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Textile Manufacturers' Market Valuation of Cotton Fiber Attributes

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ABSTRACT

This study provides an analysis of the price-quality relationships of U.S. cotton using primary data collected from textile manufacturers, the end users of fiber. Hedonic prices of fiber attributes are estimated for three production regions—West, South Central, and South—over the 1992–95 study period. Results indicate that cotton price is determined by quality attributes and nonquality factors in the end-use market. There are similarities and differences in valuation of fiber attributes based on region of origin of the cotton.

Key Words: cotton, fiber attributes, hedonic prices, regional differences.

Cotton production, marketing, and textile manufacturing are interrelated activities undertaken by the U.S. cotton industry. Growers produce cotton, textile manufacturers use cotton, and the market provides the time, form, and space utility (the marketing functions). Fiber prices, including price differentials for quality differences, are established at the fiber end-use point and are passed back through the marketing channel, assuming the market is efficient in conveying price information. Since there are thousands of quality combinations for cotton (Ethridge), no single price can adequately reflect the market value of cotton. Moreover, textile products are distinct in the mixture of different proportions of cotton fiber in the products. The efficiency of textile production processes and the quality of final textile products also depend on fiber properties.

Previous empirical work in cotton price-quality analysis provides an understanding of cotton pricing structures (Ethridge and Davis; Ethridge and Neeper; Ethridge et al.; Brown et al.; Bowman and Ethridge; Chiou, Chen, and Capps), but little is known about price-attribute relationships in the end-use market because of the difficulty of obtaining appropriate data. Although Hembree, Ethridge, and Neeper, and Ethridge and Chen examined the price-quality relationships of cotton in the textile mill market, data used in those studies were price quotations, which are highly aggregated and their reliability is unknown or suspect (Hudson, Ethridge, and Brown). An understanding of price-quality relationships for cotton by end users is important because suppliers in the market need to know the mill market prices for fiber attributes in order to meet the demands. The knowledge and information also provide textile manufacturers with a reference for making purchasing decisions and assist policy makers in formulat-

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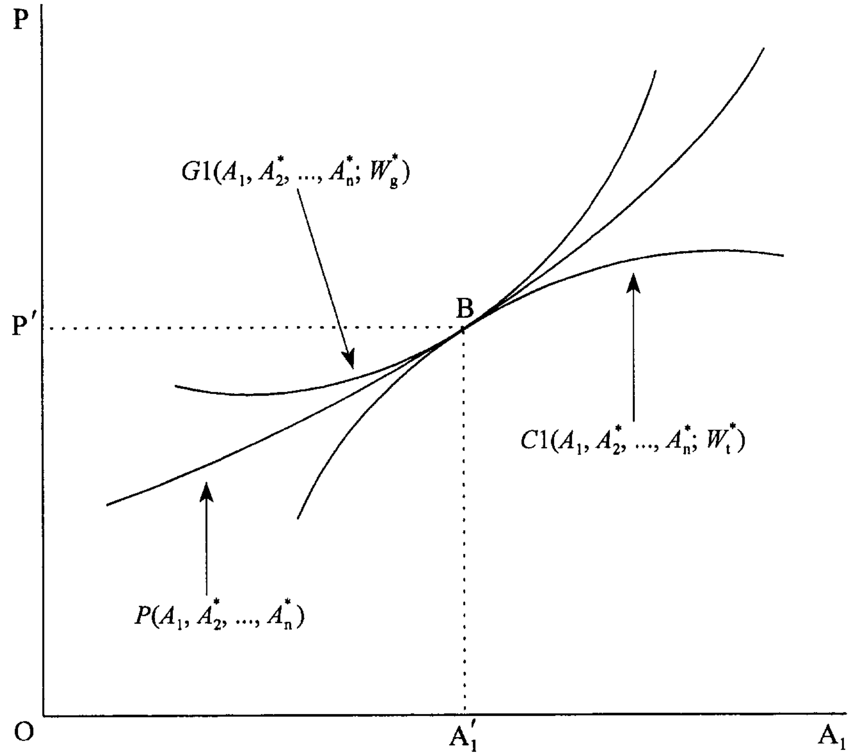

Figure 1. Determination of hedonic price for a cotton fiber attribute

ing cotton loan schedules. The objectives of this study were to determine price-quality relationships for fiber attributes in different production regions as valued by the end users and to identify the similarities and differences of the price-quality relationships across regions.

Conceptual Framework

Cotton fiber is an input for textile manufacturers, but an output for cotton growers. Textile producers purchase cotton fiber as a raw material to produce yarns and fabrics and sell these textile products to other firms. Market values of fiber attributes are determined when a market transaction takes place as market participants try to maximize profits.

Since cotton is composed of a vector of fiber attributes ($A_1, A_2, \ldots, A_n$), the relationship of cotton price and a fiber attribute, A_1, in the market may be expressed as a hypothetical function, $P(A_1, A_2^*, \ldots, A_n^*)$ (see figure 1), holding other factors constant (Rosen). Fiber attribute A_1 is assumed to have a positive impact on profits if it is optimally used. $P(A_1, A_2^*, \ldots, A_n^*)$ is determined in a bargaining process between buyers and sellers.

Modifying Rosen's framework,[1] there is a bid curve, $C1(A_1, A_2^*, \ldots, A_n^*; W_t^*)$, for a textile manufacturer derived from the manufacturer's profit function (W_t) in producing textile products with a given manufacturing technology (figure 1). The bid function defines the amount that the textile producer is willing to pay for attribute A_1 at a constant profit level (W_t^*) given $A_2 = A_2^*$, $A_3 = A_3^*$, and so on (Alonzo).

[1] The modifications involve changing from a consumer good demand orientation to a production input use orientation, i.e., from valuation of attributes embodied in a consumer good (final product) to attributes embodied in a raw material (intermediate input).

There is a family of bid curves representing different manufacturers with different technologies. A cotton grower's (seller's) offer curve for selling fiber attribute A_1 [$G1(A_1, A_2^*, \ldots, A_n^*; W_g^*)$ in figure 1] is derived from the cotton grower's profit function (W_g).[2] Points on the offer curve define the minimum prices that the cotton grower is willing to accept for selling fiber attribute A_1, given $A_2^*, \ldots, A_n^*$. There is a family of offer curves representing different producers with different resource endowments.

The manufacturer's and the seller's profits are maximized when the bid curve is tangent to the offer curve—point B in figure 1. At point B, the marginal value product for textile production equals the marginal cost of using A_1, $P(A_1)$, as an input in textile production for the manufacturer. Similarly, the marginal cost of producing A_1 equals the marginal value of an additional unit of A_1 sold in the market at point B for the cotton producer. That is, the textile manufacturer and the cotton grower jointly choose the combination P', A_1', A_2^*, $\ldots$, A_n^* for W_t^* and W_g^*. The price curve, $P(A_1, A_2^*, \ldots, A_n^*)$, represents the loci of the tangencies of families of bid and offer curves.

The price-quality relationships are determined through market negotiations and transactions between textile manufacturers (buyers) and cotton growers (sellers) in the market. Market transactions for fiber attributes take place only as the attributes supplied and demanded by cotton sellers and buyers, respectively, are matched. The market prices of fiber characteristics, A_1, are represented by the locus of tangencies between the offer and bid curves in a plane (figure 1). The shape of the locus is determined by market participants' behaviors, which are guided by profit maximization. Since there are both a family of offer curves and a family of bid curves, the market price relationship for each fiber attribute represents a joint envelope of the two families of functions. The envelope function by itself reveals nothing about the underlying members that generate it, although these members constitute the generating structure of the observations (Rosen). However, this function depicts the price-quality (i.e., hedonic) relationship for the fiber attribute A_1, and can be derived from a hedonic price equation:

$$(1) \qquad P = f(A_1, A_2, \ldots, A_i, \ldots, A_n; X),$$

where P is the observable market price for cotton, the A notations are fiber attributes, and X represents a vector of nonfiber factors. A partial derivative of the equation with respect to A_i yields the marginal implicit price of fiber attribute i (Rosen). The marginal implicit price of A_i measures the impact of fiber attribute i on cotton price as fiber attribute i changes by one unit in a competitive market, holding other factors constant.

Empirical Estimation

The Model

An appropriate empirical model to capture price-quality relationships for cotton includes two principal pricing components: fiber factors and nonfiber factors. Designated fiber attributes on which textile manufacturers purchase cotton are composite grade (consisting of trash content and fiber color),[3] fiber length, strength, and micronaire (an indicator of fiber fineness and maturity). The composite grade is a two-digit code. The first digit is a general indicator for the content of nonlint materials such as leaf, bark, and grass in the cotton and is inversely related to cotton price. The second digit is related to color (reflectance and yellowness) and is also inversely related to cotton price. Desirable micronaire range is conventionally believed to be 3.5 to 4.9 [U.S. Department of Agriculture (USDA) 1993]. As micronaire increases or decreases from its optimal range, the value of the fiber decreases.

[2] This analysis treats the grower as the seller to the manufacturer. This simplification is conceptually applicable if marketing margins are fixed.

[3] Composite grade has been separated into a color grade and a leaf grade, but the data used in this study were based on the older composite grade specifications.

Cotton fiber derives its value from the attributes embodied in the fiber, but it also has value because it is fiber. That is, there is a market (price) for cotton that is determined by the overall supply and demand for the fiber, independent of levels of attributes embodied in individual bales. Value independent of variation in attribute characteristics (i.e., the movements in the "general" cotton market) may be captured by a variable that identifies movements in the price of the overall market and for which the quality is homogeneous (Ethridge and Neeper; Brorsen, Grant, and Rister; Bowman and Ethridge; Chiou, Chen, and Capps). The indicator of the general price level movements in each regional market used in this study was the base price quotation for grade 41, staple 34, micronaire 3.5–4.9, and strength 24–25, as reported in daily issues of the USDA's "Daily Spot Cotton Quotations" during the 1992–95 study period.[4] For each transaction, the appropriate daily base price quotation for cotton from the region was matched with the sale/purchase contract.

Three production regions were specified to capture regional differences in hedonic price relationships. West (WE) consists of California, Arizona, and New Mexico. South Central (SC) includes Texas and Oklahoma. South (SO) is comprised of the southeast states (North Carolina, South Carolina, Georgia, Florida, and Alabama) and the midsouth states (Arkansas, Louisiana, Mississippi, Missouri, and Tennessee). The southeast and midsouth states were combined because textile companies usually do not differentiate cotton grown in the southeast and that grown in the midsouth in their contracts.[5]

The structure of the model estimated is shown as follows:

$$\text{(2)}\quad P_r = \alpha_{0,r}(DG1)^{\alpha_{1,r}}(DG2)^{\alpha_{2,r}}(L)^{\alpha_{3,r}}(S)^{\alpha_{4,r}} \times e^{\alpha_{5,r}(M)+\alpha_{6,r}(M^2)}(GP_r)^{\alpha_{7,r}}e^{\alpha_{8,r}(cls)} \times e^{\alpha_{9,r}(mch)+\alpha_{10,r}(exp)+\alpha_{11,r}(lm)} \times e^{\alpha_{12,r}(Y93)+\alpha_{13,r}(Y94)+\alpha_{14,r}(Y95)+\epsilon_r},$$

where

P_r = FOB price (¢/lb.) of the cotton specified by or derived from the contracts for region r (r = WE, SC, or SO region);

$DG1$ = $9 - G1$, indicating cleanness of fiber ($G1$ is the first digit of the composite grade code specified in the contracts);

$DG2$ = $8 - G2$, representing whiteness of fiber ($G2$ is the second digit of the composite grade code specified in the contracts);

L = fiber length or staple (32nds inch) specified in the contracts;

S = minimum strength (grams/tex) specified in the contracts;

M = average micronaire reading specified in the contracts (micronaire reading is a scale of 2.4–5.4);

GP_r = general price level of cotton (¢/lb.) at base quality in region r on the date of the transaction as reported in the USDA's "Daily Spot Cotton Quotations";

cls = indicator variable for type of sale ($cls = 1$ for call sale, $cls = 0$ for fixed price sale);

mch = indicator variable for type of buyer (if $mch = 1$, the buyer is a merchant/shipper, 0 otherwise);

exp = indicator variable for type of buyer (if $exp = 1$, the buyer is a foreign company, 0 otherwise; if both mch and $exp = 0$, the buyer is a domestic mill);

lm = indicator variable for pricing location (if $lm = 1$, the cotton is priced FOB mill; if $lm = 0$, the cotton is priced FOB seller's warehouse);

$Y93$ = indicator variable for crop year (if

[4] When annual, aggregated data are used, deflating with a price index such as done by Espinosa and Goodwin may accomplish the same purpose—to adjust for general price movements over time.

[5] Combining the southeast and midsouth states into a single region was subsequently supported by a statistical test for pooling between the two regions.

$Y93 = 1$, the cotton is from 1993 crop, $Y93 = 0$ otherwise);
$Y94$ = indicator variable for crop year (if $Y94 = 1$, the cotton is from 1994 crop, $Y94 = 0$ otherwise);
$Y95$ = indicator variable for crop year (if $Y95 = 1$, the cotton is from 1995 crop, $Y95 = 0$ otherwise; if $Y93$, $Y94$, and $Y95 = 0$, the cotton is from 1992 crop); and
ϵ = the random error for the model.

Nonlinear price-quality relationships for cotton were hypothesized because of the diminishing marginal returns in using fiber attributes (Brown and Ethridge). That is, as the levels of desirable fiber attributes increase, their marginal contributions to the value of the product decrease. The exception is micronaire, for which cotton value is expected to increase, then decrease, as micronaire increases, because excessive coarseness of cotton adversely affects processing performance (Ethridge and Neeper). Transformations of trash as the difference of $9 - G1$, and color as $8 - G2$ were made to convert the variables to desirable (cleanness and whiteness), rather than undesirable (trashiness and yellowness/grayness), attributes so as to more easily capture the diminishing marginal returns in a logarithmic transformation. Multiplicative price models captured the interactive effects among fiber attributes on prices.

The $\alpha_{i,r}$ associated with a fiber attribute in equation (2) is the characteristic price flexibility for the attribute, which measures the percentage change in FOB price as the fiber attribute changes by 1% in the textile mill market, ceteris paribus. The $\alpha_{i,r}$ associated with an indicator variable captures the impact of each indicator variable relative to the base on cotton price, holding other things constant. Regression coefficient estimates for all fiber attributes except micronaire squared (M^2) were expected to be positive, while the coefficient estimates for indicator variables could be positive or negative. The coefficient estimate was expected to be negative for M^2. The annual indicator variables identify annual shifts in the *structure* of prices (how price is related to attributes), not shifts in the level of prices. The general level of prices is accounted for by the GP variable. Thus, significant coefficients for $Y93$, $Y94$, and $Y95$ signify differences in the pattern of prices as they relate to attributes from the base year (1992).

Similarities or differences of the price-quality relationships between any two regions for individual fiber attributes could be statistically examined. For example, the null hypothesis of hedonic price effect between the Western and South Central regions for a specific fiber attribute was to test whether $\alpha_{i,WE}$ is equal to $\alpha_{i,SC}$ (or $\alpha_{i,WE} - \alpha_{i,SC} = 0$). The hypothesis of no difference for attribute i between the Western and South Central regions (i.e., $\alpha_{i,WE} = \alpha_{i,SC}$) follows a t-test (Snedecor and Cochran). A pooled regression model with region indicator variables must be estimated for the test of no differences in hedonic effects between regions. Using the same mathematical structure as in equation (2), the pooled hedonic price model was specified as follows:

$$(3) \quad P = \beta_0(DG1)^{\beta_1}(DG2)^{\beta_2}(L)^{\beta_3}(S)^{\beta_4}e^{\beta_5(M)} \times e^{\beta_6(M^2)}(GP)^{\beta_7}(DG1 \times SC)^{\beta_8} \times (DG2 \times SC)^{\beta_9}(L \times SC)^{\beta_{10}}(S \times SC)^{\beta_{11}} \times e^{\beta_{12}(M \times SC)+\beta_{13}(M^2 \times SC)}(GP \times SC)^{\beta_{14}} \times (DG1 \times SO)^{\beta_{15}}(DG2 \times SO)^{\beta_{16}} \times (L \times SO)^{\beta_{17}}(S \times SO)^{\beta_{18}} \times e^{\beta_{19}(M \times SO)+\beta_{20}(M^2 \times SO)}(GP \times SO)^{\beta_{21}} \times e^{\beta_{22}(cls)+\beta_{23}(mch)+\beta_{24}(exp)+\beta_{25}(lm)+\beta_{26}(Y93)} \times e^{\beta_{27}(Y94)+\beta_{28}(Y95)+\beta_{29}(SC)+\beta_{30}(SO)+\epsilon},$$

where SC is an indicator variable for the South Central region (if $SC = 1$, the cotton is from the South Central region, 0 otherwise); SO is an indicator variable for the Southern region (if $SO = 1$, the cotton is from the Southern region, 0 otherwise). If both SC and SO equal zero, the cotton is from the Western region (i.e., the Western region is the base). The pooled hedonic price model uses fixed price sale, domestic mill buyer, seller's warehouse, and crop 1992 as the bases. Interactions between regional and other indicator variables (such as regions versus type of buyer and regions versus type of seller) were not included in the pooled model because of perfect collinearity among some of these indicator variables.

While coefficient β_1 in equation (3) measures the price flexibility of fiber cleanness for Western cotton, coefficient β_8 captures the difference of hedonic price effect of fiber cleanness between the South Central and Western regions, ceteris paribus. Similarly, coefficient β_{15} measures the difference of hedonic price effect of fiber cleanness between the Southern and Western regions, holding other things constant. By the same interpretation, the rest of the coefficient estimates of fiber attributes associated with regional indicator variables in equation (3) measure the differences of price flexibilities between the West and either of the other two regions with respect to the corresponding factors.

Theoretically, a hedonic equation [equation (2)] for each of the three regions could be derived from the pooled model [equation (3)] (Pindyck and Rubinfeld). Coefficient $\alpha_{1,WE}$ in equation (2) would be equal to coefficient β_1 in equation (3), which is the price flexibility of fiber cleanness for Western cotton, holding other things constant. Coefficient estimate $\alpha_{1,SC}$ in equation (2) would equal the sum of coefficients β_1 and β_8 in equation (3), where β_8 is the difference of hedonic price effect between the South Central and West. However, the pooled model including all interactions between regional and other indicator variables in this study resulted in serious multicollinearity since the data were thin for some indicator variables (e.g., foreign buyers) in terms of observation distribution. Although the pooled model might provide similar information as individual regional models, it could not completely replace individual regional models. This is so because individual regional models avoided collinearity, providing more accurate parameter estimates for the impacts of individual fiber attributes on cotton prices. However, the differences of hedonic price effects across the regions could be examined statistically only by pooling all regional models together due to the covariance of coefficient estimates among regions. Consequently, individual regional models were used to estimate fiber attribute effects in the region, while the pooled model was used to evaluate effects of individual fiber attributes across the regions.

Natural logarithmic transformations of equation (2) were estimated by OLS for each region; then equation (3) was estimated by pooling all three regions together. Residuals were analyzed to find potential violations of OLS assumptions. The variance inflation factor was used as a check for multicollinearity (Neter, Wasserman, and Kutner).

Data

Data for this study were derived from bona fide individual marketing contracts obtained from cotton marketing (buying and selling) firms at the fiber end-use point of the market. Data providers included two of the three largest regional marketing cooperatives and six textile firms located in the southern U.S. All textile firms were buying cotton for multiple manufacturing plants. The data consisted of information from the 1992 crop through early contracts on the 1995 crop. Although the total number of U.S. textile firms is unknown, the data used in this study are considered to be representative of the U.S. cotton market because they account for 25.5% of U.S. cotton production and 41% of U.S. mill cotton consumption over the study period.

In each contract, the price and quality attributes, region of origin of the cotton, delivery dates, and any other terms between the two parties were identified. Prices specified in marketing cooperative contracts were free on board (FOB) warehouse, while prices from mill contracts were FOB mill. Contracts specified either a fixed price sale (delivered price is agreed upon) or a call price (price for a call sale against New York futures price). Call contracts were converted to an equivalent fixed price on the date of the transaction by adjusting the futures price on that day by the basis stated in the contract. Futures prices used for converting call price to fixed price were collected from the USDA's "Daily Spot Cotton Quotations." Contract data from different

Table 1. Descriptive Statistics for Continuous Variables Used in Hedonic Price Models

Region/Variables	No. Obs.	Mean	Min.	Max.
West (WE):				
Trash Content ($G1$)	3,204	3.2	1.0	8.0
Color ($G2$)	3,207	1.0	0.0	7.0
Length (L)	3,057	35.3	26.0	39.0
Strength (S)	851	26.8	18.0	32.0
Micronaire (M)	3,069	4.4	2.8	5.3
General Price Level (GP)	3,071	59.3	44.3	112.5
FOB Mill Price (P)	2,916	64.0	42.9	105.6
South Central (SC):				
Trash Content ($G1$)	974	4.4	1.0	6.0
Color ($G2$)	975	1.8	0.0	3.0
Length (L)	1,021	32.5	31.0	36.0
Strength (S)	1,002	25.4	20.0	32.0
Micronaire (M)	1,023	3.9	2.8	5.2
General Price Level (GP)	1,025	59.8	47.3	99.0
FOB Mill Price (P)	981	61.5	37.0	98.0
South (SO):				
Trash Content ($G1$)	1,721	4.2	2.0	8.0
Color ($G2$)	1,721	1.0	0.0	4.0
Length (L)	1,728	34.4	32.0	36.0
Strength (S)	1,089	25.1	23.0	29.0
Micronaire (M)	1,643	4.2	3.1	5.3
General Price Level (GP)	1,681	62.5	47.6	107.8
FOB Mill Price (P)	1,612	65.0	24.7	95.5

companies were merged into a single data file. Descriptive statistics for all continuous variables used in the models are reported in table 1.

Results

For individual regions, the OLS model estimates explained the highest proportion of cotton price variations (R^2) for the West, followed by the South Central and the South (table 2). Overall, estimated regression coefficients were as expected for all fiber attributes except strength. The estimated parameters for strength were negative, but not significant, for Southern and South Central cotton. Consequently, fiber strength was dropped from the South Central and Southern models to eliminate calculations of discounts for strength.[6] The indicator variable for crop year 1994 in the Southern model was excluded because it presented a collinearity problem with whiteness. Estimated variance inflation factors for the regional models revealed no evidence of multicollinearity for all remaining variables. Across the regions, the estimated pooled model explained about 84% of price variations (table 3). All fiber attributes except strength had expected signs and were statistically significant. Estimated variance inflation factors indicate multicollinearity for fiber attributes associated with region indicator variables. High multicollinearity associated with regions was not attributed to fiber attributes themselves, but to the process of pooling. The estimated individual error sum of squares (SSE) for each variable is also reported in table 3, so that tests involving more than one coefficient could be conducted. The differences of hedonic price effects between South and South Central cotton were also statistically tested using F-tests.[7]

[6] According to Kravis and Lipsey, consistent exclusion of the variables with $|t| < 1$ maximizes the explanatory power of the model.

[7] The calculated F-statistic for testing the differ-

Table 2. Hedonic Price Model Estimates for Cotton Fiber Attributes by Region

Independent Variables	West		South Central		South	
	Est. α[a]	*t*-Ratio	Est. α	*t*-Ratio	Est. α	*t*-Ratio
$\ln(\alpha_0)$	−3.784***	−10.370	−0.863**	−2.278	−0.890**	−1.926
*DG*1	0.124***	6.989	0.174***	13.192	0.159***	6.151
*DG*2	0.121***	3.291	0.240***	9.550	0.190***	4.575
L	1.095***	10.062	0.181**	1.878	0.232*	1.581
S	0.065*	1.531	—[b]	—	—	—
M	0.576***	5.461	0.388***	3.636	0.363***	5.120
M^2	−0.072***	−5.439	−0.054***	−3.979	−0.043***	−5.130
GP	0.541***	22.462	0.719***	37.521	0.678***	40.423
cls	0.023***	4.279	0.058***	12.369	0.080***	12.987
mch	0.023*	1.428	NA	NA	−0.036**	−2.231
exp	−0.009	−1.179	NA	NA	−0.123***	−6.815
lm	0.083***	10.687	NA	NA	0.028***	5.016
*Y*93	0.028***	4.222	−0.013***	−2.578	−0.018***	−3.365
*Y*94	0.027***	2.760	−0.010	−1.178	—	—
*Y*95	−0.073***	−4.116	−0.086***	−4.471	−0.071***	−6.473
R^2	0.861		0.808		0.637	

Notes: Single, double, and triple asterisks (*) denote significance at the 10%, 5%, and 1% level, respectively. NA = variables not available.

[a] One-tailed tests on scaler variables and two-tailed tests on indicator variables.

[b] Variable dropped.

The estimated coefficients for fiber cleanness were significant at the 1% level of probability for all production regions. The textile industry on average paid at least 0.12% more as cotton became 1% cleaner for all the regions, ceteris paribus (table 2). Textile mills discount trash in cotton because trash results in more processing waste, dust, and machinery wear. The estimated price flexibility for cleanness was significantly higher for the South Central region than for the West at the 1% level of significance (table 3), but there was no statistically significant difference between the Southern and South Central regions. A significant difference also was found for the estimated price flexibility of cleanness between the South and West. The divergences in the price-cleanness relationship between the West and either of the other two regions may be due to the relative cleanness of Western cotton and perhaps that mills tend to use Western cotton for different purposes in their mixes. The fact that trash content (*G*1) in cotton over the study period averaged 4.4 for the South Central region, 4.2 for the South, and only 3.2 for the West (table 1) suggests that relatively abundant low trash cotton resulted in a smaller cleanness price flexibility.

Price flexibility for whiteness was significantly larger than zero at the 1% level of probability for all the regions (table 2). The textile mill industry on average paid the market more than 0.12% as whiteness increased 1%, other factors remaining constant. Textile mills paid premiums for white fiber or discounted yellow fiber since white fiber usually has lower costs in dyeing and bleaching and yields higher quality products. In the South Central region, the price flexibility of whiteness was significantly different from each of the other two regions at the 1% level of significance (table 3), while there was no difference between the

ences in hedonic price effects between the Southern and South Central cottons from the pooled model was 0.542 for cleanness, 17.093 for whiteness, 1.750 for length, 0.176 for micronaire, 1.346 for micronaire squared, and 2.563 for the general market forces. This suggests that a significant difference in hedonic price effect exists for whiteness only between the two regions. (For a detailed discussion of the test procedure, see Pindyck and Rubinfeld.)

Table 3. Pooled Hedonic Price Model for Cotton Fiber Attributes Across Regions

Independent Variables	Est. β[a]	*t*-Ratio	Individual SSE[b]	Variance Inflation Factor[c]
$\ln(\beta_0)$	−4.133**	−12.174	0.551	0
*DG*1	0.112**	6.588	0.161	6
*DG*2	0.119**	3.316	0.041	11
L	1.264**	12.469	0.578	15
S	−0.064**	−2.909	0.031	2
M	0.727**	7.293	0.198	942
M^2	−0.094**	−7.574	0.213	979
GP	0.536**	37.999	5.364	5
*DG*1 × *SC*	0.073**	3.416	0.043	169
*DG*2 × SC	0.153**	3.494	0.045	1,031
L × *SC*	−1.142**	−8.308	0.256	37,215
M × *SC*	−0.397**	−2.708	0.027	53,288
M^2 × *SC*	0.047**	2.526	0.024	13,245
GP × *SC*	0.140**	8.189	0.249	786
*DG*1 × *SO*	0.054*	1.947	0.014	325
*DG*2 × *SO*	−0.014	−0.291	0.000	1,515
L × *SO*	−0.949**	−6.296	0.147	49,213
M × *SO*	−0.448**	−3.902	0.057	39,762
M^2 × *SO*	0.064**	4.515	0.076	11,056
GP × *SO*	0.169**	10.298	0.394	812
cls	0.028**	9.605	0.343	1
mch	−0.009	−0.649	0.002	1
exp	−0.024**	−3.182	0.038	1
lm	0.042**	8.984	0.300	2
*Y*93	0.008**	2.374	0.021	2
*Y*94	0.018**	4.150	0.064	3
*Y*95	−0.064**	−8.116	0.245	3
SC	3.875**	7.825	0.227	39,812
SO	3.332**	6.855	0.175	40,855
R^2 = 0.84	Sum of Indiv. SSE:		9.973	

Notes: Single and double asterisks (*) denote significance at the 5% and 1% level, respectively. *S* × *SC* and *S* × *SO* were dropped in order to keep the number of continuous variables consistent with that in the three separated regional models.

[a] One-tailed tests on scaler variable and two-tailed tests on indicator variables.

[b] SSE = error sum of squares.

[c] Variance inflation factors below 10 suggest no serious collinearity problem in the model (Neter, Wasserman, and Kutner).

Southern and Western regions. Price responsiveness to fiber whiteness was the largest for South Central cotton because whiteness was relatively scarce.

Cotton price in the textile mill market responded significantly to fiber length because length contributes to processing efficiency (especially with some spinning technologies) and to yarn quality (Starbird et al.). The price responsiveness to length was greatest for cotton from the West, probably because it is sought for use in fine-count yarns and ring spinning. Price responsiveness to length was lowest for South Central cotton (table 2), probably because it is sought for rotor spinning of coarse-count yarns. Staple price flexibility was significantly different between the West and each of the other two regions at the 1% level of significance (table 3), which could be due to differing cotton destinations. Export cotton in the sample data averaged 35.38 32nds inches and domestic use cotton averaged 34.19 32nds inches. All South Central cotton and 98% of Southern cotton from the sample data went to domestic mills, while about 50% of Western cotton went to exports. Thus, increased demand for longer cotton fiber for export may have forced the market to discriminate on length more for Western cotton.

Fiber strength significantly affected cotton mill price at the 10% level of probability in the West, but the impact was relatively small in comparison with the impact of other fiber attributes in the model (table 2). Relatively small price responsiveness to strength for Western cotton suggests that users must pay strength premiums and discounts in order to ensure against getting fibers that are too weak, but that strength discrimination is less important than discrimination on other quality attributes. The lack of price responsiveness to strength for South Central and Southern cottons probably indicates that users generally were obtaining all of the strength they desired from South and South Central cottons, so there was no need to discriminate.

Coefficient estimates of micronaire and micronaire squared were statistically significant for all the regions (table 2). Textile manufacturers discounted both extremely low micronaire (immature) or high micronaire (coarse) cotton because immature and coarse fibers reduce the strength of yarn and fabric and the appearances of finished products. Estimated micronaire discount patterns were different between the West and each of the other two regions (table 3). The optimal micronaire derived from maximizing M by solving $\partial P/\partial M = 0$ was about 4.0 for Western cotton, 4.2 for Southern cotton, but only 3.5 for South Central cotton. South Central (Southern) cotton had higher market value at the low (high) end of the conventional micronaire range. The patterns of micronaire discounts may be a result of purchasing practices as they related to textile spinning technologies and the differences in average micronaire readings across the regions.

While the general price level at base quality through time had a significant effect on mill prices paid or received, mill price moved in less than 1:1 proportion with the general market movements reported in spot market quotations in all regions (table 2). The correspondence of movements was highest in the South Central region and lowest in the Western region. Further, the impact of general price movements in the spot market was significant across regions (table 3). Prices paid by manufacturers are less correlated with the spot quotations of the USDA in the West than in the other two regions. However, the reasons for the specific pattern associated with base price movements are not clear.

Impacts of indicator variables on cotton prices for individual regions are shown in table 2. Statistical tests of differences between regions for these indicator variables were not performed due to data constraints or perfect collinearity. No export variable was available in the South Central model since all transactions from that region were for domestic sales. However, call sales in general brought a higher price than fixed price sales since call sales bear more marketing costs or risk to sellers than fixed price sales in the market. FOB mill price was higher than FOB warehouse price because of extra marketing transactions costs, such as transportation and insurance. Foreign buyers paid less than domestic mills, perhaps because export sales did not include some marketing costs and export sales may reflect some government export subsidies during the study period. The impact of crop years on the price-quality structure showed no specific pattern across the regions.

Summary and Conclusions

This study provides an application of hedonic price theory to the market price of cotton attributes using primary market data, the most reliable type of data in empirical studies of price-quality relationships. Results indicate that cotton price at the end-use point of the market is determined by quality attributes, other specific contract provisions, and general market forces. Comparison of estimated price flexibilities for fiber attributes across regions shows that the price-quality relationships of cotton were substantially different between the South Central and Western regions for all fiber attributes. Differences in the hedonic relationships also existed between the South and West for all fiber attributes except whiteness. However, no significant differences in attribute values except whiteness were found between the Southern and South Central regions.

This analysis provides the only evidence of cotton attribute values at the end-use point of the fiber market that is based on data known to be reliable. These attribute value estimates are important to cotton growers and others in fiber production (e.g., breeders, seed companies, ginners) who apply the information for decisions about variety selection and crop management practices. For example, the evidence that higher grades (i.e., lower $G1$ and $G2$) for cotton from the Western region have relatively low premiums compared to other attributes suggests that farmers and ginners may not want to emphasize better grades, but instead emphasize fiber length, for which the price responsiveness is highest. Furthermore, the information on market values of attributes may be used as a reference for textile manufacturers to make adjustments in purchasing attributes, combinations of cotton used in processing, and/or mixes of cotton from different regions.

These differences in price-quality relationships across regions also raise questions about the credibility of the national Commodity Credit Corporation's loan schedule. Since the pricing structures of cotton differ across regions, the single premium/discount loan structure for all regions may mislead the market and cause pricing inefficiency in the cotton industry. Regional loan schedules may need to be examined as an alternative.

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