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Regional and Seasonal Differences in the Cotton Basis

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The cotton basis is examined graphically and statistically to determine if the basis differs across U.S. production regions and within the crop year as economic theory predicts. The analysis indicates the basis differs for some, but not all, regions consistent with the theory. Results also show that the typical seasonal pattern is not apparent for regions which export most of their cotton, most likely because demand in these regions is seasonal.

Key Words: basis expectations, cotton marketing, futures markets, nonparametric statistics, theory of storage

Traditionally, most studies examining the basis for a commodity have concentrated on one location (e.g., Bascou, 1990; Flaskerud, 1998–99). Some recent work has expanded this view by examining prices at multiple locations (e.g., Benirschka and Binkley, 1995; Brennan, Williams, and Wright, 1997; Frechette and Fackler, 1999). Because of transportation costs, the local cash price and the local basis (defined as the cash price minus the futures price)[1] are expected to decline with distance to a consumption market. However, prices in different locations need not necessarily be apart by the cost of transportation (Brennan, Williams, and Wright, 1997). Little empirical work has attempted to determine if the local basis declines with distance to a consumption market for a particular commodity. The cotton basis is tested here for regional differences.

The theory of storage, originally presented by Working (1942, 1948, and 1949), is often used to explain the theoretical basis through time for a seasonally produced storable commodity (e.g., Tomek, 1997). Most textbooks on futures markets explain the theoretical convergence of local cash prices and the futures price through time (e.g., Kolb, 1994; Purcell and Koontz, 1999). However, this theoretical pattern relies

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[1] Although this definition is typically used in the trade, some researchers have defined the basis as the futures price minus the cash price (e.g., Tomek, 1997; Bascou, 1990; Leuthold and Peterson, 1983).

on the assumption of stable demand. For many commodities in many locations, demand is not stable through the crop year, including some cotton locations. The cotton basis is tested here for seasonal differences.

Regional and seasonal differences in the cotton basis are important to many cotton handlers because producers, mills, and merchants face the risk that cotton prices may move adversely. While they can use cotton futures or options on cotton futures to reduce this price risk,[2] these handlers then must bear basis risk. For firms using futures and options to forward-price cotton, understanding the basis is important because changes in the basis alter their profits.

Firms that currently or potentially trade cotton in multiple locations are affected by the basis in those different locations. Locational differences in the basis can affect decisions regarding the place to buy or sell. Similarly, firms trading cotton at different times during the crop year are affected by seasonal differences in the basis. Seasonal differences in the basis are particularly important to firms considering storage. A strengthening basis through time allows cotton to be hedged or forward-priced at a profit (Purcell and Koontz, 1999). Thus, seasonal differences in the basis can affect decisions regarding the time to buy or sell.

The historical basis is important to cotton handlers who hedge because they typically make basis forecasts when hedging to estimate their cash inflow or outflow from cotton trading. Simple basis models (e.g., the historical average basis) often provide basis forecasts just as reliable as those derived from more complex models (Dhuyvetter and Kastens, 1998). Knowledge of the current basis, the historical average basis, and the historical regional and seasonal patterns in the basis allows handlers to quickly estimate the future basis at multiple locations and throughout the crop year.[3]

The purpose of this study is to determine if the historical cotton basis differs across production regions and within the crop year. First, the theory of the basis is reviewed to provide an understanding of the expected theoretical relationships between cash and futures prices. The cotton basis in each of seven U.S. cotton production regions is graphed to confirm whether locational or seasonal differences are apparent visually. Finally, statistical analysis is used to determine whether the visual differences are statistically significant. The statistical findings are compared with the theory of the basis, and possible economic explanations for observed differences are given.

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[2] Cotton futures contracts are traded at the New York Cotton Exchange. The trading unit is 50,000 pounds in approximately 104 cotton bales. The delivery months are October, December, March, May, and July. Delivery is by registered warehouse receipt, at par from warehouses located in Galveston, Houston, New Orleans, Memphis, and Greenville, SC.

[3] In addition to historical averages, many cotton handlers also monitor specific factors affecting the cotton basis. These factors can help handlers to predict when the basis will be larger, smaller, or about the same as the historical average. However, evaluating these factors is beyond the scope of this study.

The Theory of the Basis for Cotton

The theory of storage predicts the basis will differ for varying production regions because the cash price differs by location, primarily due to transportation costs. In general, commodity prices decline as distance to the market increases because transport costs increase (Benirschka and Binkley, 1995). Therefore, the basis should be weaker (i.e., the cash price lower relative to the futures price) the farther a commodity is from major consumption points.

As noted earlier, cotton is either consumed domestically or exported (primarily to the Pacific Rim). Domestic textile mills, located in the Southeast region of the U.S., typically consume approximately 62% of the annual U.S. harvest (Glade, Johnson, and Meyer, 1997). The Pacific coast is the major port for cotton exported to Pacific Rim countries, typically exporting approximately 23% of the U.S. cotton harvest. The Texas gulf region, the central gulf coast, and the Atlantic coast combine to export another 10% of the crop (Glade, Johnson, and Meyer, 1997). The remaining crop is exported to Canada or Mexico, or is unaccounted for. Thus, the basis, on average, is expected to be stronger (i.e., the cash price is higher relative to the futures price) for locations in the Southeast and West, and weaker for interior locations.

The futures price minus the cash price is the price of storage and is equal to the opportunity and physical costs of storage minus convenience yield at the futures delivery point. Kaldor (1939) coined the term "convenience yield" to identify the benefit to firms from having an additional unit of a commodity in storage. The smaller the level of stocks, the greater is the convenience yield. Since convenience yield is a benefit, it is a negative cost in the price of storage. Therefore, the price of storage calculated using a futures contract expiring late in the crop year is largest at harvest because the opportunity and physical costs of storage are large (since there are many months of storage) and convenience yield is negligible (because stocks are large). As the crop year progresses, the opportunity and physical storage costs decrease (there are fewer months of storage remaining) and convenience yield increases (stocks are now smaller). Thus, the basis calculated using a futures contract expiring late in the crop year is weakest at harvest. As the crop year progresses, the basis is expected to strengthen as opportunity and physical storage costs decrease and convenience yield increases.

Based on the above discussion, the cotton basis calculated using a futures contract maturing late in the crop year is expected to be weakest at the time of major harvest, and to strengthen as the crop year progresses. While the cotton harvest in the U.S. begins at a few locations in August and September, the predominant harvest period is October through November. Consequently, based on theory, the cotton basis is expected to be weakest during the predominant harvest period (October and November) and strongest just before significant quantities of the new crop are harvested (August).

Many authors discuss this convergence of cash and futures prices through time (e.g., Kolb, 1994; Purcell and Koontz, 1999). Hieronymus (1971) notes this seasonal relationship between cash and futures prices requires that the storable commodity is produced at one time of year and used at fairly even rates throughout the year. Thus, the theoretical basis pattern may not hold when the demand function is not stable through the crop year. Domestic textile mills typically maintain only a 30- to 40-day supply of cotton, and replenish their stocks at fairly even volumes throughout the year (Glade, 1996). Therefore, the basis would be expected to follow the theoretical seasonal pattern in cotton production regions which typically supply domestic textile mills. However, U.S. Department of Agriculture/National Agricultural Statistics Service (USDA/NASS, 2000) data show the quantity of U.S. cotton that is exported follows a strong seasonal pattern, with November through March making up the heaviest export months. Thus, the theoretical seasonal basis pattern may not hold for regions typically supplying cotton for export because the demand is not stable throughout the crop year. Stronger than usual export demand in November through March may increase the cash price in these regions relative to July futures, thereby distorting the typical seasonal pattern.

Calculating the Basis

Cotton cash price data by specific location are no longer available.[4] Instead, daily and monthly cash price data are reported by region [USDA/Agricultural Marketing Service (AMS), 1988–98]. Commencing in September 1988, the USDA began reporting cash price data for the following seven U.S. production regions:

1. Southeast (Alabama, Florida, Georgia, North Carolina, South Carolina, and Virginia);
2. North Delta (Arkansas, Missouri, and Tennessee);
3. South Delta (Louisiana and Mississippi);
4. East Texas/Oklahoma (East Texas and Oklahoma);
5. West Texas (West Texas except El Paso area, and Eastern New Mexico);
6. Desert Southwest (Arizona, Southern California, Western and Central New Mexico, and the El Paso area of Texas); and
7. San Joaquin Valley (San Joaquin Valley of California).

The reported daily cash price is a weighted average cash price over a particular region, with the cash price at specific locations weighted by the quantity traded at that location. The monthly data are the simple averages of the daily cash prices for the month.[5]

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[4] Cash price data by location were available only through August 1988. Beginning in September 1988, the USDA/AMS started reporting cash price data by region.

[5] The USDA/AMS reports daily cash prices for each region even if no cotton is traded in a region. Monthly average data are used here to lessen the effect of potential incorrect data in the daily price time series.

The cash prices are reported as compressed, FOB car/truck.[6] Cash prices for base quality cotton are used in this analysis.[7]

The monthly basis for each region is calculated as the monthly average cash price for that region minus the monthly average settlement price for the July futures contract traded at the New York Cotton Exchange (also obtained from USDA/AMS). Given that the USDA defines the cotton crop year as August 1 through July 31, the basis is calculated for August 1988 through July 1998. The data represent 10 complete crop years.[8] For July, the basis is calculated using the average cash price for only those days on which the maturing July futures contract traded.

Because the cash price data are regional averages, problems of interpretation are introduced. The calculated basis in this study is a regional average and may not always provide an accurate basis estimate at a particular location within the region. While one would not expect the error to be large for a geographically concentrated production region such as West Texas, the error occasionally may be greater for a geographically large region such as the Southeast. For example, if most trading on a particular day occurred in Georgia, the basis for the Southeast region would essentially reflect the Georgia basis. As a result, the regional basis may be a poor estimate of the actual basis in a distant location in North Carolina with lighter trading on that day. Monthly averages are used in the analysis to lessen these effects. Nevertheless, due to the data limitations, the results from this study are most useful to cotton handlers trading in the more active markets.

The Regional Average Monthly Cotton Basis

In this section, the basis for each of the seven designated cotton production regions is graphed to determine whether seasonal and locational differences in the basis are apparent visually. Figure 1 shows the average monthly cotton basis for crop years 1988/89 through 1997/98 for four regions—the Southeast, San Joaquin Valley, and North and South Delta. The basis is expected to be strongest in these regions because of their proximity to domestic textile mills or western export markets.

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[6] Since August 1993, the reported cash price quotes represent the compressed, FOB car/truck price. However, earlier reported data represent prices of uncompressed cotton in the warehouse. In this analysis, compression and outhandling costs [obtained from the USDA/Economic Research Service (ERS), 1989–94] are added to the cash prices quoted prior to August 1993 to adjust these prices to FOB car/truck.

[7] Base quality cotton is defined as Color 41, Leaf 4, Staple 34, Mike 3.5–3.6 and 4.3–4.9, and Strength 23.5–25.4 grams per tex. Base quality cotton is the par delivery grade for cotton futures contracts traded at the New York Cotton Exchange. Although different qualities of cotton are grown in different regions, USDA/AMS reports base quality prices for each region. While we use base quality in our analysis for simplicity, the methods used here could also be implemented with other quality levels.

[8] As mentioned above, the USDA changed from reporting cash prices for specific locations to reporting regional prices in September 1988. In the first month of the data set (August 1988), the USDA reports the cash price data for seven specific cities, each within one of the seven production regions. For this month, Greenville was used for the Southeast quote, Memphis for the North Delta quote, Greenwood for the South Delta quote, Dallas for the East Texas/ Oklahoma quote, Lubbock for the West Texas quote, Phoenix for the Desert Southwest quote, and Fresno for the San Joaquin Valley quote.

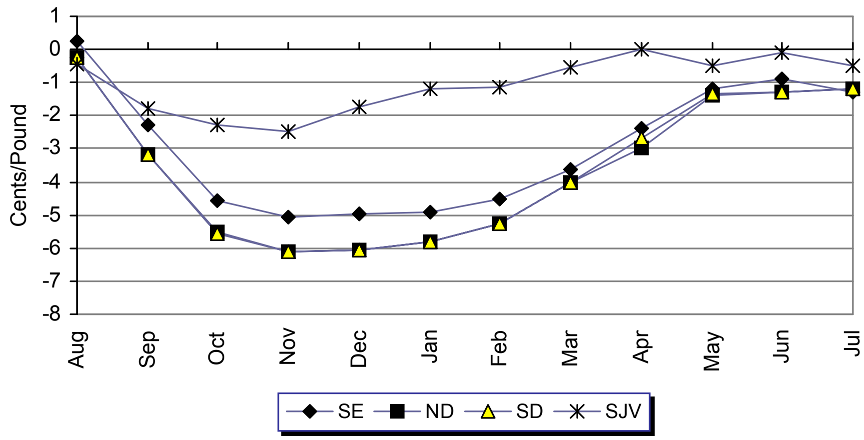

Figure 1. Average monthly cotton basis for the Southeast (SE), North Delta (ND), South Delta (SD), and San Joaquin Valley (SJV) regions, August 1988–July 1998

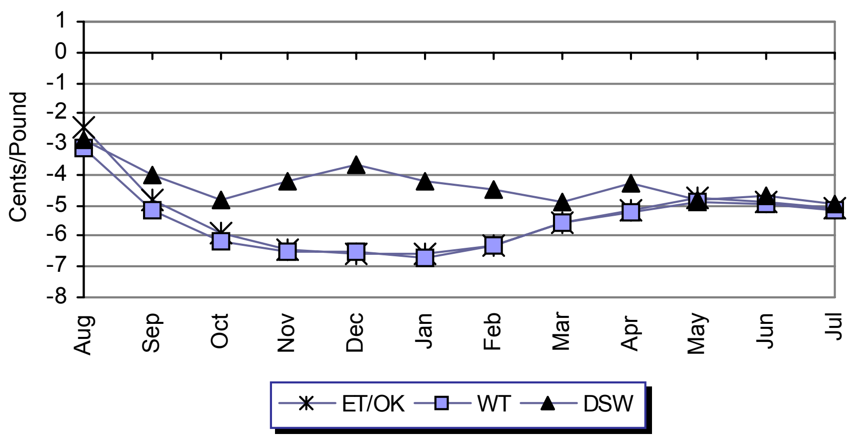

Figure 2. Average monthly cotton basis for the East Texas/Oklahoma (ET/OK), West Texas (WT), and Desert Southwest (DSW) regions, August 1988–July 1998

The San Joaquin Valley basis is the strongest, on average, for every month except August (figure 1). The Southeast basis is the second strongest on average. The basis in the Southeast, North Delta, and South Delta is similar to the San Joaquin Valley basis early and late in the crop year. Since the Southeast region encompasses the states of North and South Carolina, Georgia, and Alabama, where the majority of textile mills are located, the Southeast basis is expected to be stronger than the basis in the two Delta regions.[9] However, the stronger basis in the Southeast is less evident in the last few months of the crop year. The basis in the North Delta and South Delta regions is quite similar, with the monthly average basis differing by at most 0.051 cents.

Figure 2 shows the average monthly cotton basis for the same period for the remaining three regions—East Texas/Oklahoma, West Texas, and Desert Southwest. The basis in these three regions is similar at the beginning and end of the crop year, but stronger in the Desert Southwest region than in the East Texas/Oklahoma and West Texas regions in the middle of the crop year. The basis in the Desert Southwest region begins to strengthen after October, and is even stronger than the basis in the Southeast and Delta regions from November through February. This strength probably reflects the strong export demand to the Pacific Rim. Arizona, which makes up a large proportion of the Desert Southwest region, typically exports up to 80% of its cotton through Pacific ports headed primarily to Pacific Rim countries (Glade, Johnson, and Meyer, 1997).[10] The East Texas/Oklahoma and West Texas regions have the weakest basis of all the regions.

Regional Differences in the Basis

Based on figures 1 and 2, visual differences in the cotton basis are apparent for some, but not all, regions. The purpose of this section is to determine whether these visual differences in the basis across regions are statistically significant.

The nonparametric Friedman test is used in this analysis for two reasons. First, this test does not require the observations to be independent. The basis observations are not independent; for any month, the same futures price is used and the cash prices are determined simultaneously for all regions. Second, the Friedman test does not require that the observations come from a normal distribution or that the variances of the observations are equal. Based on the Jarque-Bera test (as described by Gujarati, 1995), there is significant evidence to indicate the basis observations were drawn from nonnormal distributions at the 1% significance level for all regions except West Texas. Further, based on the Bartlett test (as described by Snedecor and

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[9] For the 1992/93 crop year (the latest year for which these data are available), mills in North Carolina, South Carolina, Georgia, and Alabama used approximately 90% of all raw cotton consumed by domestic textile mills (Glade, 1996).

[10] National data showing exact movement of cotton from a producing region to a consuming area are not available. These data are available only by state. Arizona cotton movements probably provide a close proxy for Desert Southwest cotton movements.

Cochran, 1967), the variance of the basis was found to differ in at least one region at the 1% significance level.[11]

The Friedman test determines whether the observations differ by treatment after the effect of the blocking variable has been removed. In this analysis, the treatment variables are the seven different production regions. Each month of each crop year is a block. The crop year has 12 months and data are available for 10 crop years, giving 120 blocks for the analysis. The data are organized in matrix form below for the Friedman test.

Date	Region 1	Region 2	Region 3	⋯	Region 7
8/88	$B_{1,1}$	$B_{1,2}$	$B_{1,3}$	⋯	$B_{1,7}$
9/88	$B_{2,1}$	$B_{2,2}$	$B_{2,3}$	⋯	$B_{2,7}$
⋮	⋮	⋮	⋮	⋮	⋮
7/98	$B_{120,1}$	$B_{120,2}$	$B_{120,3}$	⋯	$B_{120,7}$

B_{ij} represents the observed monthly average basis for observation i ($i = 1, 2, ..., 120$) in region j ($j = 1, 2, ..., 7$). The observations in each block (each row from the above matrix) are ranked from lowest to highest. Thus, the data are ranked from 1 to 7, seven regions (treatments) with one observation for each date (block). The data have 120 ties in the ranks, with 119 of them occurring between North Delta and South Delta, or East Texas/Oklahoma and West Texas.[12]

The Friedman test is then used to determine if there are significant differences in the sums of the ranks for each region. That is, the test statistic indicates whether the basis in at least one region (column) is significantly different from any other region over the entire sample period. The calculated rank sums are recorded in the second column of table 1, and the calculated Friedman test statistic is 144.319 (see appendix A). The null hypothesis is rejected at the 1% significance level, implying the cotton basis is different in at least one U.S. production region.

Multiple-comparison analysis applicable to ranked data is available to determine the region or regions in which the basis differs. The difference in the rank sums is calculated for each possible pair of regions. A test statistic (q) is calculated to test the null hypothesis that the monthly cotton basis is the same for each possible pair of regions (see appendix B). The calculated q test statistic is compared to the studentized range critical value, q, which is dependent upon α (the significance

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[11] Although the parametric two-way ANOVA allows for dependent observations, it is not appropriate here. This test requires the observations to come from populations that are normally distributed and homoskedastic (Zar, 1984). Given the results of the normality tests and the significant difference in the variances, these requirements are violated here.

[12] USDA/AMS has reported the same cash price for North Delta and South Delta since March 1992. Since February 1994, the reported monthly cash prices for East Texas/Oklahoma and West Texas typically have been identical for the last half of the crop year.

Table 1. Statistical Results of Test for Regional and Seasonal Differences in Monthly Cotton Basis for Seven U.S. Production Regions, August 1988 – July 1998

Region	Rank Sum [a]	*q* Grouping [b]	Seasonal Friedman Test Statistic
San Joaquin Valley	673	A	10.45
Southeast	642	A	44.49**
North Delta	457	B	51.33**
South Delta	454	B	— [c]
Desert Southwest	429	B	3.38
East Texas/Oklahoma	301	C	— [c]
West Texas	267	C	21.31*

Notes: The basis is the cash price minus the July futures price. Single and double asterisks (*) denote significance at the 5% and 1% levels, respectively.

[a] The rank sums are calculated to test for regional differences in the basis. The Friedman test statistic for regional differences (144.319) is significant at the 1% level.

[b] Multiple-comparison analysis is used to test for significant differences in the basis for all pairs of regions. Regions found to have significantly different basis at the 5% significance level are identified by different alphabetical letters.

[c] The Friedman test statistics were not calculated for these regions because of the similarity in the basis in these regions. The basis in the South Delta and North Delta regions, and in the East Texas/Oklahoma and West Texas regions is almost identical, differing by at most 0.75 cents.

level), ∞ (infinite degrees of freedom),[13] and k (the total number of regions being tested). The third column of table 1 presents the results of the multiple pairwise comparisons made between each production region at the 5% significance level.

As shown in table 1, no significant differences in the basis are found for the following regions: (*a*) San Joaquin Valley and Southeast; (*b*) North Delta, South Delta, and Desert Southwest; and (*c*) East Texas/Oklahoma and West Texas. The similarity in the basis between the two Delta regions, and between the East Texas/Oklahoma and West Texas regions is evident visually in figures 1 and 2. However, the similarity of the basis in the San Joaquin Valley region and the Southeast region, and of the basis in the Desert Southwest region and the two Delta regions is not apparent in the graphs.

Recall the graphs represent the average basis in each month over the study period. An outlier in the data can affect averages greatly, but affects only one rank in a nonparametric statistical test. For example, exports in 1994/95 were extraordinarily high due to a small crop in China (USDA/ERS, 1996). The San Joaquin Valley and Desert Southwest enjoyed strong demand for their cotton and a strong basis.

[13] Zar's (1984) nonparametric multiple comparisons which employ tabulated studentized range values assume infinite degrees of freedom regardless of the number of observations used in the test.

Meanwhile, domestic textile mill demand was not abnormally high or low during 1994/95. The basis in the Southeast and Delta regions was not very different from average during most of the crop year. The strong basis for this crop year helped increase the average monthly basis for the San Joaquin Valley and Desert Southwest regions. However, the ranks were not greatly affected by the unusual 1994/95 export demand.

When comparing the basis in the Delta regions with the basis in the Desert Southwest, recall the Friedman test determines whether a significant difference in the basis occurs across the whole crop year. Figures 1 and 2 show the basis in the Desert Southwest is stronger than the basis in the Delta regions early in the crop year, but the basis in the Delta regions is stronger than the basis in the Desert Southwest later in the crop year. Overall, the basis is not significantly different across these regions.

These results are consistent with theory. The Southeast is a cotton-consumption region and the San Joaquin Valley is a major export market. Thus, these two regions have the strongest basis. The two Delta regions and the Desert Southwest region are geographically closer to these two markets than the Texas regions, and their basis is the next strongest. Finally, the West Texas and East Texas/Oklahoma regions are the farthest from these markets, and consequently have the weakest basis.

Seasonal Differences in the Basis

Just as theory predicted the basis should be different for varying production regions, theory also predicts the cotton basis follows a seasonal pattern. According to theory, the basis calculated using a futures contract maturing late in the crop year will strengthen as the crop year progresses. Thus, as noted earlier, the cotton basis should be weakest during the predominant harvest period (October–November) and strongest just before significant quantities of the new crop are harvested (August). Recall, however, that the assumption of a stable demand function is inappropriate for regions which typically supply cotton for export, such as the Desert Southwest and the San Joaquin Valley regions. Thus, a significant seasonal pattern may not be observed for these regions.

The purpose of this section is to determine if the monthly cotton basis exhibits a statistically significant pattern through the crop year for five production regions. Because the basis in the North and South Delta regions, and in the West Texas and East Texas/Oklahoma regions is similar visually, the South Delta region and the East Texas/Oklahoma region are not analyzed here.

Again the Friedman test is used, this time to find if a significant seasonal basis pattern emerges. Each region is tested to determine if the basis differs for each month of the crop year. In this case, the 12 months of the crop year are the treatments and the 10 crop years are the blocks. The data, shown in matrix format, are organized below for each region.

Crop Year	August	September	October	· · ·	July
1988/89	$B_{1,1}$	$B_{1,2}$	$B_{1,3}$	· · ·	$B_{1,12}$
1989/90	$B_{2,1}$	$B_{2,2}$	$B_{2,3}$	· · ·	$B_{2,12}$
⋮	⋮	⋮	⋮	⋮	⋮
1997/98	$B_{10,1}$	$B_{10,2}$	$B_{10,3}$	· · ·	$B_{10,12}$

B_{ij} represents the observed monthly average basis for crop year i ($i = 1, 2, ..., 10$) in month j ($j = 1, 2, ..., 12$). The objective is to determine if the basis in at least one month (column) differs from the basis in the other months. The fourth column of table 1 provides the Friedman test statistics and results of the test for seasonality.

While the monthly basis is found to differ in at least one month for the Southeast, North Delta, and West Texas regions, no significant difference in the monthly basis is found for the Desert Southwest and San Joaquin Valley regions. Based on these results, it appears the monthly seasonal basis pattern becomes less pronounced as one moves west across the U.S.; i.e., the Friedman test is significant at the 1% level for the Southeast and North Delta regions, significant at the 5% level for the West Texas region, and insignificant for the Desert Southwest and San Joaquin Valley regions. Thus, as observed from our findings, the seasonal basis pattern becomes less distinct when moving from regions which market predominately to domestic textile mills to regions whose market emphasis is predominately for export.

The lack of seasonality in the basis for the San Joaquin Valley and Desert Southwest coincides with the visual graphs in figures 1 and 2. This finding is probably attributed to the fact that cotton from these regions is typically exported. The seasonal export demand most likely causes the cash price in the San Joaquin Valley and Desert Southwest to rise and fall in relation to the futures price, depending on the current export market conditions. The U.S. typically exports most cotton to the Pacific Rim countries during October through March, the months in which the theoretical seasonal basis would be weakest. Apparently, the increased export demand during these months increases the cash price in these regions relative to futures prices, resulting in the basis being stronger than the seasonal pattern. Consequently, the basis is fairly constant through the crop year, as figures 1 and 2 show.

In the Southeast, North Delta, and West Texas regions, where a significant seasonal basis pattern is observed, nonparametric multiple-comparison analysis is conducted to identify the months where the basis differs. Table 2 reports the results of monthly differences in the basis for the Southeast and North Delta regions.

The results for the Southeast indicate that the monthly average basis in May, June, and August is greater than the monthly average basis in November, December, and January at the 5% significance level. The North Delta monthly average basis in May, June, July, and August is greater than the monthly average basis in November, December, and January. For these two regions, the basis is stronger later in the crop year than earlier in the crop year. Thus, the theoretical basis pattern within a crop

Table 2. Monthly Rank Sums and Multiple Comparisons for Differences in the Monthly Average Cotton Basis Across the Crop Years 1988/89–1997/98 for the Southeast and North Delta Regions

SOUTHEAST			NORTH DELTA		
Month	Rank Sum [a]	*q* Grouping [b]	Month	Rank Sum [a]	*q* Grouping [b]
June	96	A	June	93	A
May	91	A	July	91	A
August	90	A	May	91	A
July	86	A B	August	89	A
September	81	A B	April	80	A B
April	74	A B	September	74	A B
March	55	A B	March	64	A B
October	49	A B	February	54	A B
February	47	A B	October	47	A B
November	37	B	January	34	B
December	35	B	November	33	B
January	35	B	December	30	B

[a] Ranks were assigned from weakest basis to strongest basis for each month of each crop year. Thus, higher rank sums imply stronger basis, and smaller rank sums imply weaker basis.

[b] Months found to have significantly different basis at the 5% levels are identified by different alphabetical letters.

year is observed. These two regions typically serve the demand of domestic textile mills which consume cotton at relatively stable rates through the crop year. The cash price rises relative to the July futures price to provide an incentive for these producers and merchants to store cotton.

No multiple-comparison results are given for the West Texas region. The Friedman test found the basis was significantly different for at least one month in the West Texas region at the 5% significance level (table 1). However, the multiple-comparison analysis showed no difference in the monthly basis for that region at the 5% significance level. The comprehensive Friedman test takes precedence over the multiple-comparison tests (Ott, 1984).[14]

Thus, significant evidence exists that the basis in at least one month differs from the other months. Despite this finding, we are unable to identify the month or months that differ statistically. August had the highest rank sum and December the

[14] Ott (1984) reports that tests such as the Friedman test may be significant, but pairwise differences may not be significant using multiple-comparison techniques. This apparent anomaly can occur because the Friedman null hypothesis is equivalent to the hypothesis that all possible comparisons (paired or otherwise) among the population ranks are equal. The comparisons which are significant might not be of the form $R_A - R_B$, the form being used in the paired comparisons.

lowest rank sum for the West Texas region. West Texas tended to have its strongest monthly basis just before harvest and its weakest basis just after major harvest. Visually, from figures 1 and 2, the West Texas basis appears to have a less pronounced seasonal pattern than the Delta and Southeast regions, but more pronounced than the Desert Southwest and San Joaquin Valley regions. West Texas cotton is grown approximately the same distance from West Coast ports and domestic textile mills. Thus, West Texas cotton prices are likely affected by both export and domestic mill conditions, causing the monthly basis pattern there to have characteristics of both East and West cotton.

Conclusions

The basis for a storable commodity produced once a year should differ by location because of transportation costs. The nonparametric Friedman test is used to determine if the cotton basis differs across regions over the whole crop year. Differences are found which are consistent with expectations. Handlers contemplating trading cotton in different regions can expect the basis to be strongest in eastern and western markets (home to domestic textile mills and major cotton export activity, respectively), and to weaken with distance to these two markets.

A significant seasonal basis pattern is typically expected for a storable commodity produced once a year. Many authors discuss the convergence of cash and futures prices through time because storage costs decrease through time. An important assumption made by these investigators is that the demand for the commodity is stable throughout the year. Western-grown cotton destined for export typically faces greater export demand during months in which the typical seasonal pattern shows the basis to be weakest. The nonparametric Friedman test indicates no significant seasonal cotton basis pattern for western export regions. However, the Friedman test does indicate a significant seasonal cotton basis pattern for regions supplying the relatively stable demand of domestic textile mills. From the results of this analysis, the monthly seasonal basis pattern becomes less pronounced as one moves west from the regions predominately serving domestic textile mills to the regions which predominately serve the export market.

The seasonal basis pattern is important to cotton handlers contemplating storage because a strengthening basis through time allows cotton to be hedged or forward-priced at a profit. A cotton handler contemplating storage in the Southeast or Delta regions can expect the basis to strengthen significantly through the crop year. In the West Texas region, a handler can expect the basis to strengthen moderately through the crop year. Finally, in the Desert Southwest and San Joaquin Valley, our results suggest a handler cannot expect the basis to strengthen significantly through the crop year.

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Appendix A:
The Friedman Test Formula

The computational formula for the Friedman test, with ties defined by Daniel (1990) and used in this study, is written as:

$$\chi_r^2 = b(k-1)\left[\frac{12\sum_{j=1}^{k} R_j^2 - 3b^2k(k+1)^2}{b^2k(k^2-1) - b\left(\sum t^3 - \sum t\right)}\right],$$

where b is the number of blocks, k is the number of treatments, R_j is the rank sum from treatment j, and t is the number of observations tied for a given rank in any block. The calculated χ_r^2 is compared with tabulated values of χ^2 with $k-1$ degrees of freedom to determine significant differences. When ties occur, tied observations are given the mean rank positions for which they are tied.

Appendix B:
Multiple-Comparison Analysis

If a significant difference is observed using the Friedman test, multiple pairwise comparisons are possible using the studentized range critical value, q. As presented by Zar (1984), the q-value is defined as:

$$q = \frac{R_A - R_B}{\sqrt{\dfrac{bk(k+1)}{12}}},$$

where $R_A - R_B$ represents the difference between the rank sums of region A and region B, b denotes the number of blocks, and k represents the number of treatments.