An Analysis of Factors Affecting the Regional Cotton Basis

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Few empirical basis studies have examined the basis in multiple regions and few have concentrated on cotton. This paper addresses this topic, examining consumption market factors that affect the cotton basis in five U.S. cotton production regions. The seemingly unrelated regression results indicate that the following factors are significant in explaining the basis: total U.S. cotton stocks and the ratio of foreign cotton stocks to foreign mill use in the Southeast and North Delta regions; regional stocks, the opportunity cost of storage and the foreign stocks to use ratio in the West Texas region; and regional stocks, total U.S. stocks, the opportunity cost of storage, and the foreign stocks to use ratio in the Desert Southwest and San Joaquin Valley regions. All significant coefficients have the hypothesized signs except the coefficient for the opportunity cost of storage and the coefficient for the ratio of foreign stocks to foreign mill use in two regions. The results indicate that the cotton basis in different regions is typically affected by different factors.

Keywords: cotton basis, futures markets

Introduction

Typically, cotton produced in the U.S. is either consumed in domestic textile mills located predominately in the Southeastern U.S. or exported to other textile producing countries primarily from the Pacific coast. Domestic textile mills took nearly two-thirds of the 1993/94 U.S. cotton crop (latest year data are available) and 22.7 percent of the crop was exported from the Pacific coast, headed primarily to textile mills in the Pacific Rim (USDA-ERS, 1997).[1] Given that domestic textile mills typically maintain only a 30- to 40-day supply of cotton, bales are shipped to domestic mills at fairly even volumes throughout the year (Glade). However, movements to ports for export follow stronger seasonal patterns. January, February, and March are the heaviest export months for U.S. grown cotton followed by November and December (Glade). Export demand is greatest during these months before cotton grown in the Southern Hemisphere (particularly Australia) is harvested.

These two major consumption areas are supplied with cotton produced in seventeen states encompassing essentially the entire southern third of the U.S. from Virginia to California. The eastern states from Virginia to Louisiana and Arkansas predominately supply the domestic textile mills. The western states from New Mexico to California predominately supply the Pacific coast exports. Texas and Oklahoma supply significant quantities of cotton for both domestic mills and for export.

Owners of cotton at any stage of the marketing chain face the risk that the price of cotton will change adversely. These firms can use the cotton futures and options markets for risk management, and all that do are affected by the basis (defined as the cash price minus the futures price[2]). Understanding the basis is important to these firms because changes in the basis change their profits. A weaker basis adversely affects short hedgers while a stronger basis adversely affects long hedgers.[3] Even though Dhuyvetter and Kastens found that simple models (e.g., the historical average basis) provide basis forecasts as reliable as more complex ones, a knowledge of observable factors that affect the basis may enable firms to predict when the basis will be stronger, weaker, or about the same as the historical average, and thus make better marketing decisions.

Much previous research has analyzed factors that affect the basis for many commodities other than cotton. For example, Tilley and Campbell, and Bascou examined the wheat basis; Kahl and Curtis, and Garcia and Good investigated the corn basis; and Ward and Dasse studied the frozen concentrated orange juice basis. However, little research has focused on the cotton basis. Telser advanced the theoretical explanation for the basis for a commodity and tested the theory empirically using cotton. In addition, the cotton basis has been informally addressed in studies that examine cotton marketing strategies (e.g., Loyd). However, none of these studies analyzed factors that affect the cotton basis in different regions. This research is an attempt to address this void in the literature. The specific objectives are to identify factors expected to affect the basis in the different U.S. cotton production regions and estimate the effects of these factors on the cotton basis in each region.

Theoretical Model

The basis is the market-determined price of storage and locational differences used in marketing decisions. The theory of storage originally presented by Working (1942, 1948, and 1949) is typically used to explain the basis for a seasonally produced storable commodity. The theory of storage includes the supply and demand for storage and the intersection of these curves determines the basis and the amount of the commodity stored. However, many empirical basis studies include consumption factors that affect the basis (e.g., Telser; Bascou; Kahl and Curtis; and Martin, Groenewegen, and Pidgeon).

Alternatively, one can determine the basis by focusing on the consumption rather than the storage side of the market.[4] This method is consistent with the theory of storage because at any time within the crop year the commodity is either consumed or stored for later consumption. The model includes current regional and expected national cotton demand and supply equations for consumption. Each equation represents a market curve (assumed to be linear), obtained by summing the current or expected demand or supply equations for each handler in *x* regions. Each handler is assumed to be forward looking through T periods and regards any commodity held after that period to be worthless. Thus, at present (time t), each handler has expectations for each period t+i until period T. The current period demand and supply equations for a region are functions of the current regional cash price, the futures price (a component of the expected price), and curve shifters. Similarly, the national demand and supply equations expected in a future period are functions of the futures price for delivery in that period, the futures price for later delivery, and curve shifters. For simplicity, only one shifter is included in each equation. But the shifter encompasses many variables (e.g., income and preferences for demand shifters and beginning stocks and storage costs for supply shifters).

Current (period *t*) Region *r* Demand and Supply

$$q_{t,r}^{D} = a_{t,r} - b_{t,r} P_{t,r} + c_{t,r} F_{t,t+1} + d_{t,r} H_{t,r}^{D}$$

$$q_{t,r}^{S} = e_{t,r} + f_{t,r} P_{t,r} - g_{t,r} F_{t,t+1} + h_{t,r} H_{t,r}^{S}$$

Expected Future National Market Demand and Supply in Period $t+i;\ i=1,2,\ldots,T-1$

$$Q_{t+i}^{D} = a_{t+i} - b_{t+i} F_{t,t+i} + c_{t+i} F_{t,t+i+1} + d_{t+i} S^{D}$$

$$Q_{t+i}^{S} = e_{t+i} + f_{t+i} F_{t,t+i} - j_{t+i} F_{t,t+i+1} + g_{t+i} S^{S}$$

Expected Future National Market Demand and Supply in Period T

$$Q_{T}^{D} = h - kF_{t,T} + lS^{D}$$

$$Q_{T}^{S} = m + nF_{t,T} + pS^{S}$$

where

$q_{t,r}$ = quantity demanded (denoted by superscript D) or the quantity supplied (denoted by superscript S) in period t for region r, (r = 1, 2, . . ., x);[5]

Q_{t+i} = quantity demanded (denoted by superscript D) or the quantity supplied (denoted by superscript S) in the national market in period $t+i$ (i = 1, 2, . . ., T-1);

$P_{t,r}$ = the period t cash price in region r, (r = 1, 2, . . ., x);

$F_{t,t+i}$ = the period t futures price for delivery in period $t+i$ (i = 1, 2, …, T-1);

H_r = any factors that cause the current demand curve (denoted by superscript D) or the current supply curve (denoted by superscript S) in region r to shift, (r = 1, 2, . . ., x);

S = any factors that cause the future national demand curve (denoted by superscript D) or the future national supply curve (denoted by superscript S) to shift;

Economic theory provides the expected signs for most coefficients. The coefficients $a, b, c, f, g,$ $a, b, c, f, j, h, k,$ and n are each positive. The coefficients d, d and l are each positive for those factors that increase either current or future demand. The coefficients h, g and p are each negative for those factors that increase either current or future supply. The theory offers no expectations for the signs of $e, e,$ and m.

In equilibrium, the quantity demanded equals the quantity supplied. Thus, the right-hand sides of the demand curves are set equal to the right-hand sides of the corresponding supply curves. The system contains $x+T$-1 equations and $x+T$-1 unknowns. If a unique solution exists, the equations can be solved simultaneously for the current regional cash prices and for the futures prices as functions of only exogenous demand and supply shifters (or predetermined endogenous demand and supply shifters). The basis, obtained by subtracting any of the futures prices from any of the current regional cash prices, is also a function of only demand and supply shifters from the current local regional markets and from the national market for future delivery.

As an example, consider a commodity traded in two regions and the agents in these regions are forward looking for three periods, (e.g., x = 2 and T = 3). After equating each region’s supply and demand equations and the expected national supply and demand equations for periods two and three, the theoretical expression for the basis (measured as the cash price in region one in period t minus the futures price in period t for delivery in period t+1) can be solved as

$$(1) \qquad Basis = z + y\,RDS_1 - xRSS_1 + wFDS - VFSS$$

where

$$z = \frac{(a-e)}{(f+b)} + \frac{(g+c)-(f+b)}{(f+b)(f+b)}\left[(a-e)+\frac{(h-m)(j+c)}{(n+k)}\right],$$

$$y = \frac{d}{(f+b)},$$

$$x = \frac{h}{(f+b)},$$

$$w = \frac{(g+c)-(f+b)}{(f+b)(f+b)}\left[d+\frac{(j+c)\,l}{(n+k)}\right],$$

$$V = \frac{(g+c)-(f+b)}{(f+b)(f+b)}\left[g+\frac{(j+c)\,l}{(n+k)}\right].$$

The basis is directly related to factors that increase regional demand because *d, f,* and *b* and, thus, y are positive. The basis is inversely related to factors that increase regional supply because *h, f,* and *b* and thus *x* are positive, but *x* enters Equation 1 with a negative sign. The effects of shifts in the national demand and supply are more difficult to determine because the signs of *w* and z in Equation 1 can be positive or negative. The terms in brackets are positive because they contain only positive coefficients. The remaining denominator is positive for the same reason. However, the sign of the numerator depends on the relative size of *g*+*c* and *f*+*b*. Although economic theory indicates that *g, c, f,* and *b* are positive, theory cannot determine if *g*+*c* is greater than *f*+*b*. If *g*+*c* is greater than *f*+*b*, then the quantity demanded and supplied in that region in the current period is more sensitive to changes in price expectations than to changes in the current price. Intuitively, expected prices may be more influential than current prices in regions where storage is an important marketing alternative (e.g., the Southeast) while current prices may be more influential than expected prices in distribution centers where storage is less common (e.g., Pacific coast). Thus, the basis in the eastern cotton belt is expected to be directly related to factors that increase national demand and decrease national supply. The basis in the West is expected to be inversely related to such variables.

Factors Expected to Affect the Basis

The theoretical model described above indicates that the factors that affect the basis are shifters of regional demand, regional supply, national demand, and national supply. Many factors are potential shifters of these curves. In this section, factors are identified that are both measurable and thought to be major shifters of these curves. Although all regional shifters are also national shifters and vice versa,   factors are categorized where they are expected to have the largest impact.

Regional Demand Shifter

As explained earlier, the demand for cotton is primarily from domestic mills in some regions and from foreign mills in other regions. A shifter for domestic demand was not included because domestic mill consumption has been fairly stable. However, a shifter of foreign demand is included. The ratio of foreign stocks to foreign mill use is selected because data are readily available and the ratio seems to be a good summary measure of demand from the rest of the world. As foreign stocks increase relative to foreign mill use, the export demand for U.S. grown cotton is expected to decrease and the basis in major exporting regions is expected to weaken.

Regional Supply Shifters

Many variables affect regional supply such as stocks, the physical and opportunity cost of storage, and transportation costs. Regional stocks, the opportunity cost of storage, and transportation costs are included in this analysis.

The regional supply in the current period is expected to be directly related to regional stocks at the beginning of that period. Thus, Equation 1 indicates that the basis in a region should be inversely related to the cotton stocks in that region.

The opportunity cost of storage is selected as the measure of storage cost in this analysis because this component of total storage costs is the most volatile (Garcia and Good). As the opportunity cost of storage increases, the expected profits from storage decrease, causing less to be stored and more to be supplied in the current period. Thus, the opportunity cost of storage is indirectly related to the basis.

A final hypothesized supply shifter is transportation costs. Increases in transportation costs are hypothesized to cause cash prices and thus, the basis, to strengthen in consuming areas (i.e., the Southeast and Pacific port areas) and to weaken in the other producing areas.

Future Demand Shifters

Factors such as national tastes and preferences, the price of substitute and complementary products, and income are probable shifters of future national demand. Some of these variables, such as national tastes and preferences are difficult to measure accurately. The variables used in this analysis are the price of manmade fibers (a substitute product) and the foreign stocks to foreign mill use ratio, which is reexamined as a future demand shifter.

The price of rayon, a competing manmade fiber, is used here.[6] An increase in the price of rayon relative to cotton should result in more cotton demanded relative to rayon. Since changes in textile production require some lead time, more cotton is expected to be demanded in the future relative to the current time period. Thus, the price of rayon is hypothesized to be directly related to national demand. As shown earlier, the basis should be directly related to factors that increase national demand in regions that supply domestic textile mills and inversely related in regions that supply Pacific exports.

As discussed earlier, an increase in the ratio of foreign stocks to foreign mill use is expected to reduce current export demand in western regions. The increase would also reduce the expected national demand for cotton. Thus, the ratio of foreign stocks to foreign mill use is expected to be inversely related to the basis in regions that supply domestic mills and directly related to the basis in western export regions. Earlier, an inverse relationship between the basis and this variable was projected in export regions because this variable has an indirect relationship with the regional demand shifter in these regions. The shift in the regional demand shifter is expected to outweigh the shift in the future demand shifter, and a negative relationship with the basis is still expected in western export regions. The Texas and Oklahoma regions supply domestic mills as well as export markets in significant quantities. Thus, the effect on the basis in these regions is not forecast a priori.

Future Supply Shifters

The final category of theoretical variables that affect the basis includes factors that shift national cotton supply in the future period. Variables such as weather would be expected to affect the future supply of cotton significantly. However, weather is difficult to measure accurately across the entire cotton belt. Total cotton stocks in the United States are used as the shifter here.

One would expect the future national supply of cotton to be directly related to total cotton stocks in the United States in the future period, and total U.S. stocks in the future period to be directly related to national cotton stocks carried into the current period. According to Equation 1, the basis in western export regions is expected to be directly related to beginning stocks while an inverse relationship is expected for regions that supply domestic textile mills.

The Empirical Model

Typically, the basis is calculated for a specific location, e.g., a city. However, since September 1988, USDA-AMS has reported cotton cash prices by production regions. This analysis is conducted for the basis for five U.S. cotton production regions, the Southeast, North Delta, West Texas, Desert Southwest, and San Joaquin Valley regions.[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 (obtained from USDA-AMS). The analysis covers ten complete crop years, i.e., from August 1988 to July 1998. For July, the basis is calculated using the average cash price for only those days that the maturing July futures contract traded.

The initial empirical model is constructed with all variables included in linear form except the stock variables. The natural logarithm is used for the stock variables because the effect of a unit of cotton on the basis is not linear but basically has a logarithmic form because of convenience yield (Telser). All dollar-denominated data are deflated using the Consumer Price Index (CPI) for all items. The model consistent with the variables identified in the previous section is[8]

$$
\begin{aligned}
(2) \qquad COTTONBASIS_{t,r} = {} & b_0 + b_1 LNSTOCKS_{t,r} + b_2 LNUSSTOCKS_t + b_3 STORE_{t-1,r} \\
& + b_4 \Delta PRAYON_t + b_5 TRANS_t + b_6 FSTUS_t + b_7 AUGSEP
\end{aligned}
$$

where

$COTTONBASIS_{t,r}$ = average cotton basis in month *t* for region *r*, calculated as the difference between the monthly average cash price and the monthly average July cotton futures price.

$LNSTOCKS_{t,r}$ = natural log of beginning stocks of cotton in month *t* in region *r*.[9]

$LNUSSTOCKS_t$ = natural log of beginning U.S. stocks of cotton in month *t*.[10]

$STORE_{t-1,r}$ = opportunity cost of storage measured as the average cash price in month *t-1* for region *r* multiplied by the 90-day Treasury bill rate in month *t-1* multiplied by the number of months prior to contract maturity (i.e., the months of storage) divided by twelve.[11]

$D\ PRAYON_t$ = first difference of the average U.S. cash price for rayon in month *t*.[12]

$TRANS_t$ = U.S. rail rate index for farm products in month *t*.[13]

$FSTUS_{t-1}$ = the ratio of estimated foreign beginning stocks to estimated foreign mill use (foreign mill consumption) for month *t-1*.[14]

AUGSEP = a binary variable that equals one for the months of August and September, and zero otherwise.[15]

The model is estimated using seemingly unrelated regression (SUR) to account for the probable correlation between the error terms of the regressions for the five regions. The SUR technique can improve the model's sampling precision when the error terms from the individual equations are correlated compared to simply combining the data and estimating with dummy variables for regions (Griffiths, Hill, and Judge).

Given the significant autocorrelation in the initial estimation, the data are transformed using the Prais-Winsten transformation and re-estimated using SUR. The estimated coefficients for each explanatory variable are then tested for significant differences across all regions and possible pairs of regions. The reason for testing for these differences is statistical. The estimation of the empirical model may be improved if coefficients that are not significantly different are restricted to be the same. The test results lead to restricting the coefficients of the following variables to be equal:

1. LNSTOCKS for the Southeast and North Delta regions and for the Desert Southwest and San Joaquin Valley regions.

2. LNUSSTOCKS for the Southeast and North Delta regions and for the Desert Southwest and San Joaquin Valley regions.

3. STORE for the Southeast and North Delta regions and for the West Texas, Desert Southwest, and San Joaquin Valley regions.

4. ΔPRAYON for all regions.

5. TRANS for the Southeast, West Texas, Desert Southwest, and San Joaquin Valley regions.

6. FSTUS for the Southeast and North Delta regions and for the Desert Southwest and San Joaquin Valley regions.

The restricted seemingly unrelated regression is estimated on the autocorrelation corrected basis equations for the five regions (Table 1). The weighted R^2 for the system is 0.56. The Durbin-Watson test statistics indicate that first-order autocorrelation is not present for any of the regions at the five-percent level. The Breusch and Pagan error correlation test statistic is significant at the one-percent level indicating that the seemingly unrelated regression model is appropriate.

The coefficient for STOCKS is significantly negative for the West Texas, Desert Southwest, and San Joaquin Valley regions consistent with expectations. In addition, the coefficient for USSTOCKS is significantly negative for the Southeast and North Delta regions and significantly positive for the Desert Southwest and San Joaquin Valley regions. These signs are consistent with expectations and also consistent with the hypothesis that expected prices have more importance than current prices in storage regions (Southeast and North Delta) and that current prices have more importance than expected prices in export regions (Desert Southwest and San Joaquin Valley).

The coefficient for STORE is significantly positive for the West Texas, Desert Southwest, and San Joaquin Valley regions, which is contrary to expectations. The coefficient for ΔPRAYON is negative but not significant for each region. First differences, used here for stationarity reasons, often lose explanatory power compared to the actual values. The coefficient for TRANS is not significant for any of the regions. Possibly the use of transportation cost data more specific to each region (if available) may alter these findings.

The coefficient for FSTUS is significantly positive for the Southeast, North Delta, and West Texas regions and significantly negative for the Desert Southwest and San Joaquin Valley regions. These negative signs are not consistent with the hypothesis that expected prices have more importance in storage areas (Southeast and North Delta). However, these results do support the hypothesis that foreign demand impacts local demand more than national demand in export regions (Desert Southwest and San Joaquin Valley). No a priori forecast was made for the effect of FSTUS on the West Texas basis because West Texas exports significant quantities of cotton and also supplies domestic textile mills with significant quantities.

The August – September dummy variable included to account for the later harvest in some regions is significantly negative for the Desert Southwest and San Joaquin Valley regions. Cotton stocks typically do not increase until October in these regions whereas they increase in August or September in the other regions (Bureau of Census).

Conclusions

This research identifies factors that affect the cotton basis for five major cotton production regions spanning the entire cotton belt from the East Coast to the West Coast. The empirical model explains 56 percent of the variability in the cotton basis for the five regions, a result consistent with other multiple location basis models. The results indicate that the basis in different regions is typically affected by different factors.

Although most of the significant coefficients have the hypothesized signs, some signs are contrary to expectations. The foreign stocks to use ratio is positively related to the basis in the Southeast and North Delta regions and the opportunity cost of storage is positively related to the basis in the West Texas, Desert Southwest and San Joaquin Valley regions. In addition, the results are not consistent in indicating the relative influence of expected prices and current prices in export and storage regions, respectively.

Few empirical basis studies have examined the basis for multiple locations. Although this research addresses this topic, more research is needed to understand the spatial aspect of the basis. Understanding how different variables affect the basis in different regions may be useful to commodity handlers who trade in different locations.

Table 1 Estimation of the first-order autocorrelation corrected monthly cotton basis[a] with restrictions[b] in the Southeast, North Delta, West Texas, Desert Southwest, and San Joaquin Valley regions, August 1988 to July 1998.

Explanatory Variable[d]	Southeast	North Delta	West Texas	Desert Southwest	San Joaquin Valley
CONSTANT[e]	11.8468 (2.434)**[c]	13.6580 (2.496)**	-0.3003 (-0.058)	-3.8899 (-0.837)	0.8932 (0.189)
STOCKS	-0.0182 (-0.078)	-0.0182 (-0.078)	-1.0778 (-3.102)***	-2.0797 (-6.962)***	-2.0797 (-6.962)***
USSTOCKS	-1.7000 (-3.501)***	-1.7000 (-3.501)***	0.0835 (0.143)	1.9183 (3.771)***	1.9183 (3.771)***
STORE[f]	0.2756 (1.067)	0.2756 (1.067)	0.9250 (3.604)***	0.9250 (3.604)***	0.9250 (3.604)***
ΔPRAYON[f]	-0.1041 (-1.362)	-0.1041 (-1.362)	-0.1041 (-1.362)	-0.1041 (-1.362)	-0.1041 (-1.362)
TRANS[f]	-0.0175 (-0.351)	-0.0446 (-0.769)	-0.0175 (-0.351)	-0.0175 (-0.351)	-0.0175 (-0.351)
FSTUS	6.4503 (1.667)*	6.4503 (1.667)*	10.7919 (2.561)**	-9.7082 (-2.315)**	-9.7082 (-2.315)**
AUGSEP	-0.7682 (-1.138)	-1.0635 (-1.531)	-1.0866 (-1.589)	-1.1219 (-1.737)*	-1.9975 (-2.834)***
DW Test Statistics[g]	1.829	1.830	1.869	1.945	1.827

System R^2: 0.56

Error Correlation Test Statistic[h]: 253.47***

[a] The regional basis, defined as the regional cash price minus the July futures price, is deflated using the Consumer Price Index for all items (1982-84 = 100).

[b] Preliminary analysis indicated that the coefficients for the following variables be restricted to be the same: STOCKS for the Southeast and North Delta regions and for the Desert Southwest and San Joaquin Valley regions; USSTOCKS for the Southeast and North Delta regions and for the Desert Southwest and San Joaquin Valley regions; STORE for the Southeast and North Delta regions and for the West Texas, Desert Southwest, and San Joaquin Valley regions; ΔPRAYON for all regions; TRANS for the Southeast, West Texas, Desert Southwest, and San Joaquin Valley regions; FSTUS for the Southeast and North Delta regions and for the Desert Southwest and San Joaquin Valley regions.

[c] The figures in parentheses are the calculated t-values. Coefficients significantly different from zero are denoted by one asterisk for the ten-percent, two asterisks for the five-percent, and three asterisks for the one-percent level.

[d] Definitions for each explanatory variable are given in the text.

[e] The constant term is the coefficient on data transformed from ordinary least squares as specified by Greene.

[f] The data are deflated using the Consumer Price Index for all items (1982-84 = 100).

[g] The Durbin-Watson test statistics are used to test for first-order autocorrelation. All of the test statistics exceed the Durbin-Watson upper critical value (1.826) indicating that first-order autocorrelation is not present at the five percent level.

[h] The Breusch and Pagan Lagrange multiplier test statistic is used to test the null hypothesis that contemporaneous correlation across the error terms does not exist. The critical value from the chi-square distribution with ten degrees of freedom for this problem is 23.21 at the one percent level.

Endnotes

[1] The USDA-ERS publishes detailed cotton disappearance data at approximately seven-year intervals. The latest report issued in 1997 covers the 1993/94 crop year.

[2] 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, Bascou, and Leuthold and Peterson).

[3] The basis becomes weaker when the cash price decreases relative to the futures price and stronger when the cash price increases relative to the futures price.

[4] Earlier research extends Tomek's two-period theory of storage model into a formal multi-period theoretical basis model that focuses on the consumption side of the market (Seamon and Kahl).

[5] The quantity demanded in a region in period t equals the amount of the commodity in that region demanded for consumption in period t by agents within or outside of that region. The quantity supplied in a region in period t equals the amount of the commodity (either grown in that region or purchased from other regions) supplied in that region for consumption in period t.

[6] Monthly average price data are available for rayon and polyester, two fibers that compete directly with cotton. Rayon was chosen for this analysis because its price has been more variable than the polyester price over the study period.

[7] The USDA-AMS also reports cash price data for the South Delta and East Texas – Oklahoma regions. These regions were not included here because their cash price data are not significantly different from the cash price data in the North Delta and West Texas regions, respectively (Seamon, Kahl, and Curtis).

[8] All data used in the empirical model are tested for stationarity using standard Dickey and Fuller (1979, 1981) unit root tests. The test results imply that all variables are stationary except the price of rayon. However, the first difference in the rayon price is found to be stationary and is used in this analysis.

[9] Monthly stocks of cotton held in public warehouses and at compresses are reported for states or pairs of states instead of by regions (*Consumption on the Cotton System and Stocks*). Alabama, Florida, Georgia, North Carolina, and South Carolina stocks are used to estimate Southeast stocks. Arkansas, Missouri, and Tennessee stocks are used to estimate North Delta stocks. Oklahoma/Texas stocks are used as a proxy for West Texas stocks, Arizona/New Mexico stocks are used as a proxy for Desert Southwest stocks, and California stocks are used as a proxy for San Joaquin Valley stocks. Only quarterly data are available for 1991. These data are converted into monthly data by noting that the quarter reported represents ending stocks for that quarter, and assuming that stocks are added or subtracted in equal increments during each month between the available data points.

[10] T*he Cotton and Wool Situation and Outlook* reports monthly ending U.S. stocks. However, only quarterly data are available for 1991. These 1991 data are converted into monthly data in the same manner as regional stocks.

[11] The relevant interest rate used to measure the opportunity cost of storage varies among researchers. For example, Garcia and Good, and Kahl and Curtis used the 90-day T-bill rate, a lending interest rate. Bascou, and Tilley and Campbell used the prime interest rate, a borrowing rate. The 90-day T-bill rate (obtained from the *Survey of Current Business*) used here represents a proxy for the interest rate that cotton handlers can reasonably expect to receive on their capital. The rate, quoted on an annual basis, is divided by 12 to convert it to the interest rate relevant for the storage period.

[12] Rayon cash price data (obtained from *The Cotton and Wool Situation and Outlook Report*) are monthly average rayon prices at f.o.b. producing plants in the U.S.

[13] Cotton is transported from gins and warehouses to domestic consumption centers and port areas for export primarily by truck (Glade). Therefore, the Producer Price Index for trucks – farm products appears to be a better measure of relevant transportation costs than the rail index. However, the truck index has only been reported since June 1992 and thus does not cover the complete study period. The rail index (obtained from the U.S. Department of Labor) is used here because it was reported for the entire period of analysis and because preliminary analysis showed that the rail and truck indices were significantly correlated over the period in which both data are reported.

[14] *The Cotton and Wool Situation and Outlook* reports monthly estimated foreign ending stocks and monthly estimated foreign mill use for all years except 1991. Quarterly data were reported in 1991. For that year, the data for foreign mill use were converted to monthly data by assuming mill use was constant for the quarter reported. The data for foreign ending stocks were converted to monthly data in the same manner as regional stocks and total U.S. stocks.

[15] Recall that the USDA cotton crop year is from August to July. Only West Texas consistently has production in August and many regions have no production until October. This presents a problem calculating the opportunity cost of storage from August and September until July for late producing regions. This dummy variable is included to account for regions without new cotton in August and September.

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