The Journal of The Textile Institute

Volume 88 • 1997

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Textile Manufacturers.**

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Part 2: Textile Economics, Management and Marketing

Number 1

The Textile Institute

Values Placed on US Cotton-fiber Attributes by Textile Manufacturers

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Received 2.9.1996 Accepted for publication 17.1.1997

Price premiums and discounts paid for cotton quality attributes (trash, color, length, strength, and micronaire) by textile manufacturers were derived for three US cotton production regions. The data for the analysis were individual contracts of textile firm purchases representing about 26% of US cotton production and 41% of the cotton used by mills over the 1992–early 1995 period. All fiber attributes except strength significantly affected prices paid by mills for cotton from the Western, South Central, and Southern production regions. Price premiums and discounts for all fiber attributes differed between Western and South Central cottons. Region differences in price premiums and discounts between the West and South were found for length and micronaire, but little difference was found between the Southern and South Central regions for any fiber attribute except micronaire. The information obtained from the study provides better understanding of cotton pricing structures relative to quality attributes in the textile mill market.

1. INTRODUCTION

The value of an article or commodity is determined at its final demand point because prices in the intermediate-goods market are derived from that point. The final pricing point for cotton is when a textile manufacturer purchases it as fiber for transformation into other goods. An additional complication in that market is that there are many different prices rather than a single price for cotton because cotton is not homogeneous in terms of its properties. Cotton farmers provide cotton in different regions from different varieties under varied climatic conditions and cultural practices. Textile manufacturers use cotton with different attributes and processing equipment to produce a range of final products. This generates many prices for cotton based on combinations of fiber attributes embodied in the cotton. Prices for cotton are most commonly represented within the industry as a 'base price' (for a base grade, length, micronaire, and strength) and a group of price differentials (premiums and discounts) as attributes vary from the base. However, markets do not reveal these price differentials directly; they must be *derived* from market data. Since both buyers (consumers/textile manufacturers) and sellers need reliable market-price information, it is important that the derived prices and fiber premiums and discounts be accurate.

The primary objective of this study was to determine the prices, including fiber premiums and discounts, paid by textile manufacturers for US cotton. Specific objectives included determining the extent to which the pricing structures may vary across regions of origin of the cotton within the USA.

Most previous studies (Bowman and Ethridge, 1992; Brown and Ethridge, 1995; Chio

et al., 1993; Ethridge and Davis, 1982; Ethridge and Neeper, 1987) that estimated the market value of cotton quality attributes in the cotton market have analyzed producer prices. A small number of studies (Ethridge and Chen, 1993; Hembree *et al.*, 1986) examined the price-quality relationships of cotton in the textile mill market, but the data used in these studies were price quotations that are highly aggregated, and their reliability is unknown (Hudson *et al.*, 1995). While several of the studies of producer prices (Ethridge and Davis, 1982; Ethridge *et al.*, 1994; Hudson *et al.*, 1995) have used primary market data, those data from the textile mill market have not been available in sufficient quantity for reliable analysis. This research uses primary market transaction data as a vehicle for determining cotton pricing structure(s) at the point of final demand.

2. METHODS AND PROCEDURES

2.1 The Data

Data used in this analysis were market contracts provided by two marketing co-operatives and six textile firms. The data span the 1992 crop through early contracts on the 1995 crop. The observed purchases represent 26% of US cotton production and 41% of mill consumption of cotton during the study period. Duplicate observations (a sale by a seller also being reported as a purchase by a buyer) were eliminated from the data set. The price and quality attributes, production region or origin, delivery dates, and other terms between the two parties were identified in each contract. While purchase prices for mill contracts were free on board (FOB) mill, sale prices specified in marketing co-operative contracts were FOB warehouse. Contracts were either fixed-price sale (delivered price is agreed upon) or call price (a basis was fixed and price would be called by the buyer on the New York Futures price). Call contract prices 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 (US Dept. of Agriculture: Daily Spot Cotton Quotations, 1992-95).

Three cotton production regions were identified in this study. The West (WE) consists of California, Arizona, and New Mexico, and the South Central (SC) region includes Texas and Oklahoma. The South (SO) consists of the South-east states (North Carolina, South Carolina, Georgia, Florida, and Alabama) and Midsouth (Arkansas, Louisiana, Mississippi, Missouri, and Tennessee). The South-east and Midsouth were treated as one region because contracts typically did not differentiate between cottons grown in the South-east and Midsouth. Subsequent statistical tests confirmed that the price structures between the regions are not different.

2.2 Analytical Procedures

Hedonic price-analysis procedures (Rosen, 1974) were used to determine how various attributes affect the value of cotton. These procedures are well documented in the literature and have been applied to numerous goods, commodities, and services (Griliches, 1961; Kravis *et al.*, 1971; Stanley *et al.*, 1991; Wilson, 1987; Witte *et al.*, 1979). Fiber attributes on which textile manufacturers buy cotton are grade, length, strength, and micronaire (an indicator of fiber fineness and maturity). The composite grade, an indicator of foreign matter and color, is a two-digit code. In this analysis, the first digit was used as a general indicator of trash content in cotton and the second digit was used as an indicator of color (grayness and yellowness). The composite grade designation has been disaggregated into separate color and leaf grades, but the data for this study specified the prior grade designations. Cotton fiber derives its value from the fiber itself and from the attributes embodied in the fiber. That is, cotton has market value because it is cotton, independent

from the variation in its attributes. The market value of cotton independent of variation in fiber attributes can be represented by the daily market movement in the price of the 'base' quality (grade 41, staple 34, micronaire 3.5–4.9, and strength 24–25) (Bowman and Ethridge, 1992; Chiou *et al.*, 1993; Ethridge and Neeper, 1987). The indicator of the general market movements used in this study was the base price reported by US Department of Agriculture, which was linked to each textile market purchase/sale for each region on the date of the transaction.

The hedonic price model for each region was specified as follows:

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

where P = FOB price (c/lb) of the cotton specified by or derived from the contracts; r = regional indicator for the WE, SC, and SO regions, respectively; $DGI = 8 - G1$, 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 = length (32nds of an inch); S = minimum strength specification (gf/tex); M = micronaire reading, an average of high and low micronaire values specified in the contract; GP = general price level of cotton (c/lb) at base quality (i.e. grade 41, staple 34, micronaire 3.5–4.9, and strength 24 and 25) on the date of the transaction as reported in 'Daily Spot Cotton Quotations'; cls = indicator variable for type of sale – if $cls = 1$, sale is a call sale, if $cls = 0$, the sale is a 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 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 for delivery at the mill (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 the 1994 crop, $Y94 = 0$ otherwise; $Y95$ = indicator variable for crop year – if $Y95 = 1$, the cotton is from the 1995 crop, and $Y95 = 0$ otherwise (if $Y93$, $Y94$, and $Y95 = 0$, the cotton is from the 1992 crop).

The price–quality relationships of cotton for all attributes were hypothesized to be non-linear because marginal returns of using fiber attributes diminish (Brown *et al.*, 1995). With micronaire, the market values are expected to increase, and then decrease as micronaire increases; excessive coarseness or fineness of cotton adversely affects processing performance (Ethridge and Neeper, 1987). An advantage of the multiplicative model was that the interaction effects among variables on price were also captured.

The coefficient estimate associated with a fiber attribute in the hedonic price equation is the price flexibility of that characteristic, which measures the percentage change in FOB mill price as the fiber factor changes by 1%, *ceteris paribus*. Thus, the coefficient estimates show the relative importance of the attributes' impacts on price. While coefficient estimates of fiber attributes are the price responsiveness associated with the change in fiber attributes, price premiums and discounts are price differentials associated with different fiber qualities. That is, price premiums and discounts measure how many points/lb (100 points = 1 cent) each unit of the fiber is priced as compared with base mill price (grade 41, length 34, micronaire 4.2, strength 24.5, and the mean of GP). Price premiums and discounts are calculated as the price of each attribute combination, determined from the

estimated hedonic price equation, minus the base mill price, times 100. There is a premium or discount for each combination of quality attributes other than the base quality.

3. DISCUSSION OF RESULTS

Equation (1) was estimated by using ordinary least-squares regression for each of the three cotton production regions. Results are summarized in Table I. Overall, estimated coefficients were as theoretically hypothesized for all fiber attributes except strength. Strength was statistically significant only for Western cotton. Fiber strength was excluded in the South Central and Southern models because it was contradictory to theoretical expectations and the estimates were not statistically significant. Price premiums and discounts for all fiber attributes were simulated and are summarized in Tables II–VI.

Table I
Hedonic Price Model Estimates for Cotton Fiber Attributes in the Three Production Regions, 1992–early 1995 Period

Independent Variables	West		South Central		South	
	Est. <i>B</i>	<i>t</i> -ratio	Est. <i>B</i>	<i>t</i> -ratio	Est. <i>B</i>	<i>t</i> -ratio
$\ln(B_p)$	-3.784 ^a	-10.370	-0.863 ^b	-2.278	-0.890 ^b	-1.926
<i>DGI</i>	0.124 ^a	6.989	0.174 ^a	13.192	0.159 ^a	6.151
<i>DG2</i>	0.121 ^a	3.291	0.240 ^a	9.550	0.190 ^a	4.575
<i>L</i>	1.095 ^a	10.062	0.181 ^b	1.878	0.232 ^c	1.581
<i>S</i>	0.065 ^c	1.531	—	—	—	—
<i>M</i>	0.576 ^a	5.461	0.388 ^a	3.636	0.363	5.120
<i>M</i> ²	-0.072 ^a	-5.439	-0.054 ^a	-3.979	-0.043 ^a	-5.130
<i>GP</i>	0.541 ^a	22.462	0.719 ^a	37.521	0.678 ^a	40.423
<i>cls</i>	0.023 ^a	4.279	0.058 ^a	12.369	0.080 ^a	12.987
<i>mch</i>	0.023 ^c	1.428	NA	NA	-0.036 ^b	-2.231
<i>exp</i>	-0.009	-1.179	NA	NA	-0.123 ^a	-6.815
<i>lm</i>	0.083 ^a	10.687	NA	NA	0.028 ^a	5.016
<i>Y93</i>	0.028 ^a	4.222	-0.013 ^a	-2.578	-0.018 ^a	-3.365
<i>Y94</i>	0.027 ^a	2.760	-0.010	-1.178	—	—
<i>Y95</i>	-0.073 ^a	-4.116	-0.086 ^a	-4.471	-0.071 ^a	-6.473
<i>R</i> ²	0.861		0.808		0.637	
Number of Observations			923		1495	

^a Indicates significance at 1% level, ^b indicates significance at 5% level, and ^c indicates significance at 10% level. One-tailed tests on scalar variables and two-tailed tests on indicator variables. — indicates the variable dropped and NA indicates the variable unavailable.

Table II
Estimated Trash (G1) Premiums and Discounts (Points/lb) for US Cotton, by Region^a

Composite Grade	West	South Central	South
11	384	537	501
21	273	380	355
31	146	203	190
41	Base	Base	Base
51	-175	-240	-225
61	-393	-536	-504
71	-687	-929	-875

^a Type of sale – average of fixed price and call sale; type of buyer – domestic mills; FOB mill delivery; crop year – average of 1992–early 1995 crops; color code – 1; length – 34; strength – 24.5; and micronaire – 4.2.

Fiber cleanness significantly increased the price of cotton during the study period for all three regions at the 1% level of probability (Table I). That is, textile manufacturers

discounted trash in cotton since foreign material in fiber reduces the quality of textile products. While the differences in estimated price premiums and discounts for trash were evident between the Western and the other two regions, there was little difference between the South Central and Southern regions (Table II). Western cotton had smaller trash premiums and discounts than the other two regions during the study period. The difference in trash premiums and discounts between the West and the other two regions could be due to the relative abundance of clean fiber in Western cotton. Trash content averaged about 4.4 for South Central cotton and 4.2 for Southern cotton, but only 3.2 for Western cotton over the study period. Textile manufacturers may also tend to use it for different purposes in their mixes.

Textile manufacturers paid significantly more as cotton-fiber whiteness increased for all regions (Table I). Price premiums and discounts estimated for color were lower for Western cotton than for South Central and Southern cottons, but no significant difference was found between the Southern and South Central regions (Table III). Differences of color premiums and discounts between the West and the other two regions are probably attributable to whiter cotton being more abundant in the West. That is, textile manufacturers may have paid lower premiums for whiter cotton in the West than in the other two regions because of its relative abundance.

Table III
Estimated Color (G2) Premiums and Discounts (Points/lb) for US Cotton, by Region^a

Composite Grade	West	South Central	South
40	104	205	166
41	Base	Base	Base
42	-177	-229	-186
43	-254	-488	-399
44	-416	-791	-650
45	-620	-1158	-959
46	-894	—	—

^a Type of sale – average of fixed price and call sale; type of buyer – domestic mills; FOB mill delivery; crop year – average of 1992–early 1995 crops; trash content – 4; length – 34; strength – 24.5; and micronaire – 4.2. — indicates that no data were observed in that range.

Estimated price flexibility for fiber length was significant in all three regions (Table I). An increase of length significantly increased the price premiums for cotton, *ceteris paribus*, since length is one of the key factors affecting the high quality of textile products. Yarn and fabric fineness and strength, and nep formation during processing are correlated with length (Starbird *et al.*, 1987). Calculated length premiums and discounts were larger for Western cotton than for the Southern and South Central cottons, but there was little difference between Southern and South Central cottons (Table IV). Textile manufacturers discounted short-length cotton more heavily in the West than in the other regions, while they paid higher premiums for longer cotton fibers for the West. For example, length 36 averaged 4.2 c/lb higher than the base length in the West, but only 0.66 c/lb in the South Central region, and 0.86 c/lb in the South, holding other fiber attributes at their base levels. The divergences of estimated premiums and discounts for length between the Western and other two regions may have resulted from the final destinations of cotton from each region. Based on the data used in this study, 98% of the observed Southern cotton and all South Central cotton went to domestic mills during the study period, while about 50% of Western cotton was exported. Foreign textile manufacturers may prefer longer cotton fiber because of their greater use of ring-spinning production technology. In fact, the cotton fiber used for export was longer than the cotton used for domestic mills (35.38 32nds for

exports, 34.19 32nds for domestic mills). Increased demand for longer-fiber cotton for export may have forced the market to pay higher length premiums for Western cotton.

Table IV
Estimated Length (L) Premiums and Discounts (Points/lb) for US Cotton, by Region^a

Staple Length	West	South Central	South
28	-1221	—	—
29	-1019	—	—
30	-817	—	—
31	-613	-104	-137
32	-410	-69	-90
33	-205	-34	-45
34	Base	Base	Base
35	206	33	44
36	412	66	86
37	618	—	—
38	826	—	—

^a Type of sale – average of fixed price and call sale; type of buyer – domestic mills; FOB mill delivery; crop year – average of 1992–early 1995 crops; trash content – 4; color code – 1; strength – 24.5; and micronaire – 4.2. — indicates that no data were observed in that range.

Strength significantly affected cotton price at the 10% level of significance for Western cotton only, but the price responsiveness of fiber strength was small (i.e., 0.065) (Tables I and V). The small price responsiveness of fiber strength in the West and no price response in the South Central and Southern regions for strength suggest that textile manufacturers were probably getting sufficient strength from the Southern and South Central cottons for present uses, but that they were still discriminating among cotton on the basis of strength when buying it for uses to which Western cotton was placed.

Table V
Estimated Strength (S) Premiums and Discounts (Points/lb) for US Cotton, by Region^a

Strength	West	South Central	South
18 and below	-807	—	—
19	-596	—	—
20	-412	—	—
21	-163	—	—
22	-45	—	—
23	-26	—	—
24–25	Base	—	—
26	25	—	—
27	41	—	—
28	56	—	—
29	71	—	—
30	85	—	—
31 and above	99	—	—

^a Type of sale – average of fixed price and call sale; type of buyer – domestic mills; FOB mill delivery; crop year – average of 1992–early 1995 crops; trash content – 4; color – 1; length – 34; and micronaire – 4.2. — indicates no estimates.

Estimated coefficients for micronaire evidenced that market value of cotton increased as micronaire increased, then decreased as micronaire went beyond an optimal value. The optimal micronaire (set $\partial P/\partial M = 0$ and solve for M) was about 4.0 for Western cotton, 4.2 for Southern cotton, but only 3.5 for South Central cotton. Furthermore, micronaire discounts varied with the production region. Textile manufacturers discounted less heavily on low-micronaire cotton and more heavily on high-micronaire cotton from the South

Central region than from the other two regions (Table VI). Western cotton was more heavily discounted at the low end of micronaire than cotton grown in the other two regions. Southern cotton was most heavily discounted at high micronaire. The patterns of micronaire discounts may be a result of purchasing practices as they relate to textile-mill spinning technology and the differences in averaging micronaire readings across the regions. Cotton grown in South Central had an average micronaire of 3.8, which was much lower than the cotton grown in the West (4.3) and South (4.2). South Central cotton is probably sought by textile mills using rotor-spinning technology and used in coarse-count yarns, particularly for use in denim. Consequently, South Central cotton had small discounts for low micronaire. On the other hand, the cotton grown in the Western and Southern regions was probably more appropriate for ring spinning because of longer staple and higher micronaire. Hence, the cotton grown in the West and South could have lower discounts for high micronaire.

Table VI
Estimated Micronaire (M) Discounts (Points/lb) for US Cotton, by Region ^a

Micronaire	West	South Central ^b		South
2.6 and below	-807	-200	-279	-677
2.7-2.9	-569	-82	-171	-525
3.0-3.2	-412	11	-86	-390
3.3-3.4	-163	110	Base	-199
3.5-4.9	Base	Base	-124	Base
5.0-5.2	-528	-619	-732	-220
5.3 and above	-729	-813	-921	-327

^a Type of sale – average of fixed price and call sale; type of buyer – domestic mills; FOB mill delivery; crop year – average of 1992–early 1995 crops; trash content – 4; color code – 1; length – 34; and strength – 24.5. ^b Two bases were/are shown for micronaire discounts because of the unique pattern for the South Central cotton.

The general daily market (price quotations) movement through time significantly affected cotton prices in the textile mill market for all the regions (Table I). However, prices paid by textile mills moved in less than 1:1 proportion with the spot quotations. Reasons why they may not move together more closely include: (a) the quotations represent only one (base) quality; (b) they represent a market that is not defined in terms of pricing point (it is a mixture of cotton prices from producers, merchant-to-merchant sales, and textile manufacturers); and (c) they are subjective quotations, not measures. An examination of the impacts of general market movements on cotton prices across the regions indicates a difference between the Western and other two regions (Table I), but no difference between the South Central and Southern regions.

Call-sale prices averaged higher than fixed-price sales for all the regions during the study period (Table I). This may be due to the fact that call sales bear more marketing costs than fixed sales to sellers in the market. The FOB mill price was higher than FOB warehouse price because extra transportation and insurance costs were involved. A lower price for export sales than domestic sales may be explained by the existence of export subsidy programs in the USA over the study period. There were no patterns for other indicator variables across the regions.

4. SUMMARY AND CONCLUSIONS

Prices paid by textile manufacturers for cotton are affected by quality attributes of the fiber, general market forces, and specific terms of contractual arrangements. For cotton from the Western production region, price is most responsive to the variations in length,

then to variations in micronaire, and least responsive to variations in strength. Textile manufacturers appear to have paid premiums and/or discounts on the basis of strength only for cotton from the West during the study period. Prices in the West are more responsive than those in other regions to all quality attributes except grade (trash and color).

Price-quality relationships of cotton differ with the region of origin at the end-use point of the market. Estimated price premiums and discounts for all fiber attributes were substantially different between the Western and South Central regions. While regional differences in price premiums and discounts also exist for staple and micronaire between the Western and Southern regions, the differences in premiums and discounts between the Southern and South Central regions were small except with micronaire. That is, textile manufacturers appear to treat the Southern and South Central cottons much the same except with respect to micronaire.

The analysis does not reveal definitive reasons for the inter-regional differences in price premiums and discounts, but there are some potential explanations for the regional patterns of market values placed on cotton-fiber attributes by textile manufacturers. One is that there are aspects of quality that are not measured (or measurable) with present technology, and that the users of cotton use the region of origin as a proxy for those attributes. Another explanation is that users tend to go to different regions to acquire cotton for specific manufacturing processes and/or for specific end-products, thus creating somewhat different demands for fiber attributes in the separate regions. Differences in availability of fiber attributes in the production regions can likewise create differences in attribute values. However, more specific explanations of these patterns associated with production regions require additional research.

This study demonstrates the feasibility and desirability of obtaining primary market data from users of cotton to discern the values that users place on attributes. The information is relevant to all participants in the market. It is important for buyers (mills) in that market to know what values the market is placing on attributes (not just the value their individual firms are placing on them). Fiber producers need the information to make variety selection and other production and marketing decisions. Without objective and verifiable studies, all market participants have to speculate on those values.

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