PRICE AND VALUE EFFECTS OF PECAN CROP FORECASTS, 1971-1987

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Abstract

Price equations incorporating USDA October crop forecasts and June pecan stocks provided reasonable formulations for pecan price explanation and forecasting. USDA crop forecasts exceeded final reported production in 12 of the 18 seasons from 1970 to 1987, probably resulting in slightly lower prices and crop values. Large crop forecast errors in both direction and level in 1986 and 1987 confounded the price determination process. Nevertheless, producer prices may have been lower absent the October crop forecasts, which somewhat reduce buyers' uncertainty regarding supply. Early crop estimates provided a better explanation of price behavior than postseason revised production data.

Key words: pecan prices, crop forecast errors.

Pecan production occurs throughout the southern and southwestern U.S. from North Carolina through Arizona and California during mid-September through March (Huang et al.). U.S. Department of Agriculture pecan crop estimates are issued in early fall—September and October. The bulk of the crop is harvested by December with preliminary crop size and producer price data published by the USDA in January (USDAb). Final crop and price data are issued in July.

The purpose of this paper is to examine the effects of pecan crop production forecast errors on prices and crop values by combining previously successful single equation price models with a crop forecast error variable. The primary hypothesis was that pecan price was more accurately explained by early-season crop forecasts than by the postseason final crop estimates used in previous studies. A secondary hypothesis was that crop forecast errors resulted in prices and crop values different from those which would have occurred with accurate crop forecasts.

Given the somewhat simple nature of the farm level demand structure for pecans and the fact that the bulk of the crop is harvested and sold at the farm level during approximately three months, USDA estimates of crop size issued at the beginning of the season should be important in determining farm level price.[1] That is, one would expect price to be determined more by current crop estimates than by the eventually reported revised data. Using end-of-season revised data to explain price behavior is probably unreasonable. Based on a survey in Georgia, Thorne and Frazier reported that "The U.S. Department of Agriculture forecast is generally viewed as the first basis for establishing price" (p. 32). Early crop estimates in excess of the eventual crop would be expected to reduce price below the market clearing price appropriate for the actual volume and vice versa. Overestimates would favor first-buyers of pecans—accumulators, shellers, processors, et al.—and underestimates would favor first sellers or producers.

Fowler (1963a), using USDA data on pecan crop forecasts and pecan production for 1937 through 1960, found crop forecasts were frequently significantly below eventual crop volume. Analysis based on more recent data contrasts with Fowler's (1963a) earlier findings. As shown in Table 1, the average USDA October crop forecast was 230.4 million pounds versus 225.8 million pounds reported final production during 1970-1987, a slight tendency to overestimate (+2.0 percent) the crop. However, "on-the-average" crop estimate inaccuracy is not as relevant as the

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[1]U.S. Department of Agriculture pecan crop estimates are currently first available in September. October estimates are used here as representative crop estimates.

TABLE 1. U.S. DEPARTMENT OF AGRICULTURE OCTOBER PECAN CROP ESTIMATES, FINAL PRODUCTION, AND ERROR, 1970-1987

Year	October Crop Estimate	Final Reported Production	Final Production Minus Crop Estimate	Percent[a] Error
	(MILLION POUNDS)			(PERCENT)
1970	152.5	155.1	+ 2.6	− 1.67
1971	251.8	247.2	− 4.6	1.86
1972	186.3	183.1	− 3.2	1.74
1973	276.1	275.7	− 0.4	0.14
1974	149.5	137.1	−12.4	9.04
1975	242.2	246.8	+ 4.6	− 1.86
1976	114.4	103.1	−11.3	10.96
1977	253.4	236.6	−16.8	7.10
1978	212.3	250.7	+38.4	−15.32
1979	250.3	210.6	−39.7	18.85
1980	196.6	183.5	−13.1	7.14
1981	338.0	339.1	+ 1.1	− 0.32
1982	210.6	215.1	+ 4.5	− 2.09
1983	292.5	270.0	−22.5	8.33
1984	250.4	232.4	−18.0	7.74
1985	262.7	244.4	−18.3	7.49
1986	216.1	272.7	+56.6	−20.75
1987	291.0	262.2	−28.8	10.90
Average	230.4	225.8	+ 4.5	+ 2.73

[a]Error of estimate as percent of final reported production.

Sources: USDA a,b.

forecast error for each year which, disregarding direction of error, averaged 7.4 percent during 1970–1987 and 9.9 percent during the recent 1978–1987 ten-year period. October crop forecasts greater than final production occurred in 12 of the 18 years from 1970–1987, ranging from 0.14 percent of actual production in 1973 to 18.8 percent in 1979. October crop forecasts were 8.3, 7.7, and 7.5 percent higher than final reported production in 1983, 1984, and 1985, respectively, 20.7 percent below production in 1986, and 11 percent greater in 1987. Perhaps as critical as forecast error were the misdirections in forecasts in 1978, 1979, 1986, and 1987. For example, the 1986 crop was estimated to be 11.6 percent below the 1985 crop but was eventually reported 11.6 percent greater than the 1985 crop. Fowler (1963a) did not pursue the price effects of erroneous pecan crop forecasts.

Pecans can be modeled for price explaining/forecasting purposes within a rather simple framework. No government programs are directly involved and neither substitutes, exports, nor deliberate crop allocation among outlets appear to be relevant as grower level price determinants (Fox, pp. 11–14). Production and cold storage carry-in stocks on the supply side and population and income on the demand side seem to be associated with all reasonably explainable season-to-season price changes. Fowler (1963b); Shafer and Hertel; Epperson and Allison; Huang et al.; and Wells et al. found some combination of production, carry-in stocks, income, and/or trend to be significant in explaining season average pecan price movements. Pecan prices appear to be independent of the quantities of other nuts such as walnuts and almonds (Loyns; Bushnell and King; Wells et al.).

APPROACH

Price equations (inverse demand functions) using per capita production, stocks, and income and, alternately, first differences of total production and stocks were each adjusted for crop forecast error to evaluate the price effect.

The equations estimated by OLS were:

(1) USPP = f(USPQC, CSJC, IPC),
(2) USPP = g(USPQC, CSJC, IPC, PQOE),
(3) DUSPP = h(DUSPQ, DCSJ),
(4) DUSPP = i(DOEPQ, DCSJ), and
(5) DUSPP = j(DUSPQ, DCSJ, PQOE),

where:

USPP = season's average farm

		level blend price for U.S. pecans in cents per pound,
USPQ	=	total U.S. final pecan production in millions of pounds,
CSJ	=	June U.S. pecan stocks in cold storage in millions of pounds,
IPC	=	U.S. disposable income in dollars per capita/100,
OE	=	USDA October pecan crop estimate in millions of pounds,
OEPQ	=	current OE minus USPQ last season, and
PQOE	=	USPQ minus OE.

The prefix D indicates first differences and the suffix C per capita levels. That is, equations (3), (4), and (5) are based on first differences of total production, stocks, and season average prices, while equations (1) and (2) use per capita data.

Observations are for 1970–1986 because pecan cold storage data were first available in 1970 (Wells et al.). The data are from the USDA (a,b,c,d) and are shown in the Appendix. Equation (1) represents the standard price level equation used in previous studies. Equation (2) is equation (1) adjusted for crop forecast error where the PQOE coefficient was hypothesized to have a positive sign.

Due to the marked biennial pattern in pecan production, stocks, and prices, data were transformed to first differences for equations (3), (4), and (5). Equation (3) uses first differences of final postseason estimates of production and preseason carry-in stocks. DOEPQ in equation (4) is the difference between last season's final estimated production and the current season October crop forecast. Equation (4) is a forecasting equation in that both DOEPQ and DCSJ would be known in October (i.e., early in the season). Equation (5) is equation (3) adjusted for the crop forecast error.

RESULTS

As shown in Table 2, equations (1) and (2) using per capita data yielded desirable economic and statistical attributes. The net absolute effect on price of change in pecan production per capita (USPQC) and stocks per capita (CSJC) were quite similar, as expected. The adjusted R^2's equaled or exceeded 0.73, and at least 13 of the 16 turning points for price were correctly predicted. Adding the forecast error variable PQOE resulted in explanation of one more turning point, but PQOE was not significant at any reasonable probability level.

The use of data in first differences rather than actual values around a long-term mean tends to remove trends and buffer structural changes. Equation (3) does a fair job of "explaining" year-to-year changes in price with only year-to-year changes in (a) final reported total production (DUSPQ) and (b) June total carry-in stocks (DCSJ) as explanatory variables.

Equation (3), however, may be inappropriate because the final production figures necessary for the DUSPQ variable are not reported until the July following the mid-September through December season when the price was actually determined. Thus, price would seem to be more reasonably determined by the USDA crop estimates as Thorne and Frazier indicated. A better production change (first difference) variable would be the current October crop estimate minus last season's final reported production (i.e., DOEPQ). It is hypothesized that buyers, and possibly informed sellers, are determining the difference in price they must pay or expect to receive this season versus last season in light of the forecast change in total production. Equation (4), using the forecast production change variable DOEPQ and the preseason stocks change variable, increased the adjusted R^2 considerably, predicted 15 of the 16 first differences or turning points correctly, reduced the RMSE, and yielded equivalent slope coefficients for the effect of pecan quantities on price regardless of whether the quantity change occurred in forecast production (DOEPQ) or in stocks (DCSJ).[2] In fact, the 1986 price increase can only be explained by the erroneous 1986 crop forecast which missed both level and direction.

Moving one step further in an attempt to isolate the effect of crop forecast error on price, a variable consisting of the difference between final reported production and the October crop estimate for that crop was added to equation (3). This variable, PQOE, is used to

[2]Fitting equation (4) to 1976–1987 data by way of a sensitivity test yielded results quite similar to those for the 1970–1986 run in Table 2.

TABLE 2. ESTIMATED COEFFICENTS OF PRICE EQUATIONS FOR U.S. PECANS, 1970-1986

				PER CAPITA LEVELS						
EQUATION	CONSTANT	USPQC	CSJC	IPC	PQOE	ADJUSTED R^2	TP[a]	RMSE	D-W	F
(1)	83.62	−48.9986	−43.6354	0.5746		.75	13/16	6.47	1.22	16.71
	(6.18)[b]	(4.44)	(2.22)	(5.41)						
(2)	84.72	−49.8770	−42.6611	0.5679	0.0573	.73	14/16	9.35	.98	12.09
	(6.07)	(4.39)	(2.11)	(5.20)	(0.65)					
				FIRST DIFFERENCES, TOTAL VALUES						
	CONSTANT	DUSPQ	DOEPQ	DCSJ	PQOE	ADJUSTED R^2	TP[a]	RMSE	D-W	F
(3)	4.26	− 0.2129		−0.1608		.75	14/16	7.35	2.86	23.31
	(2.02)	(5.60)		(2.30)						
(4)	5.91		− 0.2639	−0.2551		.87	15/16	5.21	2.57	52.77
	(3.84)		(8.67)	(4.59)						
(5)	5.92	− 0.2639		−0.2552	0.2648	.86	15/16	5.21	2.57	32.47
	(3.63)	(8.32)		(4.38)	(3.44)					

[a]Ratio of correctly predicted to actual turning point opportunities in dependent variable price. In the first difference form each observation is counted as a turning point.

[b]t-ratios in parentheses.

capture the price effect of a forecast error in addition to the effect of the change in actual production. Equation (5) yields essentially the same slope coefficients on DUSPQ and DCSJ as equation (4) did for DOEPQ and DCSJ. In addition, the slope coefficient on the PQOE variable, 0.2648, is essentially the same in absolute value as the other two quantity-driven slope coefficients.

The effects of crop forecast errors on prices and crop values were determined as follows. For each one million pounds the October crop estimate was below (above) final production, the change in price was increased (reduced) 0.26 cents; thus, a 10-million-pound-under-(over)estimate would produce an additional change in price of plus (minus) 2.6 cents per pound. Multiplying the PQOE coefficient by each PQ-OE difference suggests the net change in price due to the forecast error. Multiplying this computed net change in price due to the crop forecast error by the final reported volume produced (million pounds) yields an estimate of the part of the total crop value gained or lost due to deficit or excess October crop forecasts. Results of these calculations are reported in Table 3.[3]

While crops were overestimated 11 of the 17 years from 1970 to 1986, the estimated net effect on price and crop values was not as bad as might be expected. Total reported pecan crop values during 1971-1986 were $2,051.4 million so that the estimated net loss in total revenue due to October crop overestimates of $17.56 million or 0.8 percent does not seem calamitous.

Although the price effects of crop forecast errors were generally offsetting during the 1971 to 1986 period, only the erroneous forecast of a small crop in 1986 brought price increases due to short crop forecasts close to price declines due to excess crop forecasts over the period. Buyers of the 1986 crop were operating on official crop estimates of 216.1 million pounds in October 1986 to 225.2 million pounds in December 1986 (USDAa). The crop was eventually reported at 272.7 million pounds, or 26 and 21 percent greater than the October and December crop estimates, respectively. The direction of the crop forecast was wrong and the estimate was the least accurate in both relative and absolute terms during the 1970-1986 period (Table 1). The low crop estimate in 1986 seems to have, at least in part, led to the highest U.S. price since the very small estimate and correspondingly small final crop of 1980 (Appendix). The erroneous low 1986 crop forecast possibly added $40 million or 20 percent of the final reported crop value of $196 million. The buyers' mistake in 1986 in paying high prices for a relatively large crop apparently led to a very depressed 1987 price situation accentuated by USDA's October forecast error of both direction and magnitude, 10.9 percent (Table 1). The October 1987 crop forecast of 291 million pounds was 7

[3]The net price/crop value effect of crop forecast errors was computed alternatively by substituting variable DUSPQ for DOEPQ in equation (4) and recomputing DUSPP. This procedure estimates what prices should have been if the crop forecast had, in fact, been equal to the final production estimates reported the following July. Here, the difference in computed price changes was parallel to the "price effects" column in Table 3, but net crop value loss was estimated at $17.2 million or 0.8 percent of total crop values for the 16 seasons.

TABLE 3. ESTIMATED EFFECT OF OCTOBER CROP FORECAST ERRORS ON PRICE AND REVENUE USING EQUATION (5)

Year	Final production-crop estimate (PQ-OE)	Price[a] Effect	Final Production	Price effect on crop value[b]	
				GAIN	LOSS
	(million lbs)	(¢/lb)	(million lbs)	(million $)	
1971	− 4.6	− 1.22	247.2		− 3.01
1972	− 3.2	− 0.85	183.1		− 1.55
1973	− 0.4	− 0.10	275.7		− 0.29
1974	− 12.4	− 3.28	137.1		− 4.50
1975	+ 4.6	+ 1.22	246.8	+ 3.04	
1976	− 11.3	− 2.99	103.1		− 3.08
1977	− 16.8	− 4.45	236.6		− 10.52
1978	+ 38.4	+ 10.16	250.7	+ 25.47	
1979	− 39.7	− 10.51	210.6		− 22.14
1980	− 13.1	− 3.47	183.5		− 6.36
1981	+ 1.1	+ 0.29	339.1	+ 0.98	
1982	+ 4.5	+ 1.19	215.1	+ 2.56	
1983	− 22.5	− 5.96	270.0		− 16.08
1984	− 18.0	− 4.77	232.4		− 11.08
1985	− 18.3	− 4.85	244.4		− 11.84
1986	+ 56.6	+ 14.99	272.7	+ 40.87	
				+ 72.89	− 90.45
1987	− 28.8	− 7.63	262.2		− 20.00
				+ 72.89	− 110.45

[a]Coefficent 0.2648 for PQOE multiplied by the crop estimate error PQ-OE.

[b]Price effect multiplied by final production.

percent over the final 1986 crop of 272.7 million pounds while the final July 1988 estimate of the 1987 crop has been reduced to 262.2 million pounds, or 4 percent below 1986. The procedure in Table 3 suggests this excessive forecast may have reduced the 1987 price by approximately 7.6 cents per pound and crop value by 12.5 percent. While both equations (4) and (5) forecast a drop in price between 1986 and 1987 due to the 1987 crop estimate error, neither forecasted the extent of the decline. Most of the 18.9 cents per pound drop was probably due to the buyers paying too much for an erroneously forecasted crop in 1986 and carrying relatively high price stocks of pecans into the 1987 crop year. Further, although almonds and walnuts have not been statistically significantly associated with pecan prices in the past, inordinately large supplies of both in 1987 may have accentuated the decline in pecan prices. Equations (4) and (5) without the crop forecast error adjustment incorrectly forecast a price increase for 1987.

SUMMARY AND CONCLUSIONS

The USDA October pecan crop forecasts were greater than reported final crop volumes by an average of only 2.0 percent during 1970–1987. However, overestimates occurred two-thirds of the time. Producer total crop values were estimated to have been reduced by 1.7 percent over the 17 years 1971–1987 due to crop overestimates.

Early season crop estimates provided a better explanation of price behavior than postseason revised production data. Pecan price equations based on October crop estimates and June cold storage carry-in stocks seemed to be both good explainers and useful forecasters of U.S. season's average pecan price changes. Equation (4) incorporating forecast change in crop size and June cold storage stocks seems the most appropriate price forecasting equation.

While the overall reduction in crop values due to crop forecast errors was relatively small, some years may have experienced significant price and crop value changes. Crop values were estimated to be 0.5 percent and 1.8 percent higher due to under forecasts in 1981 (−0.3 percent) and 1982 (−2.1 percent), respectively, and 10.1 percent and 8.3 percent lower due to crop overestimates in 1983 (+8.3 percent) and 1984 (+7.7 percent), respectively.

Considerable whiplash appears to have occurred from 1985 to 1986 and 1986 to 1987 when both direction and magnitude of the crop estimates were misleading by a considerable margin. Such is not unique to pecans nor to agricultural commodities (Wiesemeyer and Abbott; *Wall Street Journal*).

It seems apparent that early season crop estimates were better explainers of price than were the ex post revised crop data. Prices are clearly formulated on crop expectations available during the season rather than on revised post-season data. In particular, price models for fruits, vegetables and tree nuts, or any crop where significant post-season revision in production data occurs, should be fitted to both within season estimated crop data and final revised crop data as alternative explainers of prices determined during the season. One would expect better explanation of price based on the crop estimates available within the season.

Producers appeared to have been at a disadvantage from downward price bias due to crop overestimates being twice as frequent as underestimates during the 18 years 1970–1987. Only the 15 percent underestimate of the 1986 crop brought revenue gains near to the losses attributed to overestimates of crop size. A modest inquiry regarding pecan crop estimation methods seems warranted in view of the distinct tendency to overestimate crop size early in the season.

Have USDA's on-the-average excessive early season pecan crop forecasts harmed producers due to negative price effects? Yes and no. Yes, due to the possibility of a slightly reduced total crop value during the 17 years 1971–1987. No, on the average, in that without advanced estimates of supply information, growers might be receiving lower prices because of buyers' uncertainty concerning the eventual production to be handled. More information is preferred to less and, clearly, higher quality, accurate information is most preferred (Milonas). The large proportion of excessive October crop forecasts during the 1970–1987 period may be acceptable given the considerable year-to-year variation in U.S. pecan production. However, particularly large consecutive crop forecast errors in 1986 and 1987 appeared to confound the price determination process in those years. The October crop forecast seemed quite important in price determination, and, hence, its accuracy should be of keen interest to both producers and first-buyers.

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APPENDIX TABLE. DATA FOR EQUATIONS

Season	Pecan[a] Price	Pecan[a] Final Production	October[b] Crop Estimate	June Cold[c] Storage Stocks	U.S.[d] Population	Disposable[d] Income
	(¢/lb)	------------- (million	lbs.) -------------		(million)	($/capita)
1970	39.0	155.1	152.5	85.8	205.1	3348
1971	33.0	247.2	251.8	41.1	207.7	3588
1972	42.4	183.1	186.3	83.2	209.9	3860
1973	36.7	275.7	276.1	52.7	211.9	4315
1974	47.2	137.1	149.5	121.9	213.9	4667
1975	39.8	246.8	242.2	61.2	216.0	5075
1976	81.5	103.1	114.4	107.1	218.0	5477
1977	57.7	236.6	253.4	45.5	220.2	5965
1978	60.5	250.7	212.3	97.0	222.6	6968
1979	55.4	210.6	250.3	153.7	225.1	7682
1980	78.1	183.5	196.6	113.5	227.7	8421
1981	54.5	339.1	338.0	78.0	229.8	9243
1982	67.5	215.1	210.6	172.9	232.1	9742
1983	58.7	270.0	292.5	141.1	234.2	10340
1984	62.3	232.4	250.4	171.2	236.6	11265
1985	68.0	244.4	262.7	123.1	239.3	11817
1986	72.0	272.7	216.1	148.5	241.6	12508
1987	53.1	262.2	291.0	159.1	243.9	13050

Sources: [a]USDA *Noncitrus Fruit and Nut Summaries*
[b]USDA *Crop Production*
[c]USDA *Cold Storage*
[d]USDA *Working Data for Demand Analysis*, and *Agr. Outlook* July 1988 ERS, USDA