

PRICE/QUALITY RELATIONSHIPS IN THE MALTING BARLEY MARKET

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An important characteristic of the market for malting barley is the multitude of quality variables which affect the value of particular shipments. In any given day prices vary across samples for relatively small variations in quality. Indeed, one of the more frustrating problems for malting barley producers, as well as processors, is the perceived randomness in prices across shipments. The objectives of this study are to analyze statistically the relationships among various quality factors and malting barley prices and to develop and estimate a statistical model for measuring the implicit prices for selected quality factors. The implicit price of a quality attribute is an economic concept similar to premiums and discounts commonly used in the grain trade. In economic terms, implicit prices indicate the market-determined value of a quality attribute such as protein or plumpness.

Within the malting barley market price, differentials reflect the ability of barley to germinate in the malt house. Prices vary across grades and varieties and in response to kernel plumpness and the level of protein. Official grades partially reflect the quality of malting barley. There are certain varieties of barley that are recommended for malting and brewing purposes. In North Dakota, Morex, Glenn, Larker, and Beacon are six-rowed malting barley varieties approved by the Malting Barley Improvement Association. During the period 1978/81, Larker had 3 percent more kernel plumpness than Morex (Foster, 1982). However, Morex had 0.5 percent less protein and 2 percent more extract. The percent of plump kernels in malting barley produced in North Dakota, South Dakota, and Minnesota decreased from 74.4 percent in 1977 to 65.7 percent in 1980 (Pylar). The protein content was 13.6 percent in 1977, declined to 12.9 percent in 1979, but increased to 13.2 percent in 1980. A minimum level of protein is important in malting barley because it acts as a source of nitrogen for yeast metabolism and growth during fermentation and provides the enzymes necessary to convert starch to fermentable sugars. Barley with a high

level of protein, however, is undesirable because it produces a beer with unstable clarity. Consequently, maltsters generally avoid barley over 14 percent protein (Heid and Leath) and pay premiums for lower levels. Kernel plumpness affects the evenness of germination and the amount of extract which can be produced from a bushel of barley. At least 96 percent of the kernels must germinate to be classed as good quality malting barley (Briggs). Because kernel plumpness is associated with a higher rate of germination, premiums are paid for high levels of plumpness.

Empirical Procedures for Estimating Price Relationships

A statistical model was specified which was used to analyze the variability in malting barley prices and to estimate implicit prices for plumpness and protein. The unit of observation was individual sales of malting barley at the Minneapolis Grain Exchange. Characteristics of each sale included its price, level of protein and plumpness, grade, and variety. The general empirical specification was:

$$\text{Price}_i = K + b \bullet \text{Protein}_i + c \bullet \text{Plumpness}_i \quad (1.1)$$

where Price_i is the price of the i^{th} sample of malting barley at the Minneapolis Grain Exchange; K is a constant and represents the effect of grade, variety, month of year, and the level of feed grain prices; protein and plumpness refer to levels of those quality characteristics in sample i ; and b and c are parameters to be estimated. The empirical model simply states that prices of malting barley are affected by feed barley prices, the month of sale, variety, and grade (all represented in K), and levels of protein and plumpness. Coefficients b and c are particularly important in this study and represent the marginal implicit prices for protein and plumpness, respectively. A negative sign is expected for b and indicates a negative implicit price for protein. A positive sign is expected for c and indicates a positive implicit price for plumpness. Values of these coefficients indicate the extent that the market price reflects discounts and premiums for these two quality characteristics.

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This study is based on cash transactions in malting barley at the Minneapolis Grain Exchange, which is the only public market for this grain. Price discovery at this

market plays an important role in establishing prices and policies set by the U.S. malting industry and in other countries. Malting barley sold on the Exchange floor is displayed in sample pans by commission firms. Most samples represent a railroad car located at a country elevator in North Dakota, South Dakota, or Minnesota. Accompanying each sample is a "pan ticket" on which results of the official inspection and other information important to the sale are recorded. The inspection includes data on both grade and nongrade quality factors. The Sampling Department at the Exchange and an official inspection agency located in the state from which the grain originated perform the inspection. Part of the information recorded on the "pan ticket" is quoted in the **Daily Market Record**. This source quotes variety type, numerical grade, percent plumpness, protein content, and price for each carlot sold on the Exchange floor. Other quality factors might be listed, but protein and plumpness were the only factors that were included throughout the data. Data were collected for every Wednesday over the period 1978/79 to 1981/82 crop years. The last crop year, 1981/82, included only the first six months when this study was conducted. Over the three and one-half crop years, 4,105 carlots of malting barley were examined in the analysis.

Characteristics of Sales and Malting Barley at the Minneapolis Grain Exchange

The distribution of carlots among varieties is presented in Table 1. In the first crop year, 1978/79, sales of Morex and Glenn did not exist since these varieties were newly approved by the Malting Barley Improvement Association. A time lag was involved due to the availability of seed and the willingness of producers to try new varieties. Although Larker was the most popular variety in the first two crop years, both Beacon and Larker sales have decreased substantially in the last two crop years. This decline can be attributed to the popularity of Morex and Glenn. In addition, the distribution of carlots among grades revealed that over 50 percent of the carlots in every crop year were Grade No. 2.

Table 1. Distribution among varieties of 4,105 malting barley carlots sold at the Minneapolis Grain Exchange, 1978/79-1981/82.

Crop Year	Variety				Total
	Beacon	Larker	Morex	Glenn	
	-----Number of Carlots----- (% in parentheses)				
1978/79	516 (46)	605 (54)	—	—	1,121
1979/80	572 (45)	665 (52)	27 (2)	5 (1)	1,269
1980/81	249 (24)	352 (33)	408 (39)	42 (4)	1,051
1981/82*	118 (18)	85 (13)	300 (45)	161 (24)	664

*Includes July through December of 1981 only.

There is very little difference in protein content and kernel plumpness among varieties in any given crop year (Table 2). In 1978/79, the average protein content for Beacon and Larker was identical. However, Larker had the lowest protein content among varieties in the remaining years, except in 1979/80 when Morex was equal to Larker (13.1 percent). The average protein content of Glenn and Beacon was higher than Larker or Morex in any given year. The kernel plumpness of Beacon and Glenn was slightly greater than Larker and Morex in 1979/80 and 1980/81. Glenn exhibited the least variability in protein and plumpness relative to the other varieties during this period.¹

Price differences associated with varieties are presented in Table 3. Larker sold at a higher price than Beacon in the first two crop years. The largest dif-

¹The reason that the mean levels for plumpness and protein were relatively close across varieties is that country elevators blend different lots of malting barley to meet maltster's specifications. Not all malting barley purchased from producers has the desired levels of protein and plumpness on other grade factors. A country elevator blends different lots of barley together so shipments can be made of the desired levels of quality characteristics.

Table 2. Means and Measures of Dispersion of Plumpness and Protein Contents among Varieties of Malting Barley, 1978/79-1981/82.

Crop Year	Variety	Protein Content			Kernel Plumpness		
		Mean	Standard Deviation	Range	Mean	Standard Deviation	Range
		-----Percent-----					
1978/79	Beacon	13.2	.62	10.0-15.4	72	7.23	47-92
	Larker	13.2	.71	10.7-15.8	71	7.79	41-94
1979/80	Beacon	13.3	.65	11.3-15.2	72	6.93	40-98
	Larker	13.1	.72	10.8-15.7	71	8.15	46-96
	Morex	13.1	.72	11.2-14.5	69	8.41	51-85
	Glenn	13.3	.93	12.0-14.4	73	6.69	67-83
1980/81	Beacon	13.3	.67	10.6-15.0	73	7.78	44-91
	Larker	12.9	.74	11.1-15.9	71	7.67	46-91
	Morex	13.1	.76	10.5-15.1	70	8.05	46-90
	Glenn	13.4	.75	11.0-15.0	78	7.95	55-90
1981/82*	Beacon	13.4	.59	11.0-15.0	74	5.73	56-86
	Larker	13.1	.79	10.7-14.9	72	9.32	50-88
	Morex	13.2	.76	10.5-15.2	68	8.39	42-93
	Glenn	13.4	.69	10.0-15.1	72	7.04	45-88

*Includes July through December of 1981 only.

ference occurred in 1979/80 when Larker received a 12-cent premium over Beacon. In 1980/81 Morex and Glenn sold at a premium over Larker and Beacon. A closer examination of 1980/81 and 1981/82 indicated there was less variability in prices for Morex and Glenn. Standard deviations for these varieties were 25 cents and 27 cents respectively, compared to 32 cents and 34 cents for Beacon and Larker. The differences in the annual average prices across varieties were significant at the 1 percent level.

Table 3. Mean and Standard Deviation of Yearly Prices Among Varieties of Malting Barley Sold at the Minneapolis Grain Exchange, 1978/79-1981/82.

Crop Year	Variety	Mean Price*	Standard Deviation
		Cents Per Bushel	
1978/79	Larker	244.25	29.04
	Beacon	236.48	21.78
1979/80	Larker	284.78	29.69
	Beacon	272.36	22.26
	Glenn	263.00	23.08
	Morex	276.85	19.27
1980/81	Larker	349.29	33.87
	Beacon	347.97	32.10
	Glenn	358.69	24.62
	Morex	357.99	27.28
1981/82	Larker	290.52	26.82
	Beacon	292.99	27.19
	Glenn	295.55	25.72
	Morex	302.56	25.88

Estimated Equations and Marginal Implicit Prices for Plumpness and Protein

Several observations of the results can be made prior to discussing estimates of the implicit prices. The effects of month, variety, and grade were classification variables included in the analysis. The results indicated that the effect of month, or seasonal effect, was significant in all years. The effect of variety was insignificant in all years except 1981/82. Grade was also included as an effect and was insignificant in all years. These results indicated that given the other variables which affect the price of malting barley, its grade did not have a significant effect on price. However, the month of the year and the variety in the case of 1981/82 had significant effects on the price of malting barley. The variety variable represents the inherent value of a variety relative to Beacon, given the other factors in the equation (i.e., protein, plumpness, etc.). In the first three years of the study there was not a significant varietal premium which was not accounted for by differences in protein or plumpness. In 1981/82, however, the varieties had statistically significant differences in their inherent value. The value of the coefficients indicated that the inherent value of Morex was 12 cents greater than Beacon, but the values for Larker and Glenn were not significantly different than Beacon.

One final observation of the estimated equations indicated that a change is occurring in the determination

of prices in the malting barley market. Throughout the time period of this study, the coefficient associated with feed barley had decreased and in 1981/82 was not significantly different than zero. This means that in the first three years, fundamentals in the feed grains sector, as represented by feed barley prices, had a significant effect on malting barley prices. In 1978/79 for example, there was nearly a one-to-one relationship between changes in feed barley prices and malting barley prices. Since then, this has decreased and in 1981/82 changes in feed barley prices did not have a significant impact on malting barley prices. In addition, the coefficient of determination, which measures the extent that variability in malting barley prices are explained by the empirical equation, has decreased in recent years.

In 1978/79, 83 percent of the variability in malting barley prices was explained by the fundamental variables included in the equation. Since then, the value of coefficient of determination has decreased, and in 1981/82 only 34 percent of the variability in malting barley prices was explained by the equation. This meant that even though malting barley prices were still explainable, there had been more unexplained variability in recent years. These two observations indicate that changes have been occurring in the price determination mechanism in the Minneapolis malting barley market. In general, the change has been toward less influence from the feed grains sector and greater unexplained variability in malting barley prices.

The estimated equations can be used to describe the pricing structure for malting barley, which is affected by many variables, and to derive estimates of marginal implicit prices for plumpness and protein. A distinction should be made which illustrates the interpretation of marginal implicit prices.

Implied in the observed price is a premium for plumpness and a discount for protein. These are referred to as marginal implicit prices and simply mean the additional value implied in the price of malting barley which is attributed to a change in the quantity of plumpness or protein. The results indicate that prices decrease with increases in protein and increase, but at a decreasing rate, with increases in plumpness.

The estimated equations can be used to derive and evaluate marginal implicit prices for plumpness (MIP_{PL}) and protein (MIP_{PR}). The overall price structure varies from year to year as well as with respect to variety and the level of feed barley prices. These variables are referred to as shifters because they change the level of the overall price structure (i.e., K in equation 1.1), but the implicit prices for plumpness and protein vary only between crop years. An example which illustrates the price structure for Morex malting barley in August 1980 is shown in Table 4. These values were calculated using the estimated equation and the average price for feed barley during August 1980. Given a particular level of plumpness and overall price levels, the results indicated that increases in protein were associated with lower prices. In other words, protein

had a negative impact on the price structure. This effect was constant across the observable range of protein levels. In particular, a 1 percent increase in protein resulted in an 11-cent per bushel decrease in price. Although plumpness had a positive effect on prices, this effect was not constant across all levels of plumpness. Prices increased at a decreasing rate with increases in plumpness. For a given level of protein, prices increased by 33 cents per bushel for changes in plumpness between 50 and 60 percent, by 19 cents per bushel for changes in plumpness between 60 and 70 percent, and by 5 cents per bushel for changes in plumpness between 70 and 80 percent.

Table 4. Estimated Prices for Morex Malting Barley in August 1980 for Various Levels of Plumpness and Protein.

Plumpness (%)	Protein (%)			
	11	12	13	14
	-----\$/Bushel-----			
50	3.16	3.05	2.94	2.83
60	3.49	3.38	3.27	3.16
70	3.68	3.57	3.46	3.35
80	3.73	3.62	3.51	3.40

The price structure for malting barley is illustrated in Figure 1 for different levels of protein and plumpness in each of the four crop years. The overall price level in these figures is for August of each year. Larker was the variety analyzed in 1978/79 and 1979/80, and Morex was the variety in the most recent two crop years. The overall level of prices is reflected in K of equation 1.1. The shape of the price curve with respect to plumpness means that prices increase with additional units of that characteristic but reach a peak at some point. The interpretation of a constant MIP_{PR} simply means that prices decrease at a constant rate with increases in protein.

Marginal implicit prices for protein and plumpness were calculated from the estimated equations for each year and are shown in Table 5. The latter prices were calculated at 65 percent plumpness since its value varied throughout its range. In addition, marginal implicit price for plumpness varied by variety except for 1981/82 when it was constant across varieties. In 1981/82 an additional 1 percent of plumpness was valued at 1.6 cents per bushel at 65 percent plumpness. The marginal implicit price for plumpness increased for the first three years of the study but decreased in 1981/82. On the other hand, the marginal implicit price for protein was

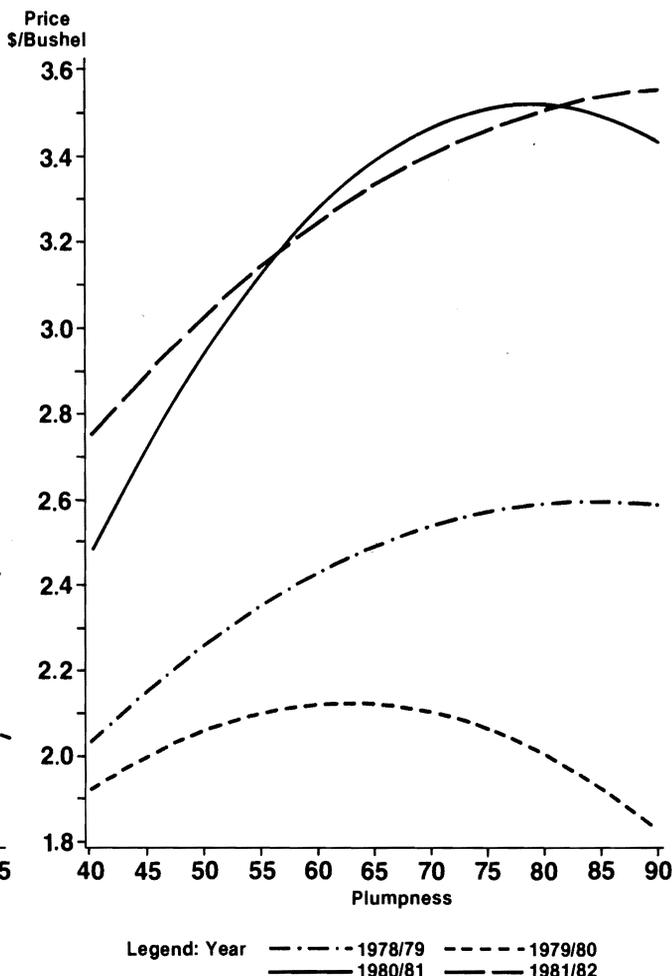
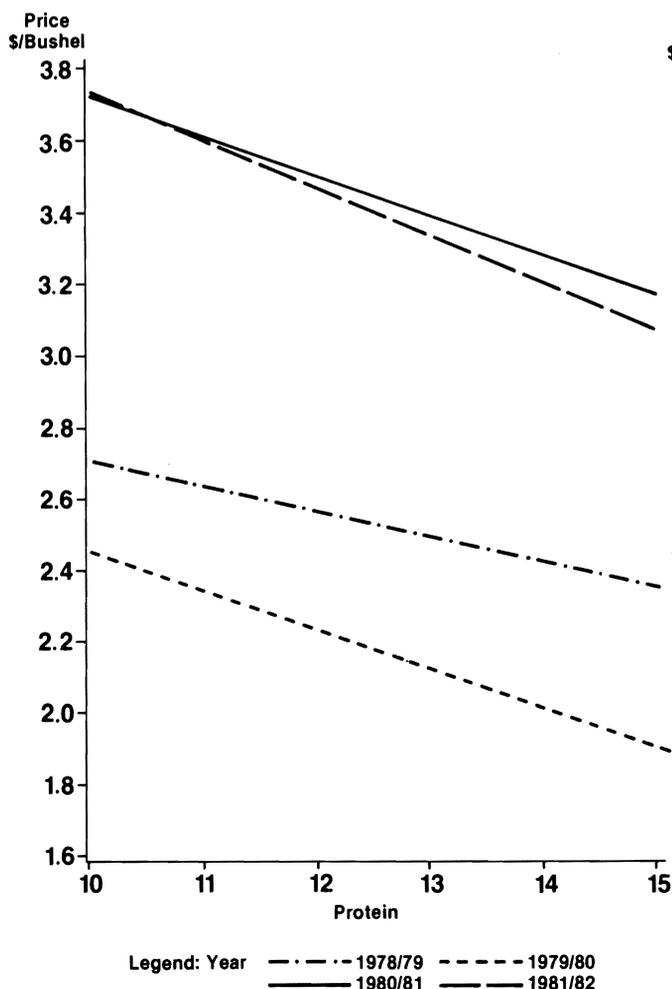


Figure 1. Prices for Morex Malting Barley in August 1980 in Relation to Protein (1a) Assuming 65 Percent Plumpness, and in Relation to Plumpness (1b) Assuming 13½ Percent Protein.

Table 5. Estimated Marginal Implicit Prices for Plumpness (at the 65 percent level) and Protein for Crop Years 1978/79-1981/82¹

Marginal Implicit Prices for Plumpness ²				
	1978/79	1979/80	1981/1982	
			---\$/Bushel---	
Beacon	.010	.021	.022	.016
Larker	.011	.002	.029	.016
Morex	(a)	(a)	.019	.016
Glenn	(a)	(a)	.018	.016
Marginal Implicit Prices for Protein				
Beacon	-0.72	-.06	-.11	-.13
Larker	-0.72	-.11	-.11	-.13
Morex	(a)	(a)	-.11	-.13
Glenn	(a)	(a)	-.11	-.13

^aNot estimated.

¹Values taken from regression results reported in Wilson and Crabtree.

²Marginal implicit prices for plumpness were calculated for plumpness equal to 65 percent.

constant across varieties except in 1979/80. Of particular importance is the fact that the marginal implicit price for protein, or discount, had increased in each year of the study. In the first year a one unit, or 1 percent, higher protein resulted in a discount of 7.2 cents/bushel (or 0.72 cents per 1/10 percent protein). In 1981/82 this discount increased to 13 cents per bushel (or 1.3 cents per 1/10 percent protein).

Summary and Conclusions

A particularly important attribute of the market for malting barley is the price differentials which are established for relatively small differences in quality. Price differentials are established between malting barley and feed barley which represents fundamentals of the feed grains sector. Price differentials are simultaneously established between different samples of malting barley. One of the purposes of this study was to develop and estimate a statistical model for measuring the implicit price for selected quality characteristics. The implicit price of a quality attribute is an economic concept similar to premiums and discounts used in the grain trade. In economic terms, implicit prices indicate the market-determined value of an additional unit of the quality attribute. Marginal implicit prices derived from estimated equations can be simply interpreted as the premiums and discounts for plumpness and protein which are implied in the price of malting barley. Separate marginal implicit prices for plumpness and protein were estimated for each crop year and variety

where appropriate. The marginal implicit price for protein was negative (implying a discount) as expected, constant across the range of protein, and constant across varieties in each year except 1979/80. In 1981/82 the marginal implicit price for protein was -13 cents per bushel, which indicated the implied discount associated with 1 percent higher protein. The marginal implicit price for plumpness was not constant throughout the range of plumpness, but varied across varieties except in 1981/82. In that year it was 1.6 cents per bushel (at the 65 percent level of plumpness) which means that a 1 percent greater level of plumpness was valued at about 2 cents per bushel. An important observation on the behavior of these marginal implicit prices is that the premium for plumpness increased during the first three years of the study and the discounts for protein have increased every year from 7.2 cents per bushel to 13 cents per bushel for a 1 percent change in protein.

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