Alternative Forms of Price Expectations in Supply Analysis For U.S. Corn and Soybean Acreages

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The consequences of frequently used price expectation models are analyzed by comparing the responsiveness of U.S. corn and soybean acreages to six alternative formulations. The trade-off between bias and variance associated with these forecasts is investigated. The results of this study have important implications for future research on supply analysis.

Key words: supply response, price expectations, government programs.

Identifying the appropriate formation of price expectations is a major challenge in supply response analysis for two reasons. First, uncertainty about how farmers formulate their price expectations has led researchers to propose different assumptions and hypotheses regarding the extent to which farmers use available outlook information in their planting decisions. As a result, different schemes have been used as proxies for price expectations in previous studies on supply analysis. The most common ones are adaptive expectations (Nerlove), naive expectations (Houck and Gallagher; Shumway and Chang), futures prices (Gardner 1976; Chavas, Pope, and Kao), effective support prices (Houck and Ryan; Houck et al.; Ryan and Abel), rational expectations formulations (Shonkwiler and Maddala), and other mixed formulas of market and support prices (Gallagher; Lidman and Bawden). Muth proposes an expectations model based on "the rational expectations hypothesis" which provides a consistent way of incorporating expectations into economic models. However, the rational expectations hypothesis generally is not used in supply response analysis because of the difficulties encountered in empirical applications (Nerlove, Grether, and Carvalho, p. 301).

Second, price expectations as proxies for "true" unobservable prices are subject to the bias and inconsistency problems associated with errors in variables and specification bias. If errors in variables are suspected, the selection criterion is to find out the proxies which are highly correlated with true prices and uncorrelated with the error term. However, high correlation between the proxy and true price is not a sufficient basis to ignore the potential bias caused by specification errors, such as the omission of a relevant variable (Garrod and Roberts). The impact of specification bias can be minimized by using more than one regressor as the proxy for the true price.

The previous work on supply response of field crops suggests the following points. There appears to be no a priori method to identify a superior specification for price expectations for empirical supply response analysis. Furthermore, there appears to be little agreement among researchers on which specification for price expectations should be used in empirical work.

Since these conclusions are based on aggregate supply response studies, they may not reflect the way in which individual decision makers formulate their price expectations (Fisher and Tanner). Analyses that used data obtained from individual farmers have shown that the adaptive expectations hypothesis performed well in explaining price expectations of farmers (Fisher and Tanner; Valentine). These studies provide no empirical evidence to support the use of the extrapolative or the

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rational expectations hypotheses. In contrast, Turnovsky provides empirical evidence favoring the extrapolative scheme. In addition, his results suggest that both the extrapolative and adaptive expectations models tend to be inconsistent with the assumption of rationality. For a predictive scheme to be rational, it is necessary for the expectations and the realizations to follow the same autoregression (Turnovsky). But results of a test for rationality indicate that expectations of extrapolative and adaptive models do not follow the same autoregressive pattern of price realizations. Thus, this violates the requirements imposed by Muth for expectations to be rational; namely, expectations should be unbiased and accurately reflect movements in price realizations.

Previous studies provide another result in that the sum of the lag coefficients is less than unity (Valentine; Jonson and Mahoney). Therefore, imposing the restriction that this sum is unity will underestimate the coefficient on price expectations and thus produce misleading policy implications.

Since most formulations of price expectations have shortcomings (Cowling and Gardner), the choice of any particular specification needs to be based on the performance of alternative formulations in supply response equations of a particular commodity. This, however, may not be a matter of simply selecting one of the alternative schemes to represent price expectations. This task is particularly difficult for crops subject to farm programs. As Morzuch, Weaver, and Helmberger argue, these programs change every three to five years and tend to complicate supply estimation because relevant variables and structural parameters may change over time.

The objective of this study is to analyze alternative specifications of price expectations in explaining fluctuations in U.S. corn and soybean acreages. Results from this study should be useful in identifying which specifications of price expectations are most appropriate for further research. Furthermore, these results should be useful in evaluating the impact of using any particular specification of price expectations.

Conceptual Framework

A basic economic model explaining planted acreage of a crop can be formulated as a function of expected prices for the crop in question and competing crops and other exogenous variables. In its simplest form, the supply response model is:

$$(1)\quad PA_t = B_0 + B_1 P_{it}^* + B_2 P_{jt}^* + B_3 T + U_t,$$

where PA is planted acreage; P_j^* is expected own price; P_j^* is expected price of a competing crop, j; T represents all other exogenous variables, and U_t is a stochastic disturbance term.

To complete the stochastic specification of the model, the following autoregressive moving-average (ARMA) model for P_t is assumed:

$$(2)\qquad \alpha(L)P_t = \gamma(L)\epsilon_t,$$

where ϵ_t is a white noise process independent of U_t, and $\alpha(L)$ and $\gamma(L)$ are polynomials in the lag operator L of degree p and q, respectively.

With the lack of structural information regarding the generation of the exogenous variable, P_t, the optimal one-step forecasts are given by (see Wallis, pp. 52–53):

$$(3)\qquad P_t^* = -\alpha_1 P_{t-1} - \ldots - \alpha_p P_{t-p} + \gamma_1 \epsilon_{t-1} + \ldots + \gamma_q \epsilon_{t-q}.$$

The impact of past information on prices can be measured by substituting (3) for P_t^* in (1) which then may be estimated jointly with the ARMA model, (2). If expectations are formed rationally, the model can be estimated using a nonlinear systems procedure in which expectational consistency requires cross-equation constraints. The imposition of cross-equation parameter constraints by full systems estimation has a major limitation, because a single misspecification in any equation leads to inconsistent estimates of all parameters in the model (Cumby, Huizinga, and Obstfeld). Alternately, this time-series model can be estimated by an appropriate procedure to generate the one-step forecasts. The constructed forecasts can be treated as data in equation (1) which, in turn, can be estimated by a standard ordinary least squares procedure. This is essentially the method of "quasi-rational expectations" as developed by Nerlove, Grether, and Carvalho (pp. 302–08).

While the distributed lag model offers a conceptual framework for this study, it is subject to theoretical and statistical limitations. To overcome these difficulties, this study uses simpler procedures to reflect price expectations. Selected proxies for price expectations are used in supply analysis. Each alternative specification of price expectations is treated as an explanatory variable in a single-equation regression model, equation (1). Treating price as exogenously determined is consistent with the theory of a competitive firm which assumes that producers are price takers. Also, market price during harvest is unknown to producers while making planting decisions, so price expectation must be an exogenous variable. Alternative specifications of price expectations are used because a superior formulation for empirical analysis is difficult to identify.

Empirical Specification of Price Expectations

Six alternative specifications of price expectations are considered in this study. Each of the first three models uses a single source of market information. The naive expectations model specifies that the expected price is the same as the market price in the previous year. In the futures price model the price associated with a futures contract at harvest is used for price expectations. Similarly, the effective support price model bases price expectations on the effective support price. Alternatively, other models of price expectations combine more than one set of market information.

The conditional price expectations model draws upon Anderson, Dillon, and Hardaker (pp. 34–41). With this specification, expected price is calculated on the basis of a joint distribution of market and support prices. The estimated relationship between market and support prices in any period is assumed to be based on observed relationships during the previous five-year period. The mean of support price, $E(SP)$, the standard deviations of market price and support price, σ_{MP} and σ_{SP}, and the correlation between market price and support price, $r_{MP,SP}$, are calculated on the basis of observed data for the previous five years. Assuming that market price (MP) and support price (SP) are jointly normally distributed, then the mean of the conditional distribution of market price (P_t^*) is defined as:

$$(4) \qquad P_t^* = E(MP \mid SP = SP^*) = E(MP) + r_{MP,SP}(\sigma_{MP}/\sigma_{SP})(SP^* - E(SP))$$

where SP^* is the annual announced or weighted support price, and $E(MP)$ is expected market price. The expected market price is specified in two different ways. One is based on approximating $E(MP)$ by lagged cash price, P_{t-1}, hereafter referred to as "conditional expectations based on cash prices." The other is based on substituting futures price for lagged cash price as a proxy for $E(MP)$, hereafter referred to as "conditional expectations based on futures price." Substituting futures for lagged cash prices is supported by earlier results (Gardner 1976; Chavas, Pope, and Kao) which suggest that both prices may reflect similar information. Further, combining information on futures prices and support prices may provide better estimates of price expectations than futures prices alone. This is an important issue since previous work found that including both series as separate variables reduced the efficiency of futures prices (Chavas, Pope, and Kao).

The conditional expectations models examine expectations in the presence of price supports in a manner similar to Gardner's (1987, pp. 280–82) approach in that *ex ante* expectations of prices are revised by the existence of the support prices, irrespective of whether the intervention mechanism becomes effective, *ex post,* in any particular year. However, the conditional expectations models are empirically more tractable than Gardner's model in that they do not require a nonlinear relationship between price variables. The approach suggested by Gallagher is considerably more general and allows for relating the expected market price and the support price in forming price expectations under government intervention. However, the procedure depends on whether the support price becomes effective, *ex post,* in any particular period. The determination of the effectiveness of the support price is an *ex post* consequence which is not known at the time farmers make their planting decisions.

The final model combines futures prices and cash market prices to specify price expectations. Previous studies suggest that near observations of futures prices (FP) are more powerful than the distant ones in predicting cash prices (Just and Rausser; Leuthold). Theoretically, this finding is consistent with the Koyck approach to lag models:

$$(5) \qquad P_t = \alpha + \beta_0 FP_t + \beta_1 FP_{t-1} + \beta_2 FP_{t-2} + \dots + V_t,$$

where V_t is a stochastic disturbance term. Furthermore, it is assumed that the βs decline geometrically:

$$(6) \qquad \beta_k = \beta_0\lambda^k,\ k = 0, 1, \ldots \text{ and } 0 < \lambda < 1,$$

where λ is the rate of decline. Equation (6) implies that as one goes back into the distant past, the effect of past futures price on current cash price becomes progressively smaller. Following the Koyck transformation (Gujarati, pp. 261–63), the final model to be estimated is:

$$(7) \qquad P_t = \alpha(1 - \lambda) + \lambda P_{t-1} + \beta_0 FP_t + N_t,$$

where $N_t = (V_t - \lambda V_{t-1})$. The statistical properties of N_t depend on what is assumed about the statistical properties of V_t. Since the V_ts are assumed to be serially uncorrelated, the N_ts are serially correlated but not according to the first-order autocorrelation scheme. This error is generated by a moving-average process, meaning that adjacent errors are correlated, but errors two or more periods distant are uncorrelated (Kennedy). Therefore, the coefficient estimates of equation (7) by the use of ordinary least squares (OLS) are inconsistent. To avoid this difficulty, an iterative search procedure was used to obtain consistent estimates under the assumption of the MA(1) disturbance process (see Johnson, pp. 368–71 for details). The predicted values from equation (7), P_t^*, hereafter referred to as "Koyck-type expectations," are used for price expectations in equation (1).

Data and Variable Measurements

Planted acreage of corn and soybeans in the U.S. was analyzed for the 1951–86 period. Expected farm prices of corn and its major competitor, soybeans, were measured according to the six procedures of price expectations described earlier. The effective support price data used for corn followed the development of Houck and Ryan; Ryan and Abel; Houck et al.; and Gallagher. The announced support price was used for soybeans, because diversion programs were not in effect for this commodity.

Conditional price expectations were calculated as follows. Historical observations of the 1948–86 period were used on a five-year moving sample basis to construct σ_{MP}, σ_{SP}, and $r_{MP,SP}$ to empirically implement the conditional expectations for corn and soybean prices. For each commodity, σ_{MP} is the standard deviation of seasonal average prices received by farmers for corn, σ_{SP} is the standard deviation of weighted loan rate, and $r_{MP,SP}$ is the correlation coefficient between farm price and weighted loan rate.

Following Chavas, Pope, and Kao, futures prices of corn and soybeans were collected for December and November contracts, respectively. Since it was not clear exactly when the acreage decision was made, the futures price quotations in the period preceding the planting season were used (Gardner 1976; Chavas, Pope, and Kao). Futures prices observed on March 15 by the Chicago Board of Trade were chosen in the analysis for both corn and soybeans. Only a single observation of futures prices was used on the assumption that daily fluctuations in prices are relatively small.

U.S. Department of Agriculture estimates of variable costs of producing selected field crops are considered the best available estimates for production costs of corn and soybeans. The index of prices paid by farmers for production items, interest, taxes, and wage rates was used to adjust the cost values for the 1948–86 period.

In addition to effective support price, two other policy variables were considered for corn. These variables reflect effective (weighted) diversion payment and payment-in-kind (PIK) programs. The effective diversion payment was based on the formulation used by Houck and Ryan; Ryan and Abel; Houck et al.; and Gallagher. The PIK program, which was designed to reduce planted acreage, was accounted for by the use of a dummy variable with a value of one for 1983 and 1986 and zero otherwise.

Market risk was represented by price risk. The risk variables were calculated as deviations of corn and soybean prices from three-year moving averages following Gallagher's procedure.

Estimation and Results for Corn and Soybean Acreage Response Models

The estimated corn and soybean acreage response models under various scenarios of price expectations are presented in tables 1 and 2, respectively. The estimates have the right signs and most of them are significantly different from zero at the 5% or 1% levels. The coefficient of lagged corn and soybean acreages

Table 1. Estimates of U.S. Corn Acreage Response Model under Alternative Procedures of Price Expectations, 1951-86[a]

	Price Expectations					
Variables	Naive Expectations	Futures Price	Effective Support Price	Conditional Expectations Based on Futures Price	Conditional Expectations Based on Cash Price	Koyck-Type Expectations
Constant	14,932.29 (1.13)	21,554.32 (1.77)$^{+}$	37,672.82 (3.24)**	38,497.77 (5.08)*	32,132.17 (2.86)**	16,354.61 (.78)
Lagged dependent variable	.2995 (3.81)**	.2935 (3.36)**	.2302 (2.74)*	.2743 (3.63)**	.3214 (3.87)**	.2952 (3.41)**
Weighted diversion payment of corn ($/bu.)	−45,205.30 (−6.60)**	−49,925.43 (−8.10)**	−37,100.33 (−4.94)**	−44,109.85 (−7.05)**	−49,330.70 (−7.39)**	−48,323.65 (−6.91)**
Expected price of corn/production variable cost of corn	6,372.90 (2.40)*	5,600.06 (2.20)*	4,675.18 (2.88)**	5,129.88 (3.22)**	3,628.22 (1.98)$^{+}$	6,603.83 (1.88)$^{+}$
Expected price of soybeans/production variable cost of soybeans	−2,302.09 (−1.35)	−2,440.59 (−1.18)	−2,047.69 (−1.27)	−1,486.57 (−1.66)$^{+}$	−1,764.06 (−1.63)	−2,122.09 (−1.01)
Trend (1951 = 51, . . . , 1986 = 86)	512.39 (3.78)**	452.46 (3.77)**	297.83 (2.33)*	244.34 (3.84)**	322.21 (3.13)**	491.78 (2.28)*
Price risk of corn	−2,102.38 (−.59)	−446.95 (−.14)	−2,809.90 (−1.03)	−365.54 (−.15)	−2,796.00 (−1.06)	−2,674.69 (−.98)
PIK variable (PIK = 1 for 1983 and 1986, 0 otherwise)	−15,373.94 (−5.56)**	−15,267.79 (−5.31)**	−16,377.81 (−5.30)**	−16,545.22 (−6.16)**	−15,032.65 (−5.93)**	−14,285.00 (−5.19)**
Expected deficiency payments of corn[b]	1,562.80 (.79)	2,357.01 (1.23)	4,618.29 (1.60)	4,036.71 (2.95)*	876.13 (.57)	994.10 (.56)
R^2	.89	.89	.91	.91	.90	.89
F-Statistic	28.74**	28.33**	34.32**	33.44**	27.83**	26.59**
Durbin *h*-Statistic[c]	.31	−.03	−.08	.54	.45	.33

[a] Dependent variable is U.S. corn planted acreage (1,000 acres).

[b] Expected deficiency payments of corn = target price of corn − conditional expected price of corn.

[c] *h*-statistic is ~$N(0, 1)$. The critical *h* value is 1.645 at the .05 level of significance.

Note: Numbers in parentheses are *t*-statistics. Significance levels with 27 degrees of freedom are $^{+}$ for .10, * for .05, and ** for .01, respectively.

Table 2. Estimates of U.S. Soybean Acreage Response Model under Alternative Procedures of Price Expectations, 1951-86[a]

Variables	Price Expectations					
	Naive Expectations	Futures Price	Effective Support Price[b]	Conditional Expectations Based on Futures Price	Conditional Expectations Based on Cash Price	Koyck-Type Expectations
Constant	−10,002.54	−29,586.26	−19,828.10	−29,559.91	−18,414.65	−38,084.79
	(−.595)	(−1.588)	(−1.195)	(−1.956)$^+$	(−1.277)	(−1.559)
Lagged dependent variable	.8201	.7272	.7232	.6737	.7510	.6688
	(6.279)**	(4.995)**	(4.654)**	(4.653)**	(5.857)**	(4.844)**
Expected price of soybeans/production variable cost of soybeans	5,773.83	5,856.06	379.64	2,142.98	3,397.72	5,379.77
	(4.187)**	(3.402)**	(.292)	(2.400)*	(3.458)**	(2.939)**
Expected price of corn/production variable cost of corn	−5,044.96	−3,574.04	−115.69	−988.22	−2,343.99	−2,848.31
	(−2.435)*	(−1.581)	(−.091)	(−.969)	(−1.524)	(−.881)
Trend (1951 = 51, . . . , 1986 = 86)	183.688	472.39	463.27	582.98	365.51	619.87
	(.646)	(1.514)	(1.551)	(2.10)*	(1.440)	(1.767)$^+$
R^2	.9806	.9784	.9694	.9741	.9779	.9769
F-Statistic	393.37**	352.35**	245.76**	292.35**	343.59**	327.99**
Durbin h-Statistic[c]	.879	−.440	.216	1.057	.533	−1.380

[a] Dependent variable is U.S. soybean planted acreage (1,000 acres).

[b] For soybeans the effective support price is equal to the announced support level.

[c] h-statistic is $\sim N(0, 1)$. The critical h value is 1.645 at the .05 level of significance.

Note: Numbers in parentheses are t-statistics. Significance levels with 31 degrees of freedom are $^+$ for .10, * for .05, and ** for .01, respectively.

Table 3. Decomposition of the Mean-Squared Errors into Bias, Variance, and Covariance Components

	Corn (.3980)[a]				Soybeans (3.5374)[a]			
Price Expectations	MSE	Bias Component	Variance Component	Covariance Component	MSE	Bias Component	Variance Component	Covariance Component
Naive expectations	.09096	.000177	.3962	−.70341	.72301	.003566	3.5802	−6.3981
Futures price	.14645	.019290	.5462	−.81704	.59174	.001111	3.6413	−6.5881
Effective support price	.37161	.146518	.3005	−.47341	3.0801	1.07237	1.5636	−3.0932
Conditional expectations based on futures price	.43677	.031558	.8632	−.85598	.91738	.000005	3.7334	−6.3534
Conditional expectations based on cash price	.13123	.000184	.4538	−.72075	.79485	.008860	3.9576	−6.7090
Koyck-type expectations	.08478	.000007	.2655	−.57873	.56313	.000002	3.0247	−5.9989

[a] Numbers in parentheses are variances of the actual prices.

(.23–.32 and .67–.82, respectively) are highly significant and positive, suggesting that a period of more than one year is required for the economic adjustments in corn and soybean acreages.

To further analyze the alternative formulations of price expectations, the mean-squared errors (MSE) of the one-step ahead forecasts of the 1951–86 period were decomposed into bias, variance, and covariance components following a procedure outlined by Just and Rausser. Accordingly, the following formula was used for decomposition:

$$MSE = (\bar{Y} - \bar{X})^2 + \sigma_X^2 + \sigma_Y^2 - 2\sigma_{XY},$$

where Y and X are predicted and actual prices, respectively. The term $(\bar{Y} - \bar{X})^2$ is the bias squared, σ_Y^2 is the forecast variance, σ_X^2 is the actual variance, and the term $-\ 2\sigma_{XY}$ is the covariance component. The results of this process are presented in table 3. The main implication of the decomposition is that the type of error varies by model and commodity. For example, in corn the effective support price has the highest bias followed by conditional expectations based on futures price and by futures price. For soybeans, the highest bias is associated with the effective support price followed by conditional expectations based on cash price and naive expectations.

For both commodities, the two conditional expectations show high forecast variability compared with other procedures of price expectations (see variance component in table 3). However, this high forecast variance is caused by introducing the variability of historical prices (measured by σ_{MP} and σ_{SP}) into the formulation of conditional price expectations [equation (4)]. Unlike the other forms of expectations, conditional expectations allow for supply adjustment in response to historical variability. On this issue Pope shows that aggregate supply may respond to the variability of historical prices, regardless of risk attitude.

Since futures prices are biased forecasts and have greater variance than naive expectations, futures and lagged cash prices are not good substitutes in corn acreage supply response analysis. This argument is further supported by the bias created in conditional expectations when futures price is substituted for lagged cash price. This result differs from Gardner (1976) and Chavas, Pope, and Kao who argue that these two series may reflect similar information. Similar conclusions hold for soybeans with more bias associated with the lagged cash price and its corresponding conditional expectations.

Effective support price greatly underestimated the expected price, suggesting that this proxy variable may not reflect all available information. The bias may be attributed to specification error in the form of an omitted relevant variable, such as lagged cash price. Meanwhile, Koyck-type expectations are unbiased and have the minimum forecast variance.

The trade-off between bias and variance components among alternative price expectations is important to decision makers for choosing one method over another. Given the assumption that a firm's profit is inversely related to forecast error, a risk-neutral firm may trade higher variance for lower bias. Alterna-

Table 4. Estimates of Short-Run and Long-Run Elasticities for U.S. Corn and Soybean Acreages[a]

	Corn				Soybeans			
	Own-Price Elasticity		Cross-Price Elasticity		Own-Price Elasticity		Cross-Price Elasticity	
Price Expectations	Short Run[b]	Long Run	Short Run[b]	Long Run	Short Run[b]	Long Run	Short Run[b]	Long Run
Naive expectations	.199 (.082)	.284	−.095 (.070)	−.136	.404 (.199)	2.245	−.252 (.150)	−1.401
Futures price	.187 (.085)	.263	−.103 (.087)	−.145	.410 (.214)	1.576	−.179 (.137)	−.687
Effective support price	.116 (.041)	.151	−.068 (.053)	−.088	.019 (.065)	.068	−.005 (.055)	−.018
Conditional expectations based on futures price	.175 (.057)	.240	−.063 (.038)	−.086	.150 (.089)	.454	−.059 (.066)	−.179
Conditional expectations based on cash price	.109 (.056)	.160	−.071 (.044)	−.104	.241 (.125)	.964	−.129 (.101)	−.516
Koyck-type expectations	.213 (.116)	.305	−.091 (.090)	−.130	.412 (.226)	1.248	−.164 (.199)	−.497

[a] The elasticities were calculated at the mean values of the corresponding variables.

[b] Numbers in parentheses are the asymptotic standard errors of estimated elasticities.

tively, a risk-averse firm may accept biased forecasts in favor of lower variance (Just and Rausser). Accordingly, a risk-neutral decision maker may use Koyck-type expectations, conditional expectations based on cash price, and naive expectations in modeling supply response for corn. Likewise, a risk-neutral decision maker may choose Koyck-type expectations, futures price, and conditional expectations based on futures price in modeling supply response for soybeans. On the other hand, a risk-averse decision maker may prefer the lower variability of effective support price, Koyck-type expectations, and naive expectations for both commodities. As indicated earlier, the relatively high variability of conditional expectations can be attributed to the use of historical variability measures in its formulation, and thus it is difficult to compare conditional expectations with other formulations on the basis of type of error.

Elasticities

Short-run elasticities of corn and soybean acreages with respect to various specifications of price expectations were calculated using mean values for the 1951–86 period (table 4). To account for the adjustment process, long-run elasticities were estimated following the partial adjustment hypothesis of Nerlove.

The short-run elasticities of corn acreage with respect to its expected price ratios range between .109 and .213, with conditional expectations based on cash price and Koyck-type expectations being the lower and upper limits, respectively. The range is .019 to .412 for soybean acreage with respect to its price ratios, with effective support price and Koyck-type expectations identifying the lower and upper bounds of the range, respectively.

To test for statistically significant differences among these elasticities, the asymptotic variances of the estimated elasticities were calculated from the following formula (Miller, Capps, and Wells):

$$S_{\hat{\eta}}^2 = \hat{\eta}^2 \left[\frac{S_{PA}^2}{\widehat{PA}^2} + \frac{S_{b_1}^2}{b_1^2} \right],$$

where $\hat{\eta}$ is the estimated elasticity with respect to the expected price evaluated at mean levels, $\widehat{PA}$ is the predicted acreage, b_1 is the estimated slope coefficient, and S^2 is the estimated variance of subscripted variables.

The estimated variances were then used to test whether the estimated elasticities were statistically different from each other by using the F-test with one degree of freedom in the numerator and $n - k$ degrees of freedom in the denominator (where n is number of observations and k is the number of parameters including the intercept) (Miller, Capps, and Wells). Using pair-wise comparisons, nine out of 15 pairs of corn own-price elasticities and 12 out of 15 pairs of soybean own-price elasticities were significantly different from each other at the 5% level. The elasticities can generally be grouped into three categories. The elasticities based exclusively on market signals (naive, futures, and Koyck) are higher than other elasticities but not statistically different from each other. The elasticities based exclusively on government signals (support rates) are significantly lower than most other elasticities. The elasticities based on a combination of market and government signals (conditional expectations) lie between the other elasticities and in several cases are significantly different from elasticities that are based exclusively on either market or government signals.

Nonnested Test for Alternative Specifications of Price Expectations

The *J*-test proposed by Davidson and MacKinnon (1980, 1981) is used to test for nonnested specifications of price expectations. The validity of the following linear regression model with one form of price expectations

$$(8) \qquad H_0\colon Y_t = f_t(X_t, \beta) + \mu_{0t}, \quad \mu_{0t} \sim N(0, \sigma_0^2)$$

is tested against the evidence provided by an alternative specification of price expectations,

$$(9) \qquad H_1\colon Y_t = g_t(Z_t, \gamma) + \mu_{1t}, \quad \mu_{1t} \sim N(0, \sigma_1^2),$$

where Y_t is the t^{th} observation on the vector of the dependent variable, planted acreage; X_t and Z_t represent the t^{th} observations on vectors of exogenous variables; β and γ are a K vector and an L vector of parameters to be estimated.

To implement the test, the following linear regression is estimated

$$(10) \qquad Y_t = (1 - \alpha) f_t (X_t, \beta) + \alpha g_t(Z_t, \hat{\gamma}) + \mu_t,$$

where $\hat{\gamma}$ is the least squares estimate of γ from equation (9). The test statistic is then the *t*-statistic on α, which is asymptotically $N(0, 1)$ if H_0 is true. Davidson and MacKinnon called this test the *J*-test because β and α are estimated jointly. Testing each model against the evidence provided by the other may result in one model being rejected while the other is not, both models being rejected, or neither model being rejected. This implies that the *J*-test is designed for testing model specification, not for choosing among competing models (Davidson and MacKinnon 1981). For choosing among competing models, model selection criteria are required, whereas nonnested hypothesis tests are used for testing model specification. Model selection criteria are appropriate when the concern is to choose one out of a group of competing models. Nonnested hypothesis tests, on the other hand, are tests of model specification which rely on the existence of nonnested alternative models. The application of such tests to two alternative models cannot, in general, result in choosing one of the two. But it provides evidence that one of the models, or perhaps both models, are misspecified (MacKinnon).

Table 5 represents the statistics of pair-wise tests of each price expectation against each of the other alternatives. Each row relates to a particular tested hypothesis while each column relates to the alternative. Results of table 5 allow for any pair-wise comparison among the alternative specifications of price expectations. However, only the comparisons of "combined" versus "individual" expectations are emphasized in this section.[1] Testing the individual corn price expectations against the combined alternatives shows that all individual price expectations are rejected in favor of the conditional expectations based on futures price at the 5% level for naive expectations and futures price and the 10% level for effective support price. Similarly, the truth of both futures and effective support prices is also rejected against the conditional expectations based on cash price. However, none of the individual expectations are rejected in favor of the Koyck-type expectations. Reversing the test by considering the combined expectations as the tested hypothesis against the individual expectations as alternatives, suggests that all combined expectations be rejected in favor of the effective support price. Further, the hypothesis of conditional expectations based on cash price is rejected in favor of futures price.

For soybeans, the results are somehow different from those of corn. Testing the individual expectations against the combined alternatives indicates that only the effective support price hypothesis is rejected in favor of all the

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[1] Combined expectations refer to conditional expectations based on futures price, conditional expectations based on cash price, and Koyck-type expectations. Individual expectations include naive expectations, futures price, and effective support price.

Table 5. *J*-Test Statistics for Specification of Alternative Price Expectations for Corn and Soybeans

	Alternative Hypotheses					
Tested Hypotheses	Naive Expectations	Futures Price	Effective Support Price	Conditional Expectations Based on Futures Prices	Conditional Expectations Based on Cash Price	Koyck-Type Expectations
Corn						
Naive expectations		.642	2.901**	2.196*	1.317	−.408
Futures price	.843		2.408*	2.245*	1.938^{+}	−.014
Effective support price	1.039	.441		1.941^{+}	2.000^{+}	.310
Conditional expectations based on futures price	.904	.796	2.096*		.827	.025
Conditional expectations based on cash price	1.648	2.250*	4.029**	3.069**		1.341
Koyck-type expectations	1.436	1.236	2.817**	3.218**	1.601	
Soybeans						
Naive expectations		.161	1.872^{+}	1.543	.892	.209
Futures price	1.885^{+}		1.328	.992	1.677	−.669
Effective support price	4.851**	3.934**		2.396*	3.780**	3.201**
Conditional expectations based on futures price	3.840**	3.046**	.298		2.769**	2.795**
Conditional expectations based on cash price	2.303*	1.915^{+}	1.490	1.313		1.477
Koyck-type expectations	2.475*	1.630	.622	.955	1.933^{+}	

Note: Numbers in the table are asymptotic *t*-statistics. Significance levels are $^{+}$ for .10, * for .05, and ** for .01 percent, respectively.

combined expectations. The hypotheses of naive expectations and futures prices are not rejected against any of the combined expectations. Reversing the test, however, shows that all the combined expectations are rejected in favor of the naive expectations. Moreover, both conditional expectations are rejected against the futures price alternative. The effective support price, on the other hand, failed to reject any of the combined expectations, suggesting that the effective support price does not contain evidence sufficient to reject any of the combined price expectations for soybeans. Actually, all the specifications of price expectations provide evidence against the truth of the effective support price.

Every formulation of price expectations has been rejected against at least one alternative. No unique specification emerged as a single "best" for both commodities. However, conditional expectations based on futures price of corn and naive expectations for soybeans contained the most information, as evident by the results of the *J*-test. These results are generally consistent with those of Orazem and Miranowski in that no single expectation model dominates across commodities. However, this study is more conclusive as to whether a single "acceptable" empirical expectation regime can be found for a particular crop. This study considers a wide range of expectation regimes, and thus allows for discriminating among "program" and "free market" commodities with respect to the formulation of price expectations. As suggested by the *J*-test, price expectation models that combine support and market signals (e.g., conditional expectations based on futures price) are more acceptable for program commodities, e.g., corn. Meanwhile, models that assume producers base decisions exclusively on market signals (e.g., naive expectations) may be recommended for free market commodities, e.g., soybeans. Orazem and Miranowski, however, consider some expectation regimes based on market signals alone. Accordingly, their results were inconclusive even among program and free market commodities.

Concluding Remarks

This study shows that estimated elasticities of corn and soybean acreages are sensitive to the formulation of price expectations. Statistical tests indicated that own-price elasticity estimates could be divided into two groups. First, naive expectations, futures price, and Koyck-type expectations gave similar elasticity estimates. Second, effective support price, conditional expectations based on futures price, and conditional expectations based on cash price gave similar elasticity estimates. The elasticity estimates for the first group were higher and statistically different from the estimates for the second group.

The mean-squared errors associated with alternative expectations were decomposed into bias, variance, and covariance components. The main implication of the decomposition is that the type of error varies by model and commodity. In addition, the trade-off between bias and variance components among alternative price expectations is important to decision makers for choosing one method over another. Under the assumption that a firm's profit is inversely related to forecast error, a risk-neutral firm may trade higher variance for lower bias. Alternatively, a risk-averse firm may accept biased forecasts in favor of lower variance.

The results of the *J*-test show the performance of alternative price expectations is not consistent between corn and soybeans. For example, no single price expectation is nonrejected against at least one alternative for corn, while effective support price is the only specification which has been conclusively rejected for soybeans. Similarly, effective support price and conditional expectations based on futures price contain evidence sufficient to reject all the other price specifications for corn. For soybeans, however, naive expectations provide evidence against the truth of all the alternatives. If corn and soybeans are representative for "program" and "free market" commodities, respectively, no unique specification of price expectations is applicable for both groups. Conditional expectations based on futures price may be an acceptable specification for corn, while naive expectations are recommended for soybeans. However, a degree of caution is in order since each of these two price specifications has been rejected against one alternative. In fact, both specifications are rejected against the effective support price at the 5% and 10% levels for corn and soybeans, respectively. This does not suggest, however, that the support price provides a satisfactory explanation of the phenomenon under consideration given its frequent rejection against other alternatives.

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