Textile Market Valuation of Cotton Quality Attributes

by

Changping Chen and Don E. Ethridge

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This study analyzed cotton pricing structures associated with quality attributes at the end-use point of U.S. cotton market using a hedonic framework for the 1992-1995 period. Results based on the information from primary market transactions show how the price of cotton is influenced by fiber attributes--trash content, color, staple, fiber fineness and maturity, etc. The textile industry differentiates cotton by the region of origin in terms of fiber attributes. Fiber premiums and discounts were substantially different between the West and South Central regions. Staple premiums and discounts were different between the West and South. Micronaire discounts differed across all regions. This study provides the first objective evidence on cotton price-quality relationships at the end-use point of cotton market that is based on *bona fide* market transactions.

Introduction

The U.S. cotton industry is composed of three segments--fiber production, marketing, and textile manufacturing. As a middle process, cotton marketing connects fiber producers and textile manufacturers. Information on fiber demand from textile mills and fiber supply from cotton growers is carried through the market channel by price signals. At least two relevant pricing points can be identified given cotton ownership changes several times along the market channel that the cotton flows. The first is a producer price, which is established at the beginning of the market and reflects how much cotton growers receive from the market. Another price is the mill price, which is formed at the last point at which cotton is sold while it is still in the form of cotton lint. Knowledge of the pricing structures associated with fiber attributes at both ends of the market is important because the quality of final textile products depends on fiber attributes.

Since the early 1980s the bulk of literature has been developed on price-quality relationships at the producer pricing point (Ethridge and Davis; Ethridge and Neeper; Ethridge

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et al.; Brown et al.). Cotton price is significantly affected by its quality attributes. Market values of cotton fiber attributes vary with production region (Bowman and Ethridge; Chiou et al.). However, little is known on the price-quality relationships of cotton at the mill pricing point in the market because of the difficulty of obtaining information. Hembree et al. and Ethridge and Chen examined these prices, but the data used were price quotations, which are highly aggregated and their reliability is not known or suspect (Hudson et al.). The information on the pricing structures related to quality attributes in the textile mill market is of increasing importance to market participants because the final demand comes from fiber users in the market. Cotton growers need the information to adjust their cropping practices to produce more desirable or higher value cotton. Textile manufacturers may also need the knowledge as a reference for making cotton purchasing decisions.

The general objective of this analysis was to determine the market values of cotton fiber attributes paid by textile manufacturers. Specific objectives were to estimate the price-quality relationships in different production regions and identify the patterns of similarities and differences in the pricing structures across the regions.

Theoretical Framework

Cotton is an input for textile manufacturers, but an output for cotton growers. Textile producers purchase cotton fiber as a raw material to produce yarns, fabric, etc., and sell these textile products to other industries. Cotton growers produce and sell cotton as a product. The market value of a fiber attribute is determined when a market transaction takes place between the buyer (textile manufacturer) and seller (cotton grower).

The conceptual basis of hedonic prices is that a good has value only through its utility bearing characteristics (Lancaster). A good is bought because the characteristics embodied in the good give rise to utility for buyers. Rosen's framework was slightly modified by assuming that textile manufacturers seek profit instead of utility. Assume that there is a bid function, $\Phi_1=\Phi(A_1,A^*_2,\ldots A^*_n;\pi^*_m)$, for a specific textile manufacturer in the market. The A's in the bid function represent fiber attributes and π^*_m denotes the profit maximized for the textile manufacturer. The bid function defines the amounts that the mill producer is willing to pay for a fiber attribute A_1, at the profit π^*_m, given $A_2=A^*_2$, $A_3=A^*_3$, and so on. The function is derived from the manufacturer's profit function. Symmetrically, an offer function, $\theta_1=\theta(A_1,A^*_2,\ldots A^*_n;\pi^*_g)$, is also assumed to exist for a specific cotton grower in the market. π^*_g is the profit maximized for the cotton grower. The offer function defines the amounts that the cotton grower is willing to accept for selling a unit of fiber attribute A_1 at the profit π^*_g. The market value of fiber A_1 is determined at the equilibrium where the textile mill manufacturer's bid function is tangent to the cotton grower's offer function (Rosen). At the equilibrium point the amounts the textile mill manufacturer is willing to pay equal that the cotton grower is willing to accept for a certain amount of A_1. Since there are a family of offer functions from cotton growers and a family of bid functions from textile manufacturers, the price of each fiber attribute in fact represents a joint envelope of the two families of functions (Rosen). The locus of these tangencies between individual offer and bid functions depicts the price-characteristic (i.e., hedonic) relationship for the fiber attribute A_i and can be derived from a hedonic price equation.

Methods and Procedures

Data used in this analysis were *bona fide* market transactions specified in the indi buy and sell contracts from eight firms at the fiber end-use point of the market across all the cotton production regions for the period 1992-94 and early 1995. The information represe average of 26% of U.S. cotton production and 41% of U.S. mill consumption of cotton. Ir contract, the price, quality attributes, production origin, delivery dates, and other terms be the two parties were identified. Contracts were either fixed price or call sale. Call contracts converted to an equivalent fixed price on the date of the transaction by adjusting the futures on that day by the basis stated in the contract. All information was converted to a consi format for model estimations.

The factors determining cotton price consist of two principal components--fiber attrib and other determinants. Cotton fiber attributes include composite grade, staple (i.e., fiber leng strength, and micronaire. The composite grade is a two-digit code, with the first digit (ra from 1 to 8) being associated with trash content in fiber. As trash content increases, the qua of the fiber declines. The second digit of the grade code ranges from 0 to 7 and represents color of fiber. As the second digit of the grade increases, the fiber becomes more yellow pigmental. Staple and strength positively affect the quality of textile products. Microna measures the fineness and maturity of fiber. The most desirable micronaire is conventiona believed to be the range of 3.5 to 4.9 (U.S. Department of Agriculture, 1993). As microna increases or decreases from this range, the value of the fiber decreases.

A variable was included to control or capture the general demand and supply market forc for cotton. The variable was the daily price quotations at the base quality: grade 41, staple 3 micronaire 4.2, and strength 24.5 reported in the Daily Spot Cotton Quotations (U.S. Departme of Agriculture, 1992-95). This approach was also used by Bowman and Ethridge and Chiou al. The price quotations were linked to the contract price in the data from cotton firms by the da specified in the contracts.

Based on the information available, three regions were specified to capture the price quality relationships associated with regions. The Western region consists of California, Arizona and New Mexico. The South Central region includes Texas and Oklahoma. The Southern region comprises all the cotton states in the Southeast and Mid-south.

The hedonic price equation for cotton was specified as:

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

where:

P = FOB price (¢/lb.) of the cotton specified by or derived from the contracts;

r	=	regional indicator for the Western (WE), South Central (SC), and Southern (SO) regions, respectively;
DG1	=	8 - G1, indicating cleanness of fiber, G1 is the first digit of the composite grade;
DG2	=	9 - G2, representing whiteness of fiber, G2 is the second digit of the composite grade;
L	=	staple (32nds inch);
S	=	minimum strength specified in the contract (grams/tex.);
M	=	micronaire reading, an average of high and low micronaire;
GP_r	=	general price movement of cotton (¢/lb.) at base quality in region r on the date of the transaction as reported in "Daily Spot Cotton Quotations";
cls	=	indicator variable for type of sale--if cls = 1, the sale is a call, if cls = 0, the sale is fixed price;
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 country, 0 otherwise (If both mch and exp = 0, the buyer is a domestic mill);
lm	=	indicator variable for location--if lm = 1, the cotton is priced at mills (i.e., FOB mill), If lm = 0, the cotton is priced at sellers' warehouse (i.e., FOB warehouse);
Y93	=	indicator variable for crop year--if 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, and
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 specified since marginal returns in using fiber attributes diminish (Brown and Ethridge). Transformations of trash as the difference of 9 - G1 and color as 8 - G2 were due to the properties of the two fiber attributes. The use of difference specifications for trash and color allowed parameter interpretations of the two negative fiber attributes in the same fashion as positive fiber attributes. The transformation also avoided the problem that color code could not be logarithmically transformed with zero of G2. The expected effects of cleanness, whiteness, staple length, and strength on cotton prices were to increase at a decreasing rate. The effect of micronaire on cotton prices was expected to increase, then decrease, since excessive coarseness or fineness of cotton adversely affects processing performance (Ethridge and Neeper; Brown and Ethridge). The multiplicative hedonic price model captures the interaction effects among variables.

The model was transformed into an additive form by taking the natural logarithm and estimated using ordinary least squares. The model was estimated for all regions. Following the procedures established by Krivis and Lipsey for model estimations, continuous variables that were contradictory to theoretical expectations and indicator variables with a t-statistic less than one were excluded from the models. Based on model estimates, premiums and discounts of each individual fiber attribute were estimated for further interpretations and comparisons across regions. Premiums/discounts measure how many points/lb. (1¢ =100 points) each unit of the fiber attribute paid or received in the market as compared with an estimated base mill price.**

Findings

Model estimates are summarized in Table 1. The signs of coefficient estimates were as expected and magnitudes appeared realistic for all fiber attributes except strength in all regions. Strength was statistically significant only in the Western model. There was no evidence of collinearity among fiber attributes except micronaire and micronaire squared. The collinearity of micronaire and micronaire squared was expected because the two variables have a multiplicative relationship. The Western model explained the highest proportion of the price variations for cotton, in terms of R^2, followed by the South Central and Southern models, respectively (Table 1). The premiums and discounts of each individual fiber attribute, holding the rest of other quality attributes as the base level, are plotted in Figure 1 to facilitate the interpretations of the results.

Estimated price flexibility of fiber cleanness was positive and significant at the 1% level of probability. Textile manufacturers paid at least 0.12% more to the market on average for all regions as cotton was 1% cleaner, *ceteris paribus*. Textile manufacturers paid price premiums for clean cotton because less trash cotton results in lower processing waste and dust, and less machinery wear. A comparison of estimated premiums and discounts for trash content shows that while trash premiums and discounts were smaller for the West than other two regions, there was little difference between the South Central and Southern regions (Panel A, Figure 1). The differences of trash premiums and discounts between the West and other two regions may be attributed to the relative cleanness of Western cotton and that mills tend to use it for different purposes in their mixes. Average trash content was above 4.2 for the South Central and Southern

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**Premiums and discounts are the derived price differentials for each unit of a fiber attribute. For example, staple premiums and discounts for region r could be calculated using the following formula:

$$
\begin{aligned}
P/D_{L,r} = {} & 100*(b_{0,r}(9-4)^{b_{1,r}}(8-1)^{b_{2,r}}(L_r)^{b_{3,r}}(24.5)^{b_{4,r}} \\
& e^{b_{5,r}(4.2)+b_{6,r}(4.2)^2}(GP_{r,m})^{b_{7,r}}\, e^{b_{8,r}(cls)+b_{9,r}(mch)} \\
& e^{b_{10,r}(\exp)+b_{11,r}(lm)+b_{12,r}(Y93)+b_{13,r}(Y94)+b_{14,r}(Y95)} \\
& -BP_r),
\end{aligned}
$$

where $P/D_{L,r}$ = estimated premiums and discounts for staple L; $GP_{r,m}$ = the mean of GP in region r during the study period, and BP_r = base price paid by textile manufacturers. $P/D_{L,r}$ changes as L_r changes. The changes of $P/D_{L,r}$ associated with L_r constitute the premium and discount schedule for staple. A positive $P/D_{L,r}$ means premiums for staple, while a negative $P/D_{L,r}$ suggests discounts. The premiums and discounts of other fiber attributes can be also derived using the same procedure.

cotton, but only 3.2 for the Western cotton. Abundant low trash cotton in the West might result in its smaller trash price premiums and discounts.

Cotton price at the end-use point of market responded to the whiteness of fiber for all the regions. As the whiteness of fiber increased by 1%, textile manufacturers paid 0.24% more for South Central cotton and 0.12% to Western cotton, other things constant. Whiter fiber has lower costs (in dyeing and bleaching) and produces high quality textile products. As Panel B, Figure 1 shows, color premiums and discounts were smaller for the Western than for the South Central cottons perhaps due in part to the fact whiter cotton was more abundant in the West. There was little difference in color premiums and discounts between the South Central and Southern regions.

Coefficient estimates of staple length were significantly larger than zero at the 1% level of probability (Table 1). Textile manufacturers pay for longer staple because longer staple usually enhances yarn and fabric fineness and strength, and nep formation during processing (Starbird et al.). Western cotton had larger staple premiums and discounts than cottons grown in the other two regions, but little difference was found for staple premiums and discounts between the South Central and Southern regions (Panel C, Figure 1). The difference in staple premiums and discounts between the West and other two regions may be due to the destinations of cotton from each region. While all South Central cotton and 98% of Southern cotton went to domestic mills during this study period, about 50% of Western cotton was sold for export. Export cotton has longer staple (35.38) than domestic mill use cotton (34.19) probably because foreign manufacturers prefer longer staple cotton due to their greater use of ring spinning production technology. Increased demand for longer staple cotton for export may have forced the market tc pay higher premiums for longer staple.

In the textile mill market price responded only to fiber strength for Western cotton during the study period, but the impact was relatively small when compared to that of other fibe: attributes in the model. The small price flexibility of strength for Western cotton and no pric responsiveness to strength for South Central and Southern cottons all suggest that textil manufacturers did not differentiate cotton by strength or did not pay strength premiums. This ma also implies that the market is getting sufficient strength for planned uses in the Southern an South Central regions.

While the estimated coefficient for micronaire were rational and significant for all th regions, the micronaire discount structure differed across regions. The optimal micronaire derive from maximizing M by solving $\partial P/\partial M = 0$ was about 4.0 for Western cotton, 4.2 for Souther cotton, and 3.5 for South Central cotton (Panel D, Figure 1). Textile mills discounted less heavil on low micronaire cotton and more heavily on high micronaire cotton from the South Centr region than from the other two regions. Western cotton was more heavily discounted at both tl low and high ends of micronaire than cotton grown in the other two regions. The patterns micronaire discounts may be a result of purchasing practices as they relate to textile mill spinni technology and the differences in average micronaire across regions.

The impacts of general price movements of cotton in the daily spot quotations on cott prices paid by textile manufacturers were significant, but the price of cotton paid by textile mi did not move in a 1:1 proportion with spot quotations for all regions (Table 1). This occur probably because the general price movement reported by U.S. Department of Agriculture is mixture of different prices. This may suggest that the price quotation is not a highly accurat indicator of the market situation for U.S. cotton. A comparison of coefficients estimated for th general price movement across regions shows that there was little difference between the Souther and South Central regions. However, the impact of general price movements on mill price wa smaller in the West than other two regions. This suggests that textile manufacturers may perceiv the base price movement, reported by Daily Spot Cotton Quotation, differently in the West tha in the other two regions.

Impacts of indicator variables on cotton prices in the textile mill market are presented i Table 1. A general comparison of indicator variables is not made for all the indicator variable because some of the indicator variables were not available due to data constraint or exclusion o indicator variables. However, call sales (cls) brought a higher price than fixed price sales perhaps because call sales bear more marketing costs to sellers in the market than fixed sales. FOB mill price was higher than FOB warehouse price since FOB mill price includes extra transaction costs such as transportation costs and insurance. Foreign buyers paid less thar domestic mills. This may have been affected by export subsidy programs in the U.S. over the study period. There was no specific pattern in the impacts of crop years on the price-quality structure across regions.

Summary and Conclusions

This study represents the first documented estimate of the price-quality relationship at the final pricing point in the textile mill market using *bona fide* market information. Results show that the price of cotton in that market is determined by cotton fiber attributes as well as general market forces. The pricing structures of cotton in the textile mill market appear to be substantially different between the Western and South Central regions for all fiber attributes. Differences also exist for the pricing structures of cotton between the West and South, but the differences were only for micronaire and staple. There is, however, little difference for any fiber attributes except micronaire between the Southern and South Central regions.

The findings of this study suggest that the market values of cotton quality attributes paid by textile manufacturers can be statistically estimated using *bona fide* market information. The methods and procedures developed in this study provide market participants with the tool for determining the premiums and discounts of cotton quality attributes. The empirical results of this study are useful to market participants in several aspects. For example, cotton growers and others in fiber production may use the information to make their production decisions about variety selections and crop management practices. Since fiber length singnificantly affects the price of cotton for all regions, it should be the first factor to be considered when selecting variety. Textile manufacturers may use the findings as references in the production cost analysis with respect to fiber attributes.

The difference in fiber premiums and discounts across regions raises questions about credibility of the CCC loan schedule. Since premiums and discounts differ across regions, the single CCC premium/discount schedule for all regions may need to be reexamined. A regional premium/discount loan schedule may better guide the market and enhance the efficiency of the cotton industry.

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Table 1. Hedonic Price Model Estimates for Cotton Fiber Attributes by Regions.

Independent	West		South Central		South	
Variables	Est. B	*t*-ratio	Est. B	*t*-ratio	Est. β	*t*-ratio
ln(intercept)	-3.784[a]	-10.370	-0.863[b]	-2.278	-0.890[b]	-1.926
DG1	0.124[a]	6.989	0.174[a]	13.192	0.159[a]	6.151
DG2	0.121[a]	3.291	0.240[a]	9.550	0.190[a]	4.575
L	1.095[a]	10.062	0.181[b]	1.878	0.232[c]	1.581
S	0.065[c]	1.531	-	-	-	-
M	0.576[a]	5.461	0.388[a]	3.636	0.363[a]	5.120
M^2	-0.072[a]	-5.439	-0.054[a]	-3.979	-0.043[a]	-5.130
GP	0.541[a]	22.462	0.719[a]	37.521	0.678[a]	40.423
cls	0.023[a]	4.279	0.058[a]	12.369	0.080[a]	12.987
mch	0.023[c]	1.428	NA	NA	-0.036[b]	-2.231
exp	-0.009	-1.179	NA	NA	-0.123[a]	-6.815
lm	0.083[a]	10.687	NA	NA	0.028[a]	5.016
Y93	0.028[a]	4.222	-0.013[a]	-2.578	-0.018[a]	-3.365
Y94	0.027[a]	2.760	-0.010	-1.178	-	-
Y95	-0.073[a]	-4.116	-0.086[a]	-4.471	-0.071[a]	-6.473
R-Squared	0.861		0.808		0.637	
No. Observations	749		923		1495	

[a] indicates significance at 1% level, [b] indicates significance at 5% level, and [c] indicates significance 10% level. One-tailed tests on scaler variables and two-tailed tests on indicator variables. '-' indicates the variable dropped and "NA" indicates the variable unavailable.

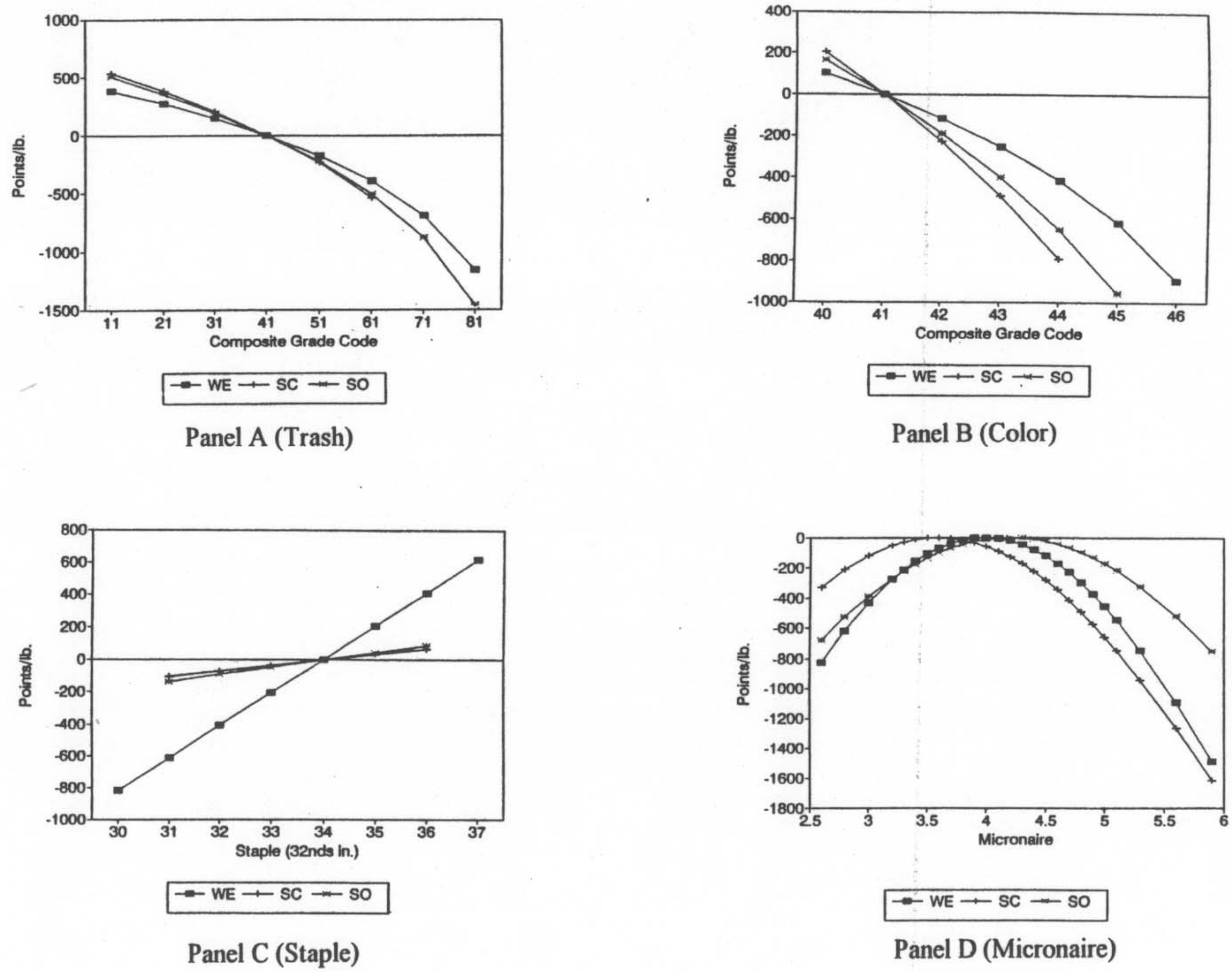

Figure 1. Market Values of Fiber Attributes for U.S. Cotton.