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Soybeans Quality Price Differentials From An Elevator's Perspective

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Abstract

Soybean prices are determined by interaction between various factors. At an elevator, discount prices for unique characteristics can range from 0.02 cents per bushel to 7.71 cents per bushel of soybeans. This variation suggests that producers of soybeans need quality-characteristic specific information concerning soybeans pricing at the market. This study uses a hedonic model to evaluate price differentials associated with soybean quality based on grain elevator data during the 1998 production period. Foreign material, moisture, bean damage, and net weight were found to significantly influence the cash price of soybeans.

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Introduction

Consumers and processing plants have become more discriminating food buyers. Producers who respond to buyer's quality needs by supplying products with desirable quality attributes generally receive a higher price for such products. It is important for producers to understand the pricing mechanism of their respective commodity in order to be able to respond efficiently to the relevant price signals.

Mississippi produced 64 million bushels and 48 million bushels of soybeans in 1997 and 1998, respectively. Soybean acreage was 2.1 million acres and 2.05 million acres for these years, constituting 3% of total U.S. planted acres. The U.S. grows almost half of the world's soybean supply and soybeans are a leading dollar earner among U.S. agricultural exports. Soybeans are used in a diverse set of food and industrial products such as soybean oil, low fat sources of protein, other human food and beverages, livestock and poultry feed, adhesives, and cleansing materials, among others.

In the past, a commodity based pricing system was used to buy and sell soybeans. This system worked well because the seed industry was primarily concerned with yield and not with the amount of individual characteristics that might be present in the seed variety. Today, processors are looking more for specific quality attributes which are usually not reflected in commonly used standards in commodity pricing (Nielsen, et al.). It is critical that the value of the desirable quality characteristics be clearly transmitted to the producers because of the diverse end-users for soybeans (Parcell et al.).

Soybean elevators purchase soybeans in anticipation of soybean use by processors. Elevators are not overly concerned with the quality of soybeans, because it is to their advantage to have a varying quality. They improve their margin by blending high quality and low quality soybeans up to the point where the mixture's qualitative characteristics do not exceed required base levels. Despite this type of "averaging" the trend will likely be towards quality pricing as end-users demand specific quality characteristics. At present it is unclear whether information about quality differentials is available to producers, or whether they understand the impact of the pricing approach of the elevator on their margins. The objective of this study is to use the actual transaction price paid to soybean producers by elevators to desegregate the value, if any, attached to the quality characteristics.

Theoretical Model

According to Rosen, markets for a class of commodities can be described by *n* attributes or characteristics, $z = (z_1, z_2, ..., z_n)$. Consumers assume that the components of *z* can be objectively measured and are identical for each good. Each good has a quoted market price and is associated with a fixed value of the vector *z*. Product markets implicitly reveal a function $p(z) = p (z_1, z_2, ..., z_n)$ relating prices and characteristics (Rosen). The marginal cost of z_i to the consumer is $p_1 (z)$.

Following Ladd and Martin (1976), a perfectly competitive market in which elevators maximize their profit by purchasing soybeans to be used in the production of different soybean products is assumed. The first order conditions of the profit maximizing function $f_y(z)$ yield a hedonic price function which is represented by the following function:

$$P_x = R_y \Sigma (\partial f_y / \partial z_{ky}) (\partial z_{ky} / \partial x_y), \qquad (1)$$

where P_x is the price of input x,

R_y is the price of output y,

$\partial f_y / \partial z_{ky}$ is the value of the marginal product of characteristic k used in the production of y,

and $\partial z_{ky} / \partial x_y$ is the marginal yield of the kth characteristic in the production of y from input x.

Term $R_y \ \partial f_y / \partial z_{ky}$ is the marginal implicit price of the kth characteristic.

Equation (1) suggests that each input equals the sum of the product's marginal implicit prices of the input characteristics and the marginal yield of those characteristics (Espinosa and Goodwin). Equation (1) is presented as a linear hedonic price function:

$$P_x = \Sigma B_k \, z_{kxy},$$

where B_k is the marginal implicit value of the characteristic k and z_{kxy} is the quantity of characteristic k contained in each unit of input x that goes into the production function, y.

Data and Empirical Model

The data for this analysis included 1877 sales and purchase contracts for the 1998 production period from an elevator company in the Delta area of Mississippi. Table 1 presents a summary of the statistics for the data. When soybeans are delivered to the elevator, a sample of each shipment is taken. This sample is examined for test weight, foreign material, moisture, and other factors. Dockage, or discounts, are determined on the basis of these factors. The soybean net weight is determined by subtracting tare or empty truck weight from gross weight.

The market prefers low moisture percentage in beans. A moisture content of 13% is considered to be the base value above which discounts are applied. The base value for damage was 2%. Discounts were imposed on soybeans for heat damage exceeding 0.2%, foreign material above 1%, splits, musty and sour soybeans, and hot and heated soybeans.

Dockage is equal to the sum of all discounts that are applied in a particular transaction. It was obtained by summing up test weight, damage, foreign materials, and moisture. Net weight of the commodity was multiplied by percent dockage to obtain percent dockage weight. Discounted net weight in pounds was obtained by subtracting percent dockage weight from net weight.

The identifiable measured characteristics of soybeans at the elevator were: the test weight, damage, foreign matter, moisture, and net weight in bushels and in pounds. It is hypothesized that these attributes implicitly influence the cash price of soybeans. The net weight is determined by discounting producers by weight based on the sum of the percentage values of the above attributes. The futures price of the January contract for soybeans was included in the model to explain all general price changes due to the movements in supply and demand in the market through time. This would allow the other variables in the model to explain the net cash price as a price implicitly dependent on the qualitative characteristics of soybeans, while controlling for general price movements.

The following semi-log specification was selected from several potential forms to represent the empirical relationship between soybean market price and marginal implicit prices:

$$P = A\, e^{(\Sigma \beta_k z_k + \beta_f P_f)} \qquad (1)$$

where k=1,2,...5,

P is the net cash price of soybeans, \$/bu;

z_k are the qualitative characteristics, which are test weight, damage, foreign matter, moisture, and net weight;

$\beta_k z_k$ represent marginal implicit price for the k=5 soybeans characteristics;

P_f is the future price of the near month contract to production.

After transformation of equation (1) into its log-linear form it is written as follows:

$$\ln P = \alpha_0 + \sum \beta_k z_k + \beta_f P_f$$

All quality variables except test weight are expressed in percentage terms (e.g., percent moisture). Test weight is used as a qualitative variable in the model. Because there is no discount for a test weight of 54 pounds or more, a dummy variable was created to eliminate the observations with test weight of 54 pounds and above (e.g. d=1 if test weight < 54; d=0 otherwise) (Figure 1). This dummy variable was multiplied by the test weight to become d*TW. The percent test weight was calculated by dividing d*TW by 54 pounds and multiplying it by 100 percent. The net cash price for soybeans was calculated by finding the difference between cash price paid by the elevator for soybeans on that particular day and the same cash price multiplied by the total percentage discount for each transaction on of the same day.

Both auxiliary regressions and tolerance values were used to gauge and avoid multicollinearity. There was no evidence of redundance in any of the predictors included in the model. Auxilliary regressions involve regressing each explanatory variable with each of the other explanatory variables. Tolerance is a statistical indicator of redundancy of variables that comes with multicollinearity. The tolerance of a variable is defined as 1 minus the squared multiple correlation of the explanatory variable in question with all the other independent variables in the regression equation. The smaller the tolerance of a variable, the more redundant is its contribution to the regression. Residual normality was tested using the Shapiro-Wilks test. An initial analysis of residuals for the regression model using Mahalanobis distance identified 16 distinct outliers, which when excluded, resulted in a failure to reject normality at 0.01 significance level.

Results

The estimated parameters for Equation 1 for both standardized regression coefficients (*BETA*), raw regression coefficients (B), tolerance, and partial correlation are presented in Table 2. Standardized regression coefficients are the result obtained through standardizing all variables to a mean of zero and standard deviation of 1. Their magnitude allows for the comparison of the relative contribution of each explanatory variable to the variation of the dependent variable. Similarly, the partial correlation is an indicator of the unique contribution of the respective explanatory variable to the prediction of the dependent variable. Both the *BETA* and partial correlation coefficients were used to identify the proportion of variation in soybean cash prices that is attributable to each of the explanatory variables.

The estimated model explained 95 percent of the variation in soybean cash prices during the production period under consideration. The computed $F(6,1180)$ of 3858.433 was statistically significant, suggesting that at least one of the slope coefficients was non-zero. All of the coefficients were statistically significant at the $\alpha = 0.01$ level. While a positive parameter estimate indicates a premium, a negative parameter estimate shows discounts relative to the average percent value for the respective characteristic, or base value in the case of Test Weight as a Percent of the Base. For example, the explanatory variable, Test Weight as a Percent of the Base (54 lbs), had a statistically significant coefficient estimate of 0.00009. Producers received a premium of .009 cents per bushel of soybeans for the net weight of their beans. The elevator preferred larger net weights to smaller ones.

The model was estimated using the values for January 1999 cash contracts as a control explanatory variable whose primary function was to account for movements in supply and demand for soybeans in the market. As expected, the estimated coefficient was 0.182, which was statistically significant. Therefore, if the average January futures price increased by a dollar, the average estimated cash price for soybeans would also increase by 18 cents. Based on both the values for the partial correlation and standardized BETA, this variable contributed the second most, after foreign material, to the explanation of variation in the cash price of soybeans (Table 4)

Producers suffered a 12 cent discount for a one percentage point increase in the percent moisture content of soybeans delivered to the elevator. Benefit-cost information may aid producers in making the decision on whether to invest in on-farm drying facilities based on the showing of the implicit price for moisture. The 1998 crop year experienced an uncharacteristic wet production period which required producers to either put in place additional grain drying procedures, or incur added discounts due to relatively high moisture content of grains delivered to the elevator. Both the *BETA* value and partial correlation, -0.296 and -0.620, respectively, reported for moisture showed the variable to be the third largest contributor to the variation of soybean cash price. The estimated average price discounts for moisture above the base value of 13% range from -.72 cents/bu to -7.17 cents/bu between 14% and 23% moisture, respectively (Table 4 and Figure 2).

The elevator imposed an average discount of approximately 12 cents per bushel for a one percentage point increase in the foreign material percentage measured in incoming beans. The implicit value represents the cost associated with handling and blending by the elevator to bring to the base level (at Base $\leq$1%). Using the reported values of the standardized regression coefficients and partial correlations, -0.73 and -0.91, respectively, the percentage of foreign material in the grain contributed most to the variation in soybean cash price. Uncharacteristic heavy rains during the 1998 production period made many weed management and control efforts by producers ineffective, which led to larger than usual discounts. The opportunity cost of separating foreign material from beans may be the least expensive activity that the producer could undertake in order to reduce the level of discounts to their beans. Proper adjustment of the harvesting equipment would help in reducing the level of foreign material delivered with grains to the elevator. Both Table 4 and Figure 2 show the estimated price discounts due to foreign material as second to that imposed on producers due to the moisture content of their sales.

Producers incurred about a 5 cent price discount for a one percentage point increase in percent damage to the beans. In the short-run, this implicit value represents the cost associated with the elevator accepting damaged beans. In the long-run, the implicit value may represent the costs associated with putting in place measures to eliminate damage to the beans prior to delivery to the grain elevator. Values for the partial correlation and Beta indicate that percent damage was the fourth largest contributor to variation in cash price, after foreign material, January futures price. As shown in Table 4 and Figure 2, the percent damage above the base value at .02% elicited discounts which were smaller than those for both moisture and foreign matter, but larger than Test Weight as a Percent of the base value (54 lbs.).

Test weight as a percent of its base value received a premium of 0.0036 cents per bushel. This implicit value represents the extra benefit associated with getting the beans to at least equal the base weight of 54 pounds. According to the estimated price discount ranges on Table 4, the closer to the base weight the Test Weight of the beans was, the less discounts the producer incurred at the elevator. When compared to the rest of the characteristics, both the Test Weight as a percent of its base value and Net Weight in bushels had the least impact, and resulted in the least penalties and premiums, respectively. The two variables also contributed least to explaining the variation in the cash price of soybeans (Table 4).

Conclusions and Recommendations

This study used elevator soybean sales data for the 1998 production period to estimate the price differentials associated with measurable quality attributes of soybeans. A hedonic model was used to estimate the model. The study showed that the soybean moisture, foreign material, damage, and test weight below the base level of the beans, received discounts and were therefore important in determining the average net cash price of soybeans. The net weight (in bushels) of soybeans registered a premium, which suggests that the elevator preferred large deliveries to small ones. However, it must be noted that these results are preliminary. Future plans are to expand the data set to cover multiple crop years and a variety of locations. This will allow examination of locational differences arising from, for example, proximity to major shipping points.

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Appendix

Table 1. Summary Statistics of Soybean Characteristics for the Selected Elevator During 1998 Production Period. (N=1187)

Variable	Mean	Minimum	Maximum	Standard Deviation.
January Contract Price	5.4670	5.207500	5.745	.1669
Test Weight as % of Base	39.6558	0.000000	99.630	47.4557
Percent Damage	0.7858	0.000000	19.600	2.0714
Net Weight (Bushels)	653.0634	5.200000	1253.290	275.2887
Percent Foreign Material	4.9886	0.000000	47.400	4.5964
Percent Moisture	12.5354	8.000000	19.500	1.6677

Table 2. Parameter Estimates for Hedonic Pricing Model for Soybean Average Discount Characteristics

Explanatory Variable	*B*-Raw	Tolerance	Partial Correlation	*BETA*- Standardized
Intercept	0.806365* (51.150)	-	-	-
January Contract Price	0.181766* (61.703)	0.917416	0.873725	0.412994*
Test Weight as % of Base	0.000036 (3.249)	0.799114	0.094162	0.023301*
Percent Damage	-0.005050* (-20.729)	0.871038	-0.516658	-0.142389*
Net Weight (Bushels)	0.000009* (5.363)	0.953784	0.154267	0.035208*
Percent Foreign Material	-0.012288* (-110.117)	0.843237	-0.954629	-0.768779*
Percent Moisture	-.011668* (-34.807)	0.709744	-.711749	-0.264872*

The t-values are shown in parenthesis. A single asterisk denotes estimates that are significantly different than zero at a 99% confidence level. (%) denotes the average percentage of soybean that took the respective characteristic.

Table 3. Estimated Soybean Price Discount Tables

Mid- % Foreign Material	Estimated Price Discounts (cents/bu)	Mid- % Moisture	Estimated Price Discounts (cents/bu)
1	0	13	0
2	-0.32	13.3	-0.22
3	-0.63	13.8	-0.58
4	-0.94	14.3	-0.94
5	-1.26	14.8	-1.30
6	-1.57	15.3	-1.66
7	-1.89	15.8	-2.02
8	-2.20	16.3	-2.38
9	-2.52	16.8	-2.74
10	-2.83	17.3	-3.10
		17.8	-3.50
		18.3	-3.81
		18.8	-4.17
Mid- Test Weight	**Estimated Price Discounts (cents/bu)**	**Mid- % Damage**	**Estimated Price Discounts (cents/bu)**
54	0	2	0
53.45	-0.01	2.55	-0.05
52.45	-0.03	3.55	-0.08
51.45	-0.05	4.55	-0.10
50.45	-0.06	5.55	-0.12
49.45	-0.08	6.55	-0.14
48.45	-0.10	7.55	-0.16
47.45	-0.12	8.55	-.19
46.45	-0.13	9.55	-0.21
45.45	-0.15	10.55	-0.23
44.45	-0.17	11.55	-0.25
43.45	-0.19	12.55	-0.27
42.45	-0.20		

Estimated Average Price was $4.91(57/100); The Average Base value for: Moisture was 13.0%; Foreign Material was 1%; Damage was 0.2%; Test Weight was 54 lbs. Mid- value is the average of the upper and lower limits.

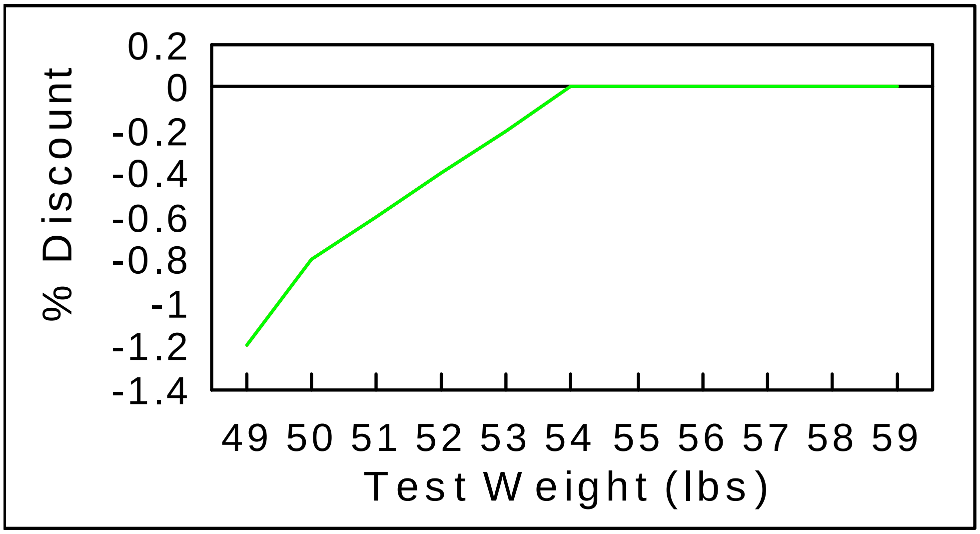

Figure 1. Effect of test weight on soybean discount

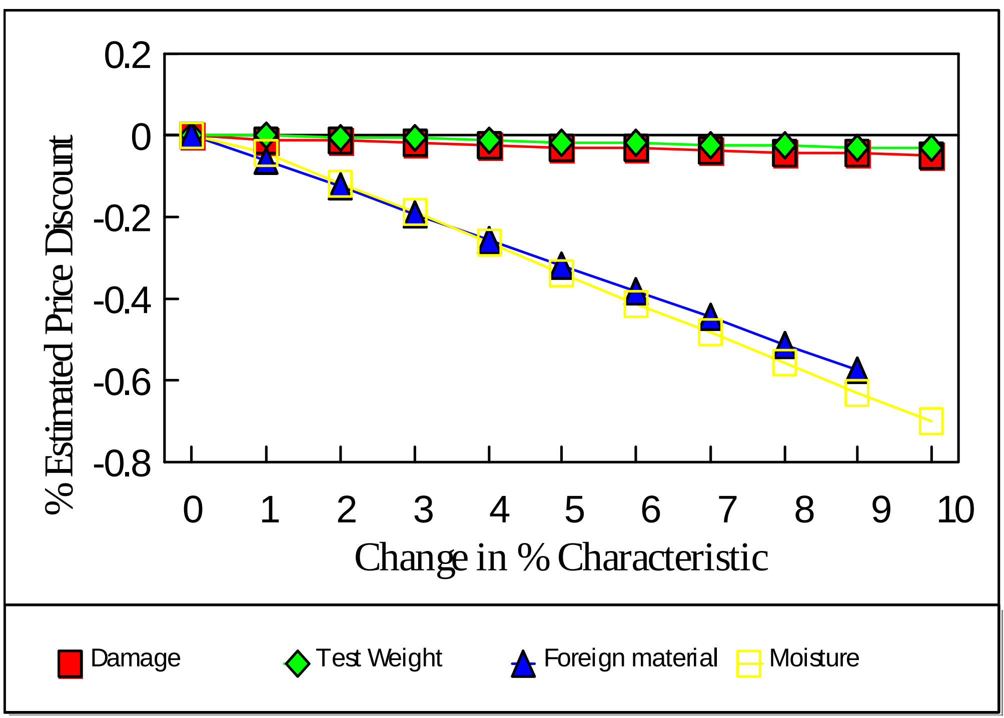

Figure 2.Estimated average price discounts due to change(s) in soybean quality attributes