FARM LEVEL DEMAND FOR PECANS RECONSIDERED

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Abstract

Previous studies have consistently indicated the anomalous result of a price inflexible demand for pecans. However, these efforts did not have an adequate measure of pecan stocks available and, as a result, stocks were either excluded from consideration or a proxy variable was introduced. A time series of pecan stocks is now available. Use of this time series in a price dependent demand function results in a flexible farm level demand for pecans. This points out the danger of excluding an appropriate variable or using a so-called "reasonable" proxy variable.

Key words: pecans, demand, farm-level, elasticity, flexibility, proxy-variable.

The demand for most agricultural products at the farm level is generallly believed to be inelastic. Thus, an increase in supply would result in a decrease in total revenue to producers as a whole, *ceteris paribus*. This characteristic of the demand for agricultural products provides the basis for many agricultural policy programs. Pecans, however, have appeared to be an anomaly. Price flexibilities estimated in previous studies indicate that the demand for pecans at the farm level shows characteristics of an elastic demand (Shafer and Hertel; Blake and Clevenger; Epperson and Allison; Fowler).

This note investigates the previous findings of a price inflexible farm level demand for pecans. There are two objectives of the investigation. First, an alternative model formulation and resulting improved price flexibility estimates for pecans are made available. Second, and just as important, the hazards of misspecification from omission of an important variable or use of a weak proxy variable are illustrated. The hypothesis to be tested is that previous models were misspecified due to the treatment of stocks; that is, when pecan stocks are appropriately considered, estimates of the farm level demand for pecans are price flexible. Prior to 1970, a measure of pecan stocks was unavailable and previous research either ignored stocks or used the carry-in stocks of all nuts excluding peanuts as a proxy variable. While this seems to be a "reasonable" proxy variable, the problem is the ease with which spurious conclusions result from the use of a "reasonable" proxy variable. Empirical researchers frequently take liberties along these lines with the hope that spurious conclusions do not result. This paper serves as a reminder of the possible consequences of using a model with estimators that are both biased and inconsistent.

PREVIOUS MODELS

Previous estimates of price flexibilities for pecans at the farm level have indicated that the demand for pecans is price inflexible. If this is the case, total revenues increase with increases in supply. Fowler estimated the United States average farm price of pecans as a function of United States net supply of pecans, an index of per capita disposable income, and time. The equation was fitted with data for the time period 1922-1956 and 78 percent of the variation in price was explained. Fowler calculated a price flexibility of -0.73. This flexibility, he noted, was almost identical to one estimated earlier by Lerner.

Using data for the time period 1960 to 1976, Epperson and Allison estimated the price of pecans at the farm level (deflated) as a function of total United States production of pecans, walnuts, and almonds; population; income (deflated); and time. The highest R^2 (78 percent) was obtained when a double log equation was used. Although Epperson and Allison did not discuss the price flexibility, the estimated quantity coefficient in the double log equation is -0.43.

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Shafer and Hertel introduced stocks of other nuts except peanuts as a proxy for pecan stocks. Their model treated United States seasonal average pecan prices as a function of net United States pecan production, disposable per capita income, and June cold storage of all nuts except peanuts. An arithmetic equation was fitted with data for the time period 1960-1977 and 83 percent of the variation was explained. The calculated price flexibility was −0.58. Shafer and Hertel stated that, "this is unusual for agricultural commodities in that most are price inelastic at the farm level (p. 16)." However, they did not present any rationale for this purported anomaly.[1]

In a more recent study by Blake and Clevenger, the price of pecans was estimated using the variables: United States production of pecans, net change in stocks of all nuts, per capita income, net exports, and per capita pecan consumption. Although Blake and Clevenger did not estimate a price flexibility, an estimate of −0.76 was obtained using their equation and data. The Blake and Clevenger model has a potential redundancy in that production and changes in stocks and an alternative measure of consumption, per capita consumption, are included in the same equation as independent variables.

COMPARISON OF ALTERNATIVE MODELS

To illustrate how the unavailability of stock information impacts the price flexibility estimates for pecans, six alternative regressions are estimated. Each equation relates United States farm level pecan prices (cents per pound) to pecan production (millions of pounds) and per capita income. In order to measure the effects of stocks on pecan prices, changes in stocks and carry-in stocks for pecans and all nuts excluding peanuts (each measured in millions of pounds) were used alternatively as regressors.[2] Regressions were fitted with annual data for the time period 1970-1982.[3]

In most applied work, the belief is evident that use of a proxy variable, even if it is a poor proxy, is superior to its omission (see Judge et al. pp. 516-8 for more detail) . The correlation between carry-in nut and pecan stocks is 0.75 and the correlation between changes in these stocks is 0.76. These correlation coefficients tend to support previous researchers inclusion of the all nut stock variable as a proxy variable. Previous researchers, of course, could not calculate these correlations because of the then unavailability of pecan stock information.

Regression results presented in Table 1 indicate that any one of the six equations taken separately is acceptable given the criteria typically used to judge empirical re-

TABLE 1. ESTIMATION RESULTS OF ALTERNATIVE PRICE DEPENDENT PECAN DEMAND EQUATIONS BASED ON ANNUAL DATA, UNITED STATES, 1970-1982

Equation	Intercept	Pecan production	Income	Pecan carry-in	Change in pecan stocks	All nut carry-in[a]	Change in all nut stocks[a]	Price flexibility at mean levels	95 percent confidence interval for flexibility	$\bar{R}^2$	D-W
(1)	82.20	−0.37 (0.06)[b,c]	0.008 (0.0009)[c]		0.32 (0.09)[c]			−1.49	−2.10 to −0.89	0.88	2.00
(2)[d]	87.41	−0.40 (0.06)[c]	0.009 (0.001)[c]		0.40 (0.06)[c]			−1.66	−2.29 to −1.05	0.85	1.91
(3)	46.47	−0.15 (0.04)[c]	0.007 (0.001)[c]					−0.61	−0.98 to −0.25	0.74	1.85
(4)	51.87	−0.18 (0.06)[e]	0.007 (0.001)[c]				0.04 (0.07)	−0.73	−1.34 to −0.14	0.72	1.74
(5)	64.29	−0.20 (0.04)[c]	0.009 (0.002)[c]			−0.13 (0.06)[f]		−0.80	−1.20 to −0.42	0.80	1.65
(6)	61.54	−0.24 (0.04)[c]	0.010 (0.001)[c]	−0.29 (0.09)[c]				−0.97	−1.35 to −0.60	0.87	2.09

[a]Excludes peanuts. [b]Standard errors in parentheses. [c]Significant at the 1 percent level. [d]Pecan production and change in pecan stocks coefficients restricted to be equal in absolute value. [e]Significant at the 5 percent level. [f]Significant at the 10 percent level.

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[1] In another section of the Shafer and Hertel work (p. 29), results of an alternative demand formualtion were presented. Using data for 1970 through 1977, pecan stocks were incorporated into their model. As a consequence, a price flexibility of −1.1 was obtained. This is consistent with the results presented herein. Shafer and Hertel, however, did not pursue the implications of this result.

[2] The quantities of substitute nuts (e.g. walnuts and almonds) were included in earlier attempts. We found, as did previous researchers, that a strong substitution relationship did not exist.

[3] Observations for the earlier years were available in Shafer and Hertel. More recent data for prices, consumption, and production were taken from *Noncitrus Fruits and Nuts,* USDA; more recent storage data were taken from *Regional Cold Storage Holdings*, USDA; and more recent income data were taken from, *Agricultural Outlook*, USDA.

sults.[4] For example, all of the signs are consistent with theory, only one coefficient is not significant at the 10 percent level or better, and all Durbin-Watson values are in the acceptable range at the 1 percent significance level. A severe problem could, however, arise if any of equations (3) through (6) were used to draw policy implications. This is because each estimate indicates a price inflexible demand which is consistent with the previous research discussed.[5] The estimated flexibilities presented in these previous research efforts averaged −0.63 while the average flexibility for equations (3) through (6) is −0.78. Since −1 is the critical value for the price flexibility separating the possibility of a price flexible demand from a price inflexible demand, the appropriate consideration is whether the 95 percent confidence interval for the flexibility includes −1 (Miller et al.). Note that the confidence interval from equation (3) does not include −1, indicating that this price flexibility is significantly different from −1 at the 95 percent level.

Equations (1) and (2) include changes in pecan stocks. This is the preferred measure of the impact of pecan stocks on pecan prices because it includes all the essential storage activity that might yield an impact on the season's average price. Additionally, the inclusion of stock changes brings the quantity measures closer to a measure of consumption. If net exports were included, all the components of domestic disappearance, a common measure of consumption, would be included. Net exports were excluded because of their minor importance in the pecan industry. On the other hand, pecan carry-in stocks as used in equation (6) do not reflect any of the dynamic aspects of the market. Thus, on *a priori* grounds equations (1) and (2) are preferred to equation (6). Equation (6) is included to show the impact of misusing correct data.

Equation (1) places no restrictions on the estimated coefficients. However, since pecans maintain a consistent quality during storage, pecans entering or leaving storage should have the same impact on price as comparable changes in pecan production. In equation (2), the coefficients for production and change in stocks are restricted to be the same magnitude but opposite in sign. Only equations (1) and (2) yield price flexibility point estimates with flexible lower bounds (i.e. flexibilities less than −1). Additionally, the 95 percent confidence limit for equation (2)'s flexibility does not include −1, indicating a flexible demand over the entire confidence interval.

For added information, the predicted prices of each equation were plotted against actual prices. Equations (1) and (2) captured each turning point within the data series. Equations (3) through (6), however, missed the turn from 1978 to 1979.

CONCLUSION

All pecan research using data prior to 1970 resulted in an implied elastic farm level demand for pecans. Beginning in 1970, storage information for pecans became available. The unavailability of stock information prior to 1970 appears to offer an explanation for the previously estimated elastic farm level demands. In these earlier studies, either no consideration of stocks was taken or a proxy variable (all nut stocks excluding peanuts) was used.

Using data from 1970 to 1982, models similar to earlier research were estimated. Each of these attempts yielded a price flexible demand. When pecan carry-in stocks were included, the price flexibility point estimate (−0.97) approached −1, a unitary price flexibility. When the change in pecan stocks replaced the carry-in variable, the possibility of an inelastic demand resulted. Models in which pecan stocks are either ignored or measured by a proxy variable yield radically different policy prescriptions than do models

[4] OLS equations were estimated for each model. The possibility of a simultaneous system with a price impact on stocks was considered and two 2SLS models were evaluated. The first 2SLS model coupled equation (1), Table 1, with a stock equation containing reported price as an independent variable. The second 2SLS model substituted equation (2) for equation (1). In both cases, the price coefficient in the stock equation was not significant at reasonable levels. Our contention is that expected prices are the most important price consideration in dealing with changes in stocks and these are adequately represented by a variable representing the cyclical (on-year, off-year) production pattern of pecans. If this is the case, a recursive system between the stock and price equation results and OLS is appropriate.

[5] It should be pointed out that the bias for the production coefficient in equation (3) resulting from omitting the relevant explanatory variable, changes in stocks, is expected to be positive which explains the larger price flexibility (Kmenta, pp. 393-5).

in which pecan stock changes are incorporated. Admittedly, the degree of bias raised by omission of a variable or use of a proxy must be evaluated on a case-by-case basis. However, these results serve as a reminder of the ease with which severe problems can creep under the surface of an analysis and, yet, leave the surface calm.

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