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PRICE-QUALITY RELATIONSHIPS IN U.S. COTTON AT THE MILL LEVEL*

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Abstract

Price-quality relationships play an important role in cotton marketing because the price incentives available for quality provide an important incentive to improve quality. As information about price-quality relationships improves, market participants can better respond to quality incentives. In this paper, the price-quality relationships are evaluated using data collected (over 800 observations) at the mill level. Cotton prices were found to be significantly effected by quality specifications for color grade, leaf grade, strength, and mironaire. In addition, prices for cotton originating from the desert Southwest region (New Mexico and Arizona) were found to be discounted relative to other regions.

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Introduction

The U.S. cotton industry generates more than 400,000 jobs from farm to textile mills while accounting for more than $25 billion in products and services annually. In this, textile manufacturers purchase cotton with specific quality characteristics to produce various textile products. Cotton textile manufacturers signal their willingness to pay for cotton, and producers and marketers can respond to these incentives. Developing better information about these price-quality interactions is the focus of this paper.

Having good information about price-quality incentive is important because textile manufacturers as cotton buyers reveal their needs concerning certain attributes of cotton characteristics. The transmission of price-quality relationships signals cotton growers to make appropriate decisions in production such as variety selection and harvesting method. Moreover, price-quality information signals industry needs and relative scarcity of fiber attributes. Hence, cotton price-quality information plays an important role in the efficiency of the overall cotton market.

This study uses data that have been collected largely from mill buyers on their contract specifications and price information. This information in the aggregate provides more accurate information on the valuation of cotton fiber attributes than is available publicly. In contrast, the general market price data for cotton are highly focused on prices at the producer level, and historically there have been differences between prices at the mill level and the producer level. The effort of this paper builds upon previous research in the area of cotton price-quality relationships (Brown et al.,1995, Chen, Ethridge, and Fletcher,1997, Ethridge, Chen, and Hudson, 1995).

The purpose of this paper is to provide more specific information on the pricing of cotton at the mill level. To accomplish this, the relationship between the price of cotton and its specific attributes was studied using primary data from cotton mill contracts along with general market price data such as the Daily Spot Cotton Quotations (DSCQ) from U.S. Department of Agriculture.

Data

The primary data used in this study were provided from written contracts of U.S. domestic mill buyers. These data are comprised of individual contracts that occur for cotton from two related marketing years--2000/01 and 2001/02. Each contract record gives information on the date of purchase, size of the cotton purchase in bales, quality attribute specifications, and requested location of production. The quality characteristics of cotton include specification on color and leaf grade, staple length, minimum strength, micronaire, and foreign matter content.

The purchase prices for mill contracts were either net free on board (FOB) mill or New York futures prices. Net FOB mill price represents the agreed upon delivered price as a fixed purchase price. The New York futures prices determine the price for a call sale and call prices were converted to a FOB cash equivalent fixed price on the transaction date after adjusting the New York futures price by the fixed basis specified in the contract. This conversion provided consistent prices whether FOB mill or New York futures price is specified in specific contracts.

Because the collected data constitute a time-series, there is a need to control for general measurement in price levels through time. To accomplish this, the base quality, i.e., color grade 41, leaf 4, staple 34, micronaire 3.5~4.9, and strength 24-25, applicable for each transaction was used. This general or reference price, thus, is a control variable for the variation in general market prices through time. Chen, Ethridge, and Fletcher (1997) used cotton quality-price relations with the reference price in their modeling effort.

Consistent with earlier research in the area, four main regions are specified as: South, Southwest, Desert Southwest, and West. South covers those Southern and Southeast states of the U.S. (NC, SC, VA, TN, GA, AL, and FL) and North and South Delta states (MO, AR, LA, MS). Southwest represents Texas and Oklahoma regions. Desert Southwest consists of New Mexico and Arizona, and West includes California and Nevada regions. These regions are important because the regional difference in price patterns due to the 1) consistency in growing certain quality attributes, 2) difference in intended end use, and, 3) perceived differences in quality.

The variables used for the analysis are defined in Table 1. Raw data on quality is transformed algebraically. The purpose of this is to establish consistent relationships between each explanatory variable to the dependent variable with positively increasing relations. Thus, the positive sign expectations for the attributes on the cotton contract price. In other words, the marginal implicit price (MIP) of cotton attributes, A_i where i = 1, …, n, exhibits nonnegative value ($\partial P / \partial A_i \rangle 0$). This allows for easy interpretation of results. Summary statistics for the data are provided in Table 2.

For example, since the grayness of fiber (C1) affects negatively on the purchase price of cotton for mill contract (PC), transforming the indicator of grayness to one of whiteness indicates an expected positive relationship between the attribute and the cotton contract price; price should increase as the cotton fiber becomes whiter. So, the transformation formula for GC1 changes the negative attributes (grayness) of cotton fiber with positive ones (whiteness). Similarly, C2 (yellowness) and LF (low leaf grade or trash content) are transformed into GC2 and GLF for increasing effects on contract price (PC). These transformations are useful for allowing such negative fiber attributes as grayness, yellowness, and trash content to the same fashion as positive fiber attributes with increasing marginal returns.

After transformations of variables all independent variables have positive sign expectations for the effects on the cotton contract price, except the square of the average of micronaire (M2). The micronaire (M) indicates both fitness (density) and maturity of cotton fiber. As the micronaire gets higher, the cotton value should increase at a decreasing rate. Thus, there is a quadratic relationship specification of micronaire (Ethridge, Swink, and Chakraborty).

Model

A hedonic price model was developed, following the approach used historically in this area (Ethridge, Swink and Chakroborty). In this, the effect of quality factors and other variables is evaluated in relationship to their effect upon price. Because of the typical declining marginal productivity of most attributes in manufacturing processes, a non-linear specification is used (Chen and Ethridge). For the regional effects of cotton prices in the contract, three dummies relating each geographical region of cotton are used for the regional effects of cotton prices. In order to determine any significant differences between marketing years, a dummy for marketing year 2001 is added in the model.

This results in the equation:

$$\log P = \beta_0 + \beta_1 \log GC_1 + \beta_2 \log GLF + \beta_3 \log LTH + \beta_4 \log STR + \beta_5 \log M + \beta_6 \log M2 + \beta_7 \log DSCQ$$

where variable definitions and sign expectations are provided in Table 1.

Results

The results of the model estimated are shown in the Table 3. All the signs of estimated parameters were as expected and significantly different from zero except some of the regional dummies. All the attributes affect positively on the price except the squared micronaire average as expected. The goodness of fit, R^2, for the model was 0.74.

The attribute with the most effect was micronaire and both the linear and quadratic micronaire coefficients were statistically significant. If micronaire increases by one percent while other variables are held constant, then the price will go up by 2.9 percent, based on double-log econometric model. However, the impact of micronaire increases at decreasing rate and after the optimal micronaire level, micronaire decreases at an increasing rate. That is, cotton with low micronaire levels (below 3.5) is assumed to be immature and the immature cotton was discounted more heavily than the coarse cotton with high micronaire levels (above 4.9).

The base price for cotton was calculated using color grade 41, leaf 4, length 34, strength 24.5, and micronaire 4.2. The reference price, DSCQ, is statistically significant and as expected is positively related to the cotton contract price. However, the magnitude of coefficient for DSCQ indicated that the cotton price averaged 0.608 percent more as the DSCQ increased by one percent holding other things constant. This shows the price of cotton in the contract related the general market price movement. Smaller magnitude of cotton price changes than that of DSCQ due to the change suggests that the textile mill manufacturers may perceive the base price movement.

The second digit of the color grade (absence of yellowness) was significantly different from zero. As the whiteness of fiber increased by one percent, cotton priced 0.146 percent higher on the average, ceteris paribus. This is plausible because textile mills pay premium for the whiter cotton because whiter cotton generally has lower costs in dying and breaching.

The premiums paid for better leaf grade was statistically significantly different from zero. The price premium due to the less leaf content was 0.17 percent increase if the grade of leaf content increases by one percent on the average, holding other things fixed.

When it comes to length, generally, textile mill manufacturers rewarded longer staple cotton and discounted shorter staples. The estimated implicit prices for staple showed that cotton averaged 0.5 percent more as the length increased by one percent, ceteris paribus.

Coefficient estimate of strength was statistically significant and indicated that the cotton price increased 0.59 percent on the average when the strength increase by one percent. Strength ranges from 24 to 38 in the dataset, but a significant number of contracts did not specify the strength characteristics, especially in Desert Southwest variety. No minimum strength is specified in the contracts, so those unspecified strength data were ignored in the analysis for finding out the effect of strength in the model.

Regional differences in cotton prices are estimated with the regional dummy variables. The South region was set as the base. Based on the results, Desert Southwest region was statistically significant and the other regions were not statistically different from the base quality. Comparing to the South as a base region, cotton from the Desert Southwest was paid less by 1.12 cents per pound.

Summary and Conclusion

The price-quality relationship of U.S. cotton was analyzed using hedonic price model to determine the implicit price of cotton attributes from the contract data covering 2000/01 and 2001/02 crop periods. Most valuable attributes from the analysis in the order were micronaire, strength, length, leaf, and whiteness. That is, textile manufacturers during the study period paid more for micronaire for further processing at the mill than for other attributes. In addition, the cotton originating in the desert Southwest region was discounted relative to other regions, controlling for all quality factors. The cause of this discount and possible remedies is a good realm for future research.

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Table 1. Variable Definitions and Expected Signs.

Dependent Variable		**Definition**	
PC		Purchase prices (cents/lb) for mill contract, free on board (FOB) mill price.	
Independent Variable	**Formula**	**Definition**	**Expected Sign**
GC1	8-C1	*Absence of grayness; i.e., whiteness.* C1 is the first digit of the grade code which varies from 1 through 7; Since C1 has a maximum value of 7, subtracting from 8 converts C1 from an indicator of grayness to an indicator of whiteness.	+
GC2	6-C2	*Absence of yellowness; i.e., whiteness.* C2 is the second digit of the grade code which varies from 1 through 5; Since C2 has a maximum value of 5, subtracting from 6 converts C2 from an indicator of yellowness to an indicator of whiteness.	+
GLF	8-LF	*Leaf grade*, the third digit of grade code varying from 1 through 7; Since LF has a maximum value of 7, subtracting from 8 converts LF from an indicator of a low grade to an indicator of a high grade.	+
LTH		*Staple length*, the fourth and fifth digit of grade code varying from 34 to 39; The fiber length in 32nd's of an inch and indicates the uniformity of fiber length.	+
STR		*Strength*, the minimum Grams per Textile (GPT). The average strength is about 28.	+
M		*Average micronaire*	+
M2	M*M	*Squared Average micronaire*.	-
RP		*Reference price*, the Daily Spot Cotton Quotation as a reference spot price (cents/lb) of cotton at base quality level (grade 41, staple 34, strength 24, and micronaire 3.5-4.9).	+

Table 2. Summary Statistics of Data (n= 822).

Variables	**Mean**	**Standard Deviation**	**Minimum**	**Maximum**
PC	46.42	10.17	11.50	69.13
C1	4.29	1.13	1.00	7.00
C2	1.42	0.49	1.00	2.00
LF	3.90	0.87	2.00	6.00
LTH	34.58	1.17	31.00	38.00
STR	27.86	1.11	24.00	38.00
M	4.24	0.30	3.05	5.23
M2	18.05	2.62	9.30	27.30
RP	39.60	10.50	24.59	63.13

Table 3. Hedonic Price Model Parameter Estimates.

Variable	**Coefficient**
Constant	-4.423*
	(-4.268)[a]
Log of whiteness grade (GC2)	0.146*
	(3.324)
Log of leaf grade (GLF)	0.171*
	(6.270)
Log of length (LTH)	0.498*
	(2.822)
Log of strength (STR)	0.588*
	(4.317)
Log of micronaire (M)	2.914*
	(2.429)
Log of micronaire squared (M2)	-1.104*
	(-2.715)
Log of DSCQ	0.608*
	(21.513)
Dummy variable (Southwest)	0.002
	(0.073)
Dummy variable (Desert Southwest)	-0.114*
	(-2.935)
Dummy variable (West)	-0.036
	(-1.638)
Dummy variable (Crop year 2001)	-0.069*
	(-4.777)
R^2	**0.7431**

* denotes significance level at the 5% level.

[a] represents t-statistics