significantly from the expected price because the expected wholesale demand function is not realized. Because of the time lapse between buying and selling of pecans by shellers, this may happen for many reasons. However, a major reason—in addition to the divergence of actual production from the forecast—is likely to be the inadequate and incomplete knowledge of shellers concerning total carryover from previous crops and general demand conditions.

The expected wholesale demand function for the current crop facing shellers is drawn on the assumption of some expected level of carryover. But the realized wholesale demand function will depend in part on the actual size of the carryover. Since the actual carryover is unknown, the realized wholesale demand function may differ from the expected function because the actual carryover diverges from expected carryover.

The effect of the divergence between the expected and realized wholesale demand function on the farm-wholesale price spread is illustrated in Figure 3, assuming that expected production (forecast) is realized. If realized wholesale demand ( $D_{w1}$ ) exceeds expected demand ( $D_w$ ), i.e., shifts to the right, then realized wholesale price ( $P_{w1}$ ) exceeds

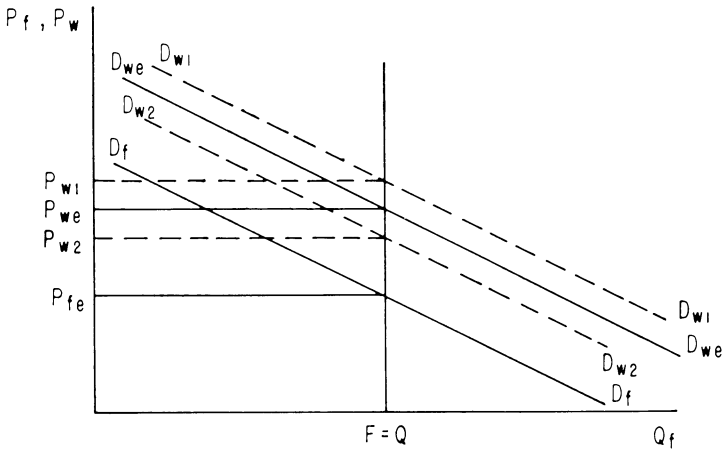


Figure 3. Illustration of the effect of a fluctuating wholesale demand schedule on the farm-wholesale price margin.

expected price ( $P_{we}$ ), and the price spread is greater than expected. The converse would occur if the realized wholesale demand schedule shifts downward or to the left relative to the expected demand schedule.

### EFFECT OF THE LAGGED FARM-WHOLESALE PRICE MARGIN ON FARM PRICE

It seems reasonable to assume that the extent of the wholesale price spread in any year is closely related to the profits (or losses) earned by shellers during that year. A wide price spread (i.e., a spread exceeding average unit costs) suggests that the actual wholesale price was greater than expected because actual production turned out to be less than expected or wholesale demand more brisk than expected. Either event would probably result in a reduction in, or a below normal carryover into the next crop year. Such a situation, together with above-normal profits and perhaps an enhanced capital and equity position, may be associated with an optimistic attitude on the part of shellers. Under such conditions, shellers may be inclined to pay growers more for their new-crop pecans than justified by potential or actual demand and supply conditions. The converse would be true in years following a narrow margin which may be associated with a build-up in carryover stocks and/or a weakening wholesale demand for shelled pecans.

These considerations lead to the hypothesis that the average price received by growers in a given year is affected by the wholesale-farm price spread in the previous year, with other factors influencing price held constant. The relation would be expected to be positive: the wider the spread, the higher the farm price; the narrower the spread, the lower the farm price.

## Statistical Analyses

### FACTORS AFFECTING FARM PRICES

This analysis of factors affecting farm prices has two major purposes: (1) to ascertain the extent to which the early-season monthly forecasts of production can be used to predict the average annual farm price, and (2) to test the hypothesis that the magnitude of the farm-wholesale price margin in one year influences the farm price in the next year.

#### The Statistical Model

Single equation least squares regression was used to estimate the relation of the average annual price received by growers for all pecans to (1) national income, (2) a time trend, (3) alternative measures of the farm supply of pecans, and (4) the farm-wholesale price margin lagged one year. The alternative measures of farm supply consisted of the production forecasts and the final estimate of production. Algebraically, the statistical model is:

$$P_{ft} = a + b_1I_t + b_2T_t + b_3M_{t-1} + b_iS_{it} + U_t$$

where  $P_{ft}$  = U.S. average annual price received by growers for all pecans (cents per pound), deflated by the CPI (1947-49 = 100)

$I_t$  = the index of disposable income per capita (1947-49 = 100), deflated by the CPI (1947-49 = 100)

$T_t$  = time in years (1937 = 1)

$M_{t-1}$  = farm-wholesale price margin lagged one year

$S_{it}$  = indicator of farm supply, i.e., either a particular monthly forecast of production (August through December) or the final estimate of production in pounds per capita ( $i = 4 \dots 9$ )

$U_t$  = an unobserved residual variable

Statistical analyses were based on annual data for the years 1937 through 1959 (Table 1). Income is for the calendar year, while price, supply and the price margin is for the crop year. Population estimates

used to convert other variables to a per capita basis are for July 1 of the indicated year.

Consumer income was included in the analysis to reflect shifts in demand due to changes in consumers' purchasing power. Price margin was included to serve as a carrier or reflector of the profit position of shellers in the preceding year. Time was included to measure continuous and systematic shifts in demand due to factors not included in the analysis. Income and supply variables were converted to a per capita

**Table 1.—Average Annual Farm Price for all Pecans and Related Variables, United States, 1937-1959<sup>1</sup>**

Years	I			S <sub>1</sub> Aug	S <sub>5</sub> Sep	S <sub>6</sub> Oct	S <sub>7</sub> Nov	S <sub>8</sub> Dec	S <sub>9</sub> Final
	P <sub>f</sub> Deflated Price	Index of Per Capita Income Deflated	M Lagged Price Margin						
	<i>Cents</i>	<i>Percent</i>	<i>Cents</i>						
				Per Capita Supply Indicators <sup>2</sup>					
				<i>Pounds</i>					
1937	12.54	72.0	8.57	0.49	0.53	0.55	0.59	0.63	0.83
1938	15.59	67.2	18.00	0.42	0.39	0.38	0.36	0.36	0.57
1939	16.33	72.6	16.14	0.48	0.47	0.46	0.46	0.47	0.74
1940	14.86	77.1	18.29	0.56	0.58	0.62	0.65	0.66	0.93
1941	16.38	88.7	14.57	0.66	0.65	0.64	0.64	0.65	0.91
1942	24.53	100.1	11.57	0.66	0.65	0.65	0.60	0.58	0.57
1943	31.08	105.8	36.15	0.72	0.72	0.77	0.77	0.84	0.97
1944	28.72	112.9	23.29	0.96	1.03	1.08	1.04	1.02	1.03
1945	31.08	112.0	26.29	1.06	1.06	1.01	0.97	0.95	0.99
1946	40.53	109.1	24.72	0.74	0.68	0.63	0.55	0.55	0.54
1947	23.66	99.2	28.43	0.74	0.71	0.70	0.72	0.70	0.83
1948	11.96	100.7	9.54	1.04	1.10	1.16	1.11	1.05	1.20
1949	18.57	100.1	31.66	0.93	0.92	0.95	0.87	0.76	0.84
1950	28.02	106.7	30.83	0.70	0.70	0.72	0.73	0.74	0.82
1951	17.84	106.3	26.30	0.83	0.87	0.95	0.96	0.93	1.02
1952	19.47	107.3	23.43	0.74	0.80	0.81	0.81	0.79	0.96
1953	14.25	110.8	21.69	1.12	1.16	1.13	1.16	1.08	1.34
1954	24.91	110.5	28.93	0.80	0.64	0.56	0.59	0.57	0.58
1955	28.73	116.2	32.46	0.43	0.49	0.54	0.55	0.59	0.89
1956	15.92	120.1	28.82	1.01	0.96	0.95	0.96	0.95	1.03
1957	19.72	120.3	31.73	0.70	0.71	0.71	0.71	0.65	0.83
1958	22.75	118.5	33.04	1.03	1.00	0.98	0.91	0.93	0.98
1959	26.00	122.5	34.72	0.78	0.75	0.73	0.70	0.72	0.81
$\bar{x}$	21.89	102.5	24.31	0.77	0.76	0.77	0.76	0.75	0.88
S	7.08	15.9	8.03	0.20	0.21	0.21	0.21	0.19	0.19

<sup>1</sup>A time trend (T), with 1937 = 1, was used in the analysis but is not shown in this table. See text for definition of variables.

<sup>2</sup>S<sub>9</sub> refers to the final estimate of production.

Source: The index of per capita deflated income is from AMS, USDA, Supplement for 1959 to *Consumption of Food in the United States, 1909-52* (Agricultural Handbook No. 62), August, 1960. Other variables are computed from basic data given in the appendix.

basis to adjust for changes in population. Likewise, the price and income data were deflated by the BLS Consumer Price Index to adjust for the effect of a changing general price level.

In computing the farm-wholesale price margin, New York wholesale price quotations for shelled pecans of typical grades (usually medium halves) in wholesale containers (30-pound cartons) were used to reflect the wholesale price variable. The annual average is the average of the 12-monthly quotations beginning in October of the specified year. When quotations were not available for all months, the average is for those months for which quotations were available. The farm price is the average annual price received by farmers for all pecans by all methods of sale as reported by the Crop Reporting Board of the USDA. The farm price was then adjusted to a shelled basis by assuming a constant shell-out of 35 per cent. Thus the margin reflects the difference between the cost at the farm level and the wholesale return per pound on a shelled basis. In this sense it is a net margin. If the gross margin were used, one would expect a high and positive correlation between the farm price and the margin under equilibrium conditions when all expectations were realized.

## **Empirical Results**

Empirical results of the regression analyses are summarized in Table 2. There is one equation corresponding to each monthly forecast of production for August through December and the final estimate of production issued in the following July. The figures in parentheses below the coefficients are t-values. Coefficients of determination ( $R^2$ ) indicate the percentage of the annual variation in the deflated farm price about its average for the 1937-59 period that is "explained by," or associated with, variations in the four explanatory factors.  $S^*$  is the standard error of estimate.

The estimated regression coefficients indicate the average change in farm price associated with a change of one unit in the corresponding independent variable during the years included in the analysis when the other variables are held constant. Based on the conventional t-test, all regression coefficients are significantly different from zero at the five percent probability level or less, except for the coefficients attached to the lagged price margin in equations for September and October forecasts. These are significant at the ten percent probability level.

Coefficients attached to the income and supply variable in each equation have the expected algebraic sign. The negative sign attached to the coefficient connecting the time variable to price indicates that

with no change in supply, income, population and the general price level, the farm price of pecans tended to decrease by about 1.3 cents per year. The fact that pecan prices in terms of current dollars have increased during the period analyzed simply means that the positive influence of population, income and the general price level has more than offset the negative influence of increased production and the negative "time trend."

Of the six situations summarized in Table 2, the equation relating average annual farm price to the August forecast is least satisfactory. Only 75 percent of the annual changes in the farm price was associated with changes in the three explanatory variables. Also the regression coefficient attached to the August forecast is smaller than those attached to the other supply variables, and the t-ratio is smaller (and standard error larger). The  $R^2$  increases as each subsequent monthly forecast is utilized as the supply variable through November and then remains substantially unchanged when the December forecast and final production are utilized as the supply variable.

**Table 2.—Regression Analysis of Factors Affecting Prices Received By Growers**

Equation No.	Supply Variable	Coefficients with Respect to:					Coefficient of determination ( $R^2$ )	S*
		Constant term (a)	Income ( $b_1$ )	Time ( $b_2$ )	Supply ( $b_3$ )	Margin ( $b_4$ )		
1	August forecast ( $F_a$ )	-28.502	0.654 (4.65)	-1.313 (4.60)	-13.345 (2.12)	0.384 (2.16)	0.75	4.56
2	September forecast ( $F_s$ )	-29.553	0.697 (5.23)	-1.340 (5.05)	-15.502 (2.73)	0.327 (1.94)	0.78	4.23
3	October forecast ( $F_o$ )	-29.514	0.705 (5.73)	-1.360 (5.44)	-16.107 (3.21)	0.323 (2.05)	0.81	3.98
4	November forecast ( $F_n$ )	-27.594	0.692 (7.15)	-1.306 (6.48)	-17.547 (4.22)	0.311 (2.42)	0.84	3.25
5	December forecast ( $F_d$ )	-28.255	0.708 (6.17)	-1.378 (5.82)	-18.938 (3.62)	0.340 (2.32)	0.83	3.76
6	Final estimate of production (Q)	-16.779	0.572 (6.56)	-1.194 (5.84)	-16.321 (4.27)	0.360 (2.88)	0.83	3.25

The regression coefficients attached to the forecasts increase through December and those relating to the November and December forecasts are both larger than the coefficient attached to the final estimate of production.

The results of the analysis show that forecasts of the pecan crop size made prior to and during the harvest season are significantly related to the average farm price and provide a reasonably satisfactory basis for forecasting the farm price. This of course is what one would expect. November and December are the major pecan marketing months. Presumably, the production forecasts provide the best available information regarding size of crop. Information utilized in making the final estimate of production is based on actual quantities handled by the trade. Sharp departures of actual marketings from the forecast will become apparent as the farm marketing season progresses, but only with a considerable time lag and much uncertainty as to the extent of the departure.

The second major purpose of this analysis was to test the hypothesis that the average price received by growers in one year was influenced by the farm-wholesale price margin in the previous year. The statistical test of this hypothesis is provided by testing the significance of the coefficient attached to  $M_{t-1}$ , i.e., the price margin lagged one year in the equations summarized in Table 2. On the basis of this criterion, the results lend support to the hypothesis. The coefficients are significantly different from zero at the five percent probability level, except in equations relating to September and October production forecasts. These coefficients are significant at the ten percent probability level.

Coefficients on  $M_{t-1}$  show that the average effect of a change of one cent in the farm-wholesale price margin in one year was a change in the same direction of 0.31 to 0.38 cents in the deflated farm price in the next year, with the other factors in the analysis held constant. Thus, on the average for the years included in the analysis, the wider the margin in one year, the higher the farm price in the next year, and the narrower the margin in one year, the lower the farm price in the next year.

### **Predictions of Farm Prices for 1960 and 1961**

The equations summarized in Table 2 were used to predict farm prices for the years of 1960 and 1961 which were not included in the analysis. The values of the independent variables for the two years are shown in Table 3. The predicted price for each year, utilizing each

successive monthly forecast to reflect supply, and the actual prices are shown in Table 4.

Although monthly production forecasts frequently differ widely from final production, the equations provide a fairly good estimate of the farm price even before the harvest season begins. For example, production forecasts were especially low in 1961 relative to final production (Table 3 and Appendix Table 1), but except in the case when the August forecast was used to reflect supply, the estimated prices approximated the actual price quite closely. The accuracy of the equations in predicting prices in each year is shown in Figure 4 where the differences between the actual deflated farm price and the price estimated from the equation using each successive monthly forecast are plotted for the years 1937-1961.

**Table 3.—Values of Independent Variables Used to Estimate the Average Farm Price for 1960 and 1961**

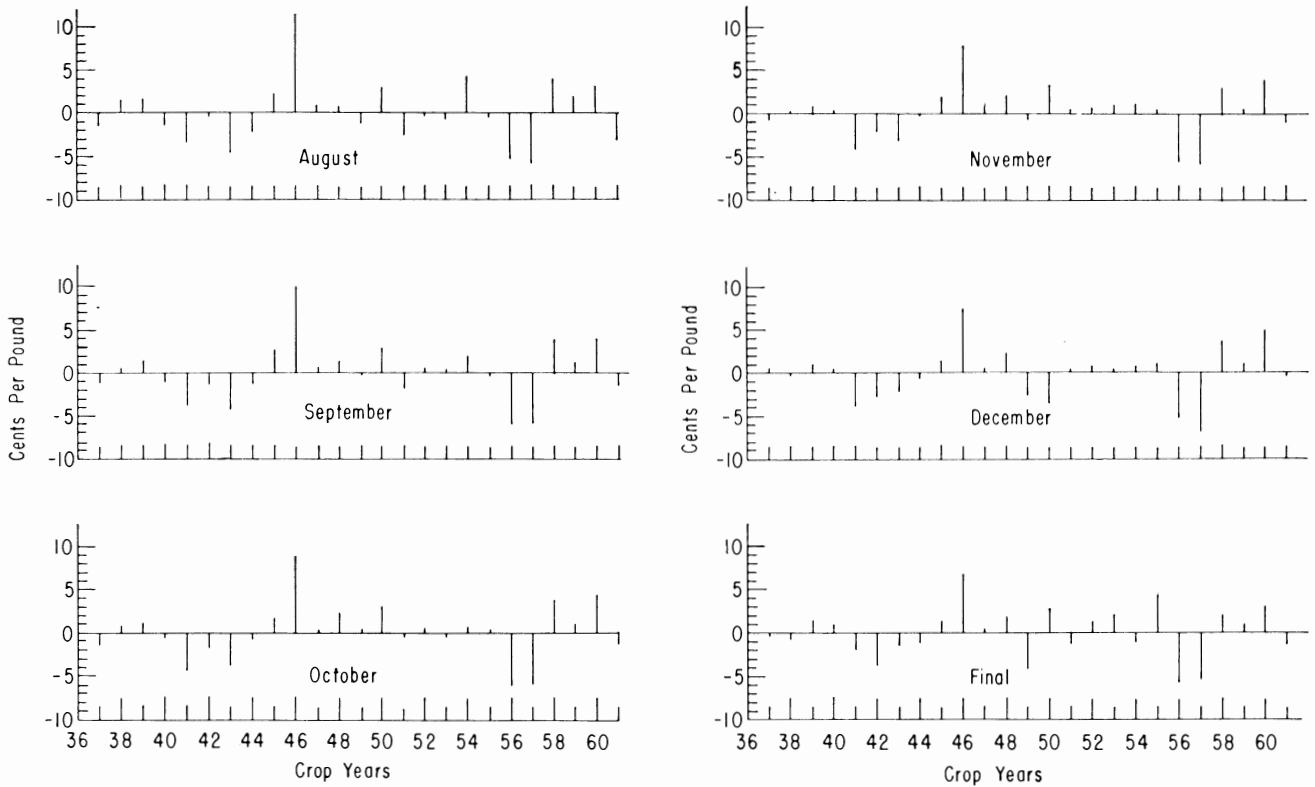
Variable	1960	1961
Income (percent)	123.3	124.1
Time (years)	24	25
Price Margin (cents)	36.51 (1959)	35.54 (1960)
Per Capita Supply (lbs.)		
Forecast:		
August	1.00	1.22
September	1.02	1.25
October	1.03	1.25
November	0.99	1.22
December	1.00	1.21
Final Production	1.04	1.34

**Table 4.—Estimated and Actual Average Farm Price,<sup>1</sup> 1960 and 1961**

Year	Aug.	Estimated Price Using Supply Variable				Final	Actual Price <sup>2</sup>
		Sept.	Oct.	Nov.	Dec.		
1960	21.30	20.36	19.98	20.47	19.34	21.28	24.51
1961	17.20	15.70	15.32	15.28	14.33	15.28	14.16

<sup>1</sup>Deflated by the Consumer Price Index. The index had a value of 126.5 in 1960 and 127.8 in 1961. The actual farm price in current dollars was 31.0 cents per pound in 1960 and 18.1 in 1961.





**Figure 4. Residuals (actual minus estimated price) from the farm price estimating equations, 1937-1961.**

## FACTORS AFFECTING THE FARM-WHOLESALE PRICE MARGIN

### Statistical Analysis of the Net Margin

In the previous section farm-wholesale price margin was defined to be the difference between price received by the grower and price received by the sheller on a shelled basis. The farm price for inshell pecans was adjusted to a shelled basis by assuming a constant shell-out of 35 percent. The difference includes all costs of processing and distribution plus profit (which may be negative). This was called the *net margin*. It is net of the loss of weight in the shelling process.

In the statistical analysis of the net price margin, single equation least squares regression was used to estimate the relation of the farm-wholesale price margin to the (1) farm-retail spread for the market basket of farm foods, (2) the wholesale price of shelled pecans, and (3) the difference between the November forecast and final pecan production. The regression equation derived from annual data for the years 1937-1959 is:

$$M = 9.605 + 0.094S + 0.113P_w + 0.134D \quad (7)$$

(1.68)
(1.93)
(1.71)

$$R^2 = 0.62 \quad S^* = 5.364$$

where:

M = the margin between the average U.S. farm price for inshell pecans converted to a shelled basis and the wholesale price of shelled pecans in New York (cents per pound)

S = the index of the farm-retail spread for the market basket of farm foods (1947-49 = 100)

$P_w$  = the wholesale price of shelled pecans in New York (cents per pound)

D = the difference between the November forecast and final production of pecans (millions of pounds)

The data are shown in Table 5.

The farm-retail spread for the market basket of farm food products was used to reflect changes in wage rates, productivity, and prices of other factors used in processing and distribution as they affect marketing costs.<sup>2</sup> It is for the calendar year following the beginning of the crop year in October. The average annual wholesale price of pecans was

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<sup>2</sup>The farm-retail spread is the difference between the retail cost and the farm value of an equivalent quantity of farm food products contained in the "market basket." For a description of the market basket of farm foods see *Farm-Retail Spreads for Farm Products*, USDA Miscellaneous Publication No. 741, A.M.S., November 1957. The indexes used in this study were taken from the Supplement for 1956-60 to Miscellaneous Publication 741, January 1961.

included as an explanatory variable because changes in the wholesale price may result in changes in the margin with little or no effect on farm prices during the marketing year. Moreover, it seems reasonable to assume that the wholesale price is independent of the margin, as implied by the statistical model. The November forecast was used to measure differences between final production and the forecast because it is available during the most active period of the farm marketing season. The use of the December forecast yields the same results.

Figures below the coefficients are t-ratios.  $S^*$  is the standard error of estimate. Only the coefficient on the wholesale price ( $P_w$ ) is significantly different from zero at the ten percent probability level, although the other two coefficients closely approximate this level of reliability. (The tabled value of "t" for 19 degrees of freedom is 1.73). However, all the coefficients have the expected sign. On the average, price margin changes in the same direction as the farm-retail spread for the market basket of farm foods and the wholesale price of pecans.

**Table 5.—Net and Gross Farm-Wholesale Price Margin and Related Variables, United States, 1937-1959<sup>1</sup>**

Year	M	M <sub>1</sub>	S	P <sub>w</sub>	D
	<i>Cents</i>	<i>Cents</i>	<i>Percent</i>	<i>Cents</i>	<i>Million Pounds</i>
1937	18.00	32.30	64.00	40.00	—30.582
1938	16.14	33.60	61.00	43.00	—27.239
1939	18.29	36.30	59.00	46.00	—36.586
1940	14.57	31.10	58.00	40.00	—36.962
1941	11.57	30.70	59.00	41.00	—37.022
1942	36.15	67.90	65.00	85.00	+ 3.474
1943	23.29	66.00	69.00	89.00	—27.975
1944	26.29	66.40	70.00	88.00	+ 1.311
1945	24.72	69.10	70.00	93.00	— 2.894
1946	28.43	91.20	78.00	125.00	+ 1.023
1947	9.54	51.51	94.00	74.11	—15.331
1948	31.66	54.50	102.00	66.80	—13.321
1949	30.83	65.93	104.00	84.83	+ 4.525
1950	26.30	79.78	103.00	108.58	—13.942
1951	23.43	60.20	111.00	80.00	— 8.830
1952	21.69	62.73	116.00	84.83	—24.954
1953	28.93	59.20	118.00	75.50	—29.208
1954	32.46	85.57	119.00	114.17	+ 2.000
1955	28.82	89.92	121.00	122.82	—55.750
1956	31.73	66.04	123.00	84.58	—13.700
1957	33.04	77.05	128.00	100.75	—20.050
1958	34.72	86.90	134.00	115.00	—15.350
1959	36.51	96.68	135.00	129.08	—21.650
—					
x	25.53	63.50	93.96	83.96	—18.220
S	7.66	19.91	27.05	27.53	+15.480

<sup>1</sup>See text for definition of variables.

The positive sign of the coefficient on D indicates that, on the average, a difference between the November forecast and final production of one million pounds was associated with a change of 0.134 cents per pound in the price margin on a shelled basis, with other factors held constant. If the forecast is less than production, D is negative, and the price margin declines. If the forecast is larger than production, D is positive and the price margin increases. Hence, results of this analysis tends to support the hypothesis that the difference between the forecast and production influences the price margin. The direction of the influence is also in agreement with the hypothesis.

### Statistical Analysis of the Gross Margin

A second regression analysis was made in which the price margin was defined to be the difference between the wholesale price on a shelled basis and the farm price on an inshell basis. This is called the *gross margin*. The regression equation derived from annual data for the years 1937 through 1959 is:

$$M_1 = 3.363 + 0.033S + 0.690P_w + 0.047D. \quad (8)$$

(1.72)      (34.53)      (1.75)

$$R^2 = .993 \quad S^* = 1.83$$

$M_1$  refers to the gross margin and the other variables are as previously defined (Table 5). Figures below the coefficients are t-ratios.  $S^*$  is the standard error of estimate. All the coefficients have the expected sign. The coefficient on  $P_w$  is significantly different from zero at the one percent probability level, and the coefficients on S and D are significantly different from zero at the ten percent probability level.

The coefficient of determination ( $R^2$ ) indicates that about 99 percent of the variation in price spread about its average was associated with variations in the three explanatory variables. This compares with the  $R^2$  of only 0.62 in the previous equation. This, of course, is a very good statistical fit. But it results primarily from the high correlation between the price margin and the wholesale price ( $r_{M_1 P_w} = 0.9956$ ).

Moreover a high correlation between these variables is expected, since the spread accounts for about 75 percent of the wholesale price. Dropping the other two variables from the equation would have a negligible effect on  $R^2$ .

The coefficient on  $P_w$  indicates that, on the average and with no change in the other variables, a change of one cent per pound in the wholesale price was associated with a change in the same direction of 0.69 cents in the price margin. Although the wholesale price exerts the

dominant influence on the price margin, results of the analysis also tends to support the hypothesis that the magnitude of the difference between the forecast and final production has made a significant effect on the farm-wholesale price margin.

Based on this analysis, the average relationship between the farm and wholesale price may be interpreted as follows. During the years included in the analysis, the index of the farm-retail price spread for the market basket of farm foods averaged 93.96 (1947-49 = 100), and the differences between the November forecast and final production averaged -18.22 million pounds per year. When these values are substituted into equation 8, the result is

$$M_1 = 5.60 + 0.69P_w. \tag{9}$$

This indicates that the price margin averaged about 5.60 cents per pound plus 69 percent of the wholesale price during the period covered in the study. Expressed in a somewhat different form, the average relationship between the farm and wholesale price was

$$P_w = 18.04 + 3.22P_f. \tag{10}$$

This means that the wholesale price averaged 18.04 cents per pound plus 3.22 times the farm price during the 1937-1959 period.

In 1961, the index of the farm-retail spread of the farm food market basket had a value of 138 (1947-49 = 100), and the November forecast was 21.95 million pounds less than final production. If we assume that the same relationship which existed between farm and wholesale prices in the period under study were valid in 1961, we get the following relation by substituting into equation 8:

$$M_1 = 6.90 + 0.69P_w. \tag{11}$$

This means that under conditions approximating those of 1961 we would expect the spread to be about 6.90 cents per pound plus 69 percent of the wholesale price.

Again relating the wholesale price directly to the farm price we obtain the following estimate of the wholesale price in terms of the farm price for 1961 conditions:

$$P_w = 22.26 + 3.22P_f. \tag{12}$$

The equation indicates that, on the average, a farm price of 18.1 cents per pound (the 1961 average) would be associated with a wholesale price of about 80.54 cents per pound, given relationships that held during the period included in the study, an index value of 138 for the farm-retail spread in the farm food market basket, and the November forecast of 21.95 million pounds less than final production.

## FACTORS AFFECTING THE WHOLESALE PRICE

The hypothesis that the magnitude of the farm-wholesale price margin was related to the extent to which actual production differed from the forecast of production was deduced from a number of considerations: (1) Farm price is determined by *expected* wholesale price and *expected* production. (2) *Expected* production is identical to the USDA monthly forecasts of production. (3) The actual wholesale price is established subsequent to the farm price and is determined primarily by the general demand for shelled pecans and actual production plus carryover stocks. (4) Among other reasons, the *actual* wholesale price differs from *expected* price (and thus the actual farm-wholesale price margin differs from the expected margin) because actual production differs from expected production (forecast).

In order to investigate the effect of the difference between the production forecast and actual production on the wholesale price and to inquire further into the farm-wholesale price relationship, least squares regression was used to estimate the relation of the wholesale price of shelled pecans ( $P_w$ ) to (1) the farm price of inshell pecans ( $P_f$ ), (2) the index of the farm-retail spread for the market basket of farm foods ( $S$ ), and (3) the difference between the November forecast of production and actual production ( $D$ ).<sup>3</sup>

The regression equation derived from annual data for the years 1937-1959 is:

$$P_{wt} = 12.902 + 2.975P_{ft} + 0.137S_{t+1} + 0.169D_t \quad (13)$$

$$\begin{array}{ccc} & (14.16) & (2.33) & (2.06) \\ R^2 = .96 & & S^* = 5.87 & \end{array}$$

The farm-retail spread for the market basket of farm foods refers to the calendar year following the beginning of the crop year (October 1). Other variables relate to the crop year.

Again, the figures below the coefficients are t-ratios, and  $S^*$  is the standard error of estimate. All the coefficients have the expected sign and are significant at the five percent probability level or less. The coefficient on  $P_f$  shows that, on the average and with no change in the other variables, a change of 1.0 cent per pound in the farm price of inshell pecans was associated with a change in the same direction of 2.975 cents in the wholesale price of shelled pecans. This appears highly reasonable, since with a shell-out of 35 percent a change in the inshell

<sup>3</sup>Except for farm price, the variables are given in Table 5. Farm price is given in Appendix Table II.

price of 1.0 cent means a change in the "break even" shelled price of 2.857 cents.

The positive sign and the statistical significance of the coefficient on  $D$  supports the hypothesis being tested. With a given farm price and farm-retail market basket spread, a difference between the forecast and final production of one million pounds of inshell pecans was associated with a change of 0.169 cents per pound in the wholesale price of shelled pecans. If the forecast exceeded production, the wholesale price increased; if production exceeded the forecast, the wholesale price declined.

Based on this analysis, the average relationship between the farm and wholesale price during the period under study was

$$P_w = 23.11 + 2.98P_f. \tag{14}$$

This means that on the average the wholesale price of shelled pecans was 23.11 cents per pound plus 2.98 times the farm price of inshell pecans. This differs somewhat from the relationship derived indirectly by transforming the margin equation (equation 10). The reason for the difference is found in the estimating procedure: In fitting the margin equation, the sum of the the squares of the residuals in the margin were minimized, while in fitting the wholesale price equation, the sums of squares of the residuals in the wholesale price were minimized.

Since  $M_1 = (P_w - P_f)$ , manipulation of equation (14) yields the following equation which relates the gross price margin directly to the farm price:

$$M_1 = 23.11 + 1.98P_f. \tag{15}$$

Since the farm price averaged 20.43 cents per pound for the 1937-59 period, this gives an estimate of 63.56 cents for the average gross price margin. This compares with the actual average margin of 63.50 cents for the period 1937-59.

Substituting the 1961 values for the farm-retail spread for the farm food market basket (138) and the difference between the November forecast and final production (—21.95 million pounds) into equation (13), we obtain:

$$P_w = 26.75 + 2.98P_f. \tag{16}$$

This means that, on the average, if the relations between the variables in the 1937-59 period were valid in 1961, a farm price of 18.1 cents per pound (the 1961 average) would be associated with a wholesale price for inshell pecans in New York of 80.69 cents per pound. This compares with an estimate of 80.54 provided by the transposed gross margin equation (12).

## Summary

The purpose of this study was to examine the pricing mechanism in the U.S. pecan market and to analyze the major factors affecting prices and price relationships. Three specific hypotheses were subjected to statistical analysis.

Statistical tests supported the hypotheses that early-season monthly forecasts of production are useful in forecasting the average annual farm price; that the farm-wholesale price margin in one year—serving as a reflector of the profit position of shellers—influences the farm price in the next year; and that differences between monthly forecasts and realized production in one year affects the wholesale price in that year—given the farm price—and thus influences the farm-wholesale price margin.

The results of the analysis of factors affecting the farm price were quite satisfactory from the statistical viewpoint. The independent variables explained from 75 percent of the annual variations in price when the August forecast was used to reflect supply to 84 percent when the November forecast was used.

The three independent variables used in estimating the farm-wholesale price margin explained 62 percent of the annual variation in the net price margin and 99 percent of the annual variations in the gross price margin. In both cases the coefficient attached to the difference between the November forecast and final production was significantly different from zero at the 10 percent probability level. In the analysis of the gross farm-wholesale margin, the wholesale price stands out as the dominant factor in explaining annual behavior in the price margin. This is to be expected since the gross margin accounts for about 75 percent of the wholesale price. The gross price margin averaged about 5.60 cents per pound plus 69 percent of the wholesale price during the 1937-59 period.

Three independent variables explained 96 percent of the annual variations in wholesale prices during 1937-59. The variables were the farm price of inshell pecans, the index of the farm-retail price spread for the market basket of farm foods, and the difference between the November forecast and final production. The farm price was most important in explaining variations in the wholesale price, but the coefficients attached to the other two variables were significantly different from zero at the five percent probability level and had the expected



sign. During the period being analyzed, the wholesale price of shelled pecans averaged 23.11 cents per pound plus 2.98 times the farm price of inshell pecans.

**APPENDIX Table I.—Pecans: Monthly Forecasts and Final Estimates of Production, United States, 1937-60**

Year	Aug.	Sept.	Oct.	Nov.	Dec.	Final
	<i>Million Pounds</i>					
1937	63.440	68.777	70.553	76.608	81.093	107.190
1938	54.201	50.832	48.737	47.084	46.566	74.323
1939	62.312	61.862	59.957	60.474	61.628	97.060
1940	73.665	76.651	81.829	85.922	87.286	122.884
1941	87.641	86.234	84.909	84.759	86.201	121.781
1942	88.888	88.161	87.900	80.848	78.100	77.374
1943	98.910	98.049	104.805	105.067	114.800	133.042
1944	132.763	142.933	150.050	143.415	141.865	142.104
1945	148.331	147.770	141.533	135.960	132.582	138.854
1946	104.085	96.523	89.042	77.248	77.155	76.225
1947	106.320	102.116	100.206	104.271	100.209	119.602
1948	152.560	160.553	169.684	162.722	153.812	176.043
1949	139.238	136.872	141.251	130.215	113.694	125.690
1950	106.571	106.438	109.731	110.688	112.530	124.630
1951	128.100	133.904	146.895	147.905	143.137	156.735
1952	116.566	125.566	127.256	126.482	123.638	151.436
1953	178.354	185.132	181.136	184.962	173.065	214.170
1954	130.628	104.378	91.252	86.600	92.502	94.600
1955	70.840	81.440	89.800	91.550	96.900	147.300
1956	169.880	161.375	159.800	160.700	160.075	174.400
1957	119.000	121.850	122.150	121.550	112.100	141.600
1958	179.200	173.400	170.500	158.000	162.100	173.350
1959	138.200	132.300	129.700	123.350	127.500	145.000
1960	181.600	185.200	185.850	179.200	181.450	187.500
1961	224.200	229.500	229.000	224.800	221.700	246.750

Source: Office of the Agricultural Statistician, Oklahoma City, Oklahoma.

**APPENDIX Table II.—Wholesale Price of Shelled Pecans, Farm Price of Inshell Pecans, Population, and the Consumers Price Index, United States, 1937-61**

Year	Wholesale Price <sup>1</sup>	Farm Price <sup>2</sup>	Population <sup>3</sup>	Index CPI
	<i>cents per lb.</i>	<i>cents per lb.</i>	<i>million</i>	<i>1947-49 = 100</i>
	(1)	(2)	(3)	(4)
1937	40.00	7.7	128.8	61.4
1938	43.00	9.4	129.8	60.3
1939	46.00	9.7	130.9	59.4
1940	40.00	8.9	132.1	59.9
1941	41.00	10.3	133.4	62.9
1942	85.00	17.1	134.9	69.7
1943	89.00	23.0	136.7	74.0
1944	88.00	21.6	138.4	75.2
1945	93.00	23.9	139.9	76.9
1946	125.00	33.8	141.4	83.4
1947	74.11	22.6	144.1	95.5
1948	66.80	12.3	146.6	102.8
1949	84.83	18.9	149.2	101.8
1950	108.58	28.8	151.7	102.8
1951	80.00	19.8	154.4	111.0
1952	84.83	22.1	157.0	113.5
1953	75.50	16.3	159.6	114.4
1954	114.17	28.6	162.4	114.8
1955	122.82	32.9	165.3	114.5
1956	84.58	18.5	168.2	116.2
1957	100.75	23.7	171.2	120.2
1958	115.00	28.1	174.1	123.5
1959	129.08	32.4	177.0	124.6
1960	124.12	31.0	180.7	126.5
1961	n.a.	18.1	183.6	127.8

<sup>1</sup>New York wholesale price quotations for shelled pecans of typical grades (medium halves in wholesale size containers). Simple average of 12 months beginning in October of year shown. When quotations were not available for some months the average price is the average of months for which quotations were available.

<sup>2</sup>For "all pecans" for all methods of sale. Prices for "all pecans" computed by weighting prices for seedling and improved pecans by quantities sold.

<sup>3</sup>Total population in United States, including Armed Forces overseas, as of July 1 of indicated year.

Source of Data:

Column 1—1937-46: Jules V. Powell and Richard S. Berberich, *Marketing Tree Nuts—Trends and Prospects*, Marketing Research Report 139, USDA, (October, 1956).

1947-60: Personal correspondence from Jules V. Powell.

Column 2—1937-56: Agricultural Statistics, USDA, (1957).

1957-61: *Tree Nuts by States*, USDA, AMS, various issues.

Columns 3 and 4—1937-60: Supplement for 1960 to *Consumption of Food in the United States, 1909-52*, USDA, AMS, Agricultural Handbook No. 62 (August 1961).

1961: *Survey of Current Business*, U. S. Department of Commerce (February, 1962).



## Oklahoma's Wealth in Agriculture

Agriculture is Oklahoma's number one industry. It has more capital invested and employs more people than any other industry in the state. Farms and ranches alone represent a capital investment of four billion dollars—three billion in land and buildings, one-half billion in machinery and one-half billion in livestock.

Farm income currently amounts to more than \$700,000,000 annually. The value added by manufacture of farm products adds another \$130,000,000 annually.

Some 175,000 Oklahomans manage and operate its nearly 100,000 farms and ranches. Another 14,000 workers are required to keep farmers supplied with production items. Approximately 300,000 full-time employees are engaged by the firms that market and process Oklahoma farm products.