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Leading Indicators of Regional Cotton Acreage Response: Structural and Time Series Modeling Results

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ABSTRACT

Resurgent cotton production compels better acreage forecasts for planning seed, chemical, and other input requirements. Structural models describe leading acreage response indicators, and forecasts are compared to time-series models. Cotton price, loan rate, deficiency payments, lagged corn acreage, the PIK program, and previous cotton yield significantly influence cotton acreage response.

Key Words: *cotton acreage, resurgent cotton production.*

In the past decade, the importance of cotton as a major national and southeast regional field crop has soared. Acreage planted in cotton has increased almost 300 percent in the southeastern states in a matter of six years, while cotton acreage nationally reached a post-1950s high of 16.93 million acres in 1995. This resurgence stimulates ancillary businesses to respond to seed, chemical, and other input requirements and for processing/ginning facilities planning. More informed response throughout the industry requires better estimation of future cotton acreage intentions. As the amount of cotton planted by farmers increases, so does the level of capital and other resources required. Thus, accurate forecasts of cotton production are increasingly important for decision making. For example, acres planted in cotton in Georgia alone doubled from 1994 to 1995, reaching 1.5 million acres. The 1995 planting was the largest cotton crop in Georgia in more than 50 years.

Identifying leading indicators and forecasting responses to changing conditions in agricultural crop production historically have been important factors in risk-management strategies for producers, input suppliers, and processors. Estimates of crop production are an important consideration when producers are making spring planting decisions for competing crops. Integrating these management components has become more important to producers with the enactment of the Federal Agricultural Improvement and Reform (FAIR) Act in 1996. Under FAIR, producers must be more responsive to available market and production information, because many government price supports have been eliminated.

Cotton acreage response is an important issue because of its recent and dramatic increase among Southeastern producers. Acreage fore-

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casts enter producers' spring planting decisions and thus are an important aid to decision making. This article presents models which identify leading indicators and forecast Southeastern region planted cotton acres, so that farmers and agribusiness suppliers can respond more efficiently to changes in cotton production and marketing.

Government Programs

Since World War II, the cotton industry has experienced several structural changes (USDA/ERS 1996a). Most of these have been in response to changes in government programs. These programs have had conflicting goals that have changed from decade to decade. Government programs have altered the loan rate, price supports, and targeted acres and production. The lack of continuity in government policy over the last 50 years makes cotton acreage and price analysis difficult. Under differing market and resource policy environments, inference from analyses of these separate periods becomes less reliable, encouraging caution in interpreting changes in the cotton market due to changing government programs.

In the 1950s and 1960s, U.S. government policy aimed to reduce cotton supply and stocks, as increased production following WWII and the Korean conflict was no longer necessary (USDA/ERS 1996a). This intention was reflected in the Agricultural Adjustment Act of 1954. Further, the Cotton-Wheat Act of 1964 was aimed at beginning voluntary programs to reduce cotton production. The number of acres planted to cotton declined dramatically during the 1960s through the 1980s compared to the post-war period, as seen in Table 1. As a result of these government programs, as well as increasing boll weevil damage and control costs, acreage in cotton declined, while cotton prices continued to be depressed by the introduction of synthetic fibers.

Despite somewhat smaller crops and lower Commodity Credit Corporation (CCC) loan rates from 1953 to 1965, Lafferty and Campbell suggested that a structural change in the cotton market occurred in 1966. This change followed the Food and Agriculture Act of 1965, which included higher diversion payments. The loan rate also dropped from 32.75 cents per pound in 1953–1965 to 20.06 cents per pound in 1966–1973. Many cotton producers and buyers responded to the large changes in yearly prices and the lower stocks of cotton by greatly increasing the amount of cotton that they forward contracted, until over half the crop was contracted in 1973 (Lafferty and Campbell).

The next major cotton policy change occurred in 1973, with the Agricultural and Consumer Protection Act. This act reversed two decades of policy and attempted to increase cotton production due to increased world demand. Changes that appeared in the 1973 act included the target price and deficiency payments. In response to this policy change, crop production and yields increased somewhat in the 1970s and 1980s. Despite brief periods of low prices and high stocks in the early 1980s which led to the payment-in-kind (PIK) program (USDA/ERS 1996a), strong domestic and export demand for cotton has fueled the recent expansion in acreage in the late 1980s and 1990s. Producers responded to higher

Table 1. U.S. and Southeastern Region Cotton Acreage and Yields, 1945–1996

	U.S.		Southeastern	
Years	Planted Acres 1,000 Acres	Yield Lb/ Acre	Planted Acres 1,000 Acres	Yield Lb/ Acre
1945–49	22,075	269	4,725	299
1950–54	24,641	296	4,494	286
1955–59	15,518	427	2,534	388
1960–64	15,728	475	2,583	403
1965–69	11,448	480	1,680	378
1970–74	12,892	469	1,545	444
1975–79	12,429	481	757	423
1980–84	11,856	528	656	559
1985–89	10,845	624	863	583
1990–94	13,359	660	1,626	662
1995	16,931	537	3,460	539
1996	14,240	703	3,164	724

Source: USDA, 1945–1994, 1997.

prices with increased productivity, acres planted, and enrollment in boll weevil eradication programs in the southeastern states.

Government disaster payments have also been available to participating producers who were unable to plant a portion of their acreage allotment or who suffered low yields due to weather extremes. Conversely, diversion payments have been used to provide incentives to deter farmers from planting all of their allotted acreage in a specific year, usually for soil conserving purposes.

Previous Acreage Response Studies

Most acreage response studies over the past two decades have focused on corn, soybeans, cotton, wheat, or a combination of these field crops. As government farm programs have been attributed the responsibility of affecting the structure of these industries, research focus also has assessed the response of farmers to the relevant programs. Gardner related planting to futures prices as a decision tool for farmers' price expectations, allowing that the price elasticity likely varies from region to region due to different substitute crops and the opportunity costs of planting alternatives. Chavas, Pope, and Kao found ambiguous results concerning the impact of futures and cash prices on acreage response, but they did support "Gardner's conclusion that futures prices perform *as well as* lagged cash prices in supply response specification"(p.32; emphasis added). Cotton has been highly regulated over the last 50 years or more, somewhat diminishing (as intended) the price response through changed government programs, including set-asides.

Shideed, Brannen, and Glover found that annual cash receipts of cotton and soybeans move in opposite directions, while real cotton prices decreased over time except for the 1970s. Corn receipts also move inversely to cotton receipts, suggesting that these two crops are competing with cotton for acreage, with price, yield, and farm receipts as determining factors in the acreage decisions. They also found cotton and peanuts much less responsive to price variation than are corn and soybeans, and one conclusion was that the government programs undermined the price response for cotton and peanuts, as they are designed to do.

Duffy, Shalishali, and Kinnucan used an expected utility model with a lagged price adjusted for downward trend in real prices and deflated with the consumer price index, in order to estimate corn, soybean, and cotton acreage. They defined the Southeast growing area as Alabama, Georgia, North Carolina, and South Carolina. Higher estimated supply elasticities for corn and soybeans in the Southeast than those found in previous national estimates were attributed to the greater variety of crops that can be grown in that region, including tobacco and peanuts. The expected utility model they used did not fit the cotton data in the Southeast particularly well, leaving room for a more accurate estimation (Duffy, Shalishali, and Kinnucan). Over time there was evidence that cotton supply elasticity had decreased, results attributed to machinery investment or capital fixity. However, except for harvesting, the machinery required for cotton production is no different than for corn or soybeans, and with availability of custom harvesting may not be an important factor in acreage response. A previous study by Duffy, Richardson, and Wohlgenant dealt heavily with government cotton programs. However, government programs change over time. Thus, forecasts using such models may be limited to cohort time periods and less easily generalized.

Parrott and McIntosh tested an adaptive regression model examining the importance of cash and government support prices in cotton acreage response in Georgia. They used lagged cash price, expected program payments, and government support prices in their models to "incorporate some measure of the expected output price" (Parrott and McIntosh, p.203). Expected prices are used in all their models of acreage response because the price that influences producers' decisions is unobservable. They concluded that cash price is more influential with producers than government program prices, even in periods of the study that were heavily regulated by government programs.

After reviewing these previous works on cotton acreage response (Duffy, Shalishali, and Kinnucan; Parrot and McIntosh), and acreage response in general (Gardner; Pope; Chavas, Pope, and Kao; Shideed, Brannen, and Glover; Shideed, White, Brannen, and Glover; Shideed and White; McIntosh and Shideed), the primary objective of this study was to develop a structural model based on producer decision variables for forecasting cotton acreage and the resulting impacts on planting and marketing decisions in the cotton industry. This goal has eluded accurate estimation, especially in recent cropping years.

Models and Data

Two approaches are used to forecast acreage response: a structural mulitvariate linear regression model and Box-Jenkins Autoregressive Integrated Moving Average (ARIMA) time-series models (Box and Jenkins). Yield and competitive crop prices are tested as factors in cotton acreage response decisions and, following Chavas, Pope, and Kao, include all reasonable cotton decision variables in the testing (including substitute crop decision variables). In particular, production and yields generally are considered important determinants for cotton and the other major field crops that compete with cotton acreage, because the comparison of these factors influences farmers' planting decisions.

Government program variables must be included in the development of such a model, according to Duffy, Richardson, and Wohlgenant, due to their ability to alter producers' planting decisions. The loan rate, target price and support payments are included in the analysis to examine their influence on acreage response. Previous studies have used relatively short periods of time under stable policy environments and, thus, may have missed capturing longer trends and policy impacts in cotton production responses. The association of cotton acreage response with each predetermined variable proposed under the criteria above was tested separately to identify lag response relationships. A structural decision model for cotton acreage was then specified as follows:

Cotton planting

= f{cotton info (price, production, yield), soybean info (price, yield, planting), corn info (price, yield, planting, harvest), government programs (cotton loan rate, target price, deficiency payment, disaster payment, diversion payment, PIK)},

where the variable descriptions and measures are presented in Table 2. The structural model thus describes planted cotton acreage as a relationship to 16 predetermined variables which can be considered in the decision-making process at the time of planting.

For purposes of comparative forecasting of cotton acreage response, time series forecasting models were also proposed. Autoregressive integrated moving average models are usually denoted by the notation ARIMA(p, d, q) where p is the order of the autoregressive process, d is the degree of differencing, and q is the order of the moving average process. The mathematical model for an ARIMA(p, d, q) can be written as:

$$\phi(\mathrm{B})\Delta^d y_t = \delta + \theta(\mathrm{B})\epsilon_t,$$

where y_t denotes acreage planted in time t, ϵ_t are random normal disturbance terms with mean zero and variance σ_t^2, and Δ^d denotes differencing, i.e., $\Delta y_t = y_t - y_{t-1}$,

$$\phi(\mathrm{B}) = 1 - \phi_1\mathrm{B} - \phi_2\mathrm{B}^2 - \cdots - \phi_p\mathrm{B}^p,$$

and

$$\theta(\mathrm{B}) = 1 - \theta_1\mathrm{B} - \theta_2\mathrm{B}^2 - \cdots - \theta_q\mathrm{B}^q,$$

where B denotes the backward shift operator such that $\mathrm{B}^n_{\epsilon_t} = \epsilon_{t-n}$. That is, the acreage response is modeled dependent on past observations of itself.

A combination of data directly related to cotton, as well as its major production substitutes, corn and soybeans, encompassed 53 years of observations, 1944 to 1996. Most previous studies have used 30 years or less. Six

Table 2. Descriptions of Variables for Southeastern Cotton Structural Models

Variable	Description	Measure
	Dependent	
Cotton Planting	Cotton acreage planted	1,000 acres
	Explanatory	
Cotton		
Price	Season average farmgate price	cents/lb
Production	Cotton production, total annual	1,000 bales
Yield	Cotton yield, annual	lb/acre
Soybean		
Price	Season average farmgate price	$/bu
Yield	Soybean yield	bu/acre
Planting	Soybean acreage planted	1,000 acres
Corn		
Price	Season average farmgate price	$/bu
Yield	Corn yield	bu/acre
Planting	Corn acreage planted	1,000 acres
Harvest	Corn acreage harvested	1,000 acres
Policy		
Cotton Loan Rate	Cotton loan rate	cents/lb
Target Price	Target cotton price	cents/lb
Deficiency Payment	Deficiency payment	binary, 1 yes, 0 otherwise
Disaster Payment	Disaster payment	binary, 1 yes, 0 otherwise
Diversion Payment	Diversion payment	binary, 1 yes, 0 otherwise
PIK	Payment-in-kind	binary, 1 yes, 0 otherwise

observations, 1991 to 1996, were withheld for out-of-sample forecasting validation. This procedure precluded directly testing for the impacts of recent technology changes in Southeastern cotton production, such as the introduction of Bt-cotton and the boll weevil eradication program, which was extended to Georgia, Florida, and Alabama in 1987 from successful trials in North and South Carolina. Cotton data were obtained for planted acreage, harvested acreage, harvested yield, total production, and season average price per pound received by farmers for cotton in each of the Southeastern states. Observations were collected for corn and soybeans to include planted acreage, harvested yield, and season average price per bushel received by farmers. Government program data were collected for the national price support loan rate for cotton, target price, deficiency payments, disaster payments, diversion payments, and payments-in-kind.

Data were collected for each of the Southeast growing region states, defined, as in the Duffy, Shalishali, and Kinnucan study, as Alabama, Georgia, North Carolina, and South Carolina. The information was then processed into weighted Southeastern numbers, as described in the following. Planted and harvested acreage and season average price per bushel received by farmers were weighted by production in each state, as in the Duffy, Richardson, and Wohlgenant study, while yield was weighted by harvested acreage. Chavas, Pope, and Kao suggested that "futures prices . . . may not be informationally efficient . . . when government intervenes in the market place"(p.31). Futures prices were not used in this regional study, because they are reported for the whole country and would reflect a bias towards the other three cotton producing regions of the country—the Delta states (Arkansas, Louisiana, Missouri, Mississippi, Tennessee), the Southern Plains (New Mexico,

Table 3. Estimated Variable Parameters for the Southeast Structural Model, 1945–1990

Variable	Coefficient	Standard Deviation	p Value
Constant	−1424.170	1443.806	0.332
Cotton Price t − 1	38.107	16.734**	0.031
Cotton Production t − 1	0.815	0.169***	0.000
Cotton Yield t − 2	−4.348	1.323***	0.003
Soybean Price t − 1	−216.545	168.021	0.208
Soybean Yield t − 2	87.183	54.141	0.119
Soybean Planting t − 2	−0.017	0.071	0.818
Corn Price t − 1	198.587	304.815	0.520
Corn Yield t − 2	4.976	13.933	0.724
Corn Planting t − 1	0.364	20.569***	0.001
Corn Harvest t − 2	0.160	0.124	0.208
Cotton Loan Rate t	−70.551	20.569***	0.002
Target Price t	10.322	15.164	0.502
Deficiency Payment t − 1	1323.470	497.134**	0.013
Disaster Payment t − 1	−3.536	263.888	0.989
Diversion Payment t − 1	327.809	307.802	0.296
PIK t − 1	924.796	387.382**	0.024
N		46	
Adjusted R-square		0.92	
F-value		34.20	
Mean absolute error		270.215	
DW statistic		1.80	

Note: *, **, and *** indicate significance levels of 0.10, 0.05, and 0.01, respectively.

Oklahoma, Texas), and the Southwest (Arizona, California). Regional prices may reflect quality differentials, transportation, and local processing demand.

Southeastern Regional Cotton Results

The estimated structural model explains 92 percent of the variation in planted cotton acreage in the Southeast (Table 3). Several variables provide information which could serve as leading indicators for planted cotton acreage responses in this region. Based on a level of significance of 10 percent or greater, seven explanatory variables—cotton price, cotton loan rate, the presence of a deficiency payment, cotton production, cotton yield, corn acreage, and PIK program—appear to be significant leading indicators for Southeastern producers and agribusiness firms in projecting cotton acres planted and identifying appropriate risk management strategies for participants in the cotton industry.

The directional implications of the estimated parameters of Southeastern cotton acreage response indicators were positive for own price, negative for the loan rate, and positive for the deficiency payment variable (Table 3). That is, when last year's cotton price is high, producers will increase acreage the following year. The estimated coefficient for the loan rate suggests that in a year when the cotton loan rate is raised planted acreage will decrease. This is due in part to the requirement that producers who choose to participate in the program must reduce their planting, as is mandated by the loan rate program provisions. This study used a dummy variable for indicating the presence of deficiency payment programs, and results indicate that only having a payment is sufficient for producers to expect to increase acreage in the following year.

Southeastern cotton acreage response is positively related to the previous year's production of cotton in the region, suggesting reinforcement of trends in planting in the absence of other factors, such as price or policy, which would alter the direction of response.

Table 4. Southeastern Cotton Acreage Structural Model Impact Response Elasticities for Leading Indicators, 1991–1996

	Elasticity by Lag Length		
Variable	0	1	2
Cotton loan rate	−1.61		
Cotton production		0.87	
Cotton price		1.26	
Deficiency		—	
PIK		—	
Corn acreage		0.49	
Cotton yield			−1.11

Note: Elasticities are based on mean values for the out-of-sample forecast period.

Regional yield improvements are negatively associated with current planting. Soybean prices and yields may be important in the planting decision, as shown in Table 3 also, but they were not significant at the 0.10 level during this period. The only policy variable, other than deficiency payment programs, that exerts a significant influence on cotton acreage is the presence of a PIK program in the previous year. The response of cotton planting is positively linked with the years of PIK payments, suggesting nearly a million extra acres of cotton in the region the years following such payments.

The significant Southeastern cotton acreage indicators are categorized according to lag length and are presented along with impact elasticities based on mean values for the 1991–1996 forecast period (Table 4). In particular, a 10-percent increase in cotton price in one year would induce, on average, a 12.6-percent increase in planting in the following year. On the other hand, the cotton loan rate announced for the current year demonstrates an elastic, inverse relationship with cotton acreage planting.

The structural model's U-statistic of 0.78, its mean absolute percentage error (MAPE), and its mean squared error (MSE) in Table 5 indicate the strength of its forecasts as compared to several ARIMA forecasting models and to a composite forecast. A U-statistic of less than 1 indicates that the forecasts perform as well as or better than a naive, or random walk, model.

Box-Jenkins (ARIMA) time-series models are also estimated for comparison of the structural model's forecast statistics with a time-series approach on the same data (Table 5). As determined by the U-statistic, forecast MSE and MAPE of the ARIMA forecasts, the ARIMA (0, 2, 1) model more successfully predicts Southeastern cotton acreage response

Table 5. Out-of-Sample Structural and ARIMA Model Forecasts of Southeast Cotton Acreage Response, 1991–1996

Year	Actual	Structural Model	ARIMA 1, 0, 0	ARIMA 1, 1, 0	ARIMA 0, 1, 1	ARIMA 1, 2, 0	ARIMA 0, 2, 1	Composite Structural/ ARIMA 0, 2, 1
	1,000 acres							
1991	1579	1254	1140	1088	1086	1106	1342	1298
1992	1524	2440	1564	1508	1488	1536	1802	2121
1993	1727	1828	1512	1532	1517	1529	1749	1789
1994	2170	2168	1705	1694	1688	1707	1959	2064
1995	3460	2874	2126	2099	2081	2127	2415	2645
1996	3164	2944	3352	3255	3205	3333	3738	3341
U Statistic		0.78	1.02	1.04	1.05	0.79	0.66	0.56
MSE		224447	378612	394423	404015	380483	266660	191144
MAPE		18.42	18.13	17.93	18.18	17.90	15.43	15.77

Note: MSE and MAPE are for the out-of-sample validation period. (0, 1, 1) and (1, 1, 0) models have no constant terms; (1, 0, 0) and (0, 2, 1) models have constant terms; (0, 2, 1) and (1 + 5 + 6, 2, 0) models have no constant terms.

Table 6. Duffy *et al.* (1987) Model Comparisons for Southeast Cotton Acreage, 1959–1983 and 1945–1996

Variable	Duffy 59–83	Current 59–83	Duffy 45–96	Current 45–96
Constant	2159.790***	1137.290	1419.590**	−1424.170
	(252.628)	(2540.295)	(531.403)	(1443.806)
Adjusted cotton price	16.585***	—	30.079**	—
	(4.782)		(11.384)	
Adjusted corn price	−408.562***	—	−399.444	—
	(128.799)		(254.083)	
Cotton planting t − 1	0.264***	—	0.643***	—
	(0.085)		(0.116)	
Corn planting t − 1	—	0.119	—	0.364***
		(0.237)		(0.092)
Corn price t − 1	—	−80.204	—	198.587
		(496.617)		(304.815)
Corn yield t − 2	—	3.967	—	4.976
		(14.441)		(13.933)
Corn harvest t − 2	—	0.196	—	0.160
		(0.481)		(0.124)
Cotton loan t	—	3.762	—	−70.551***
		(29.642)		(20.569)
Cotton price t − 1	—	34.490*	—	38.107**
		(15.245)		(16.734)
Cotton production t − 1	—	0.297	—	0.815***
		(0.200)		(0.169)
Cotton yield t − 2	—	−2.518*	—	−4.348***
		(1.370)		(1.323)
Soybean planting t − 2	—	0.116	—	−0.017
		(0.308)		(0.071)
Soybean price t − 1	—	−177.865	—	−216.545
		(200.705)		(168.021)
Soybean yield t − 2	—	−43.124	—	87.183
		(55.910)		(54.141)
Target Price t	—	−28.809	—	10.322
		(18.669)		(15.164)
CTEDP	−178.324***	—	−27.138	—
	(37.320)		(32.974)	
Deficiency Payment t − 1	—	−295.283	—	1323.470***
		(779.728)		(497.134)
Disaster Payment t − 1	—	−217.024	—	−3.536
		(481.633)		(263.888)
Time	−73.173***	—	−49.476***	—
	(10.316)		(16.546)	
Diversion Payment t − 1	—	−213.823	—	327.809
		(580.410)		(307.802)
PIK t − 1	—	—	—	924.796***
				(387.382)
Adj. Rsquare	0.96	0.91	0.91	0.92

Table 6. (Continued)

Variable	Duffy 59–83	Current 59–83	Duffy 45–96	Current 45–96
Durbin-Watson	2.12	1.73	1.88	1.80
F	134.03	16.59	95.43	34.20
MAE	97.60	98.97	312.75	270.22
U statistic	3.99	3.19	1.38	0.78

Note: *, **, and *** indicate significance levels of 0.1, 0.05, and 0.01, respectively. Numbers in parentheses represent asymptotic standard deviations.

than other ARIMA specifications. The ARIMA (0, 2, 1) exhibited a U-statistic of 0.66, indicating that it is superior to a naive model and outperforms the structural model in predicting annual changes in acreage planted. This suggests that ARIMA analysis is an effective complement to any forecasting venture that uses econometric tools. In fact, a composite forecasting model using a simple average of the structural and ARIMA (0, 2, 1) forecasts demonstrated U-statistics and MSE superior to the individual structural and ARIMA forecasts, with a comparable MAPE value (Table 5).

Previous literature has focused on structural models of acreage response at the regional level, as in the Duffy, Shalishali, and Kinnucan study. It should be noted that the Box-Jenkins (ARIMA) models could be expected to outperform the structural models in forecasting. Structural models of supply or acreage must rely on proxies for unobservable expectations of future prices. Thus, there is unavoidable error in determining future values of the independent variables. In addition, uncertainty with respect to the underlying functional form of the structural relationships may also cause forecasts to be sub-optimal. Even when the true underlying structural model is known with certainty, it may not forecast as well as a simple univariate time-series model (as demonstrated by Dorfman and McIntosh).

An issue of concern for both structural and time series modeling approaches is the advent of structural change in the series being studied. Changing structure over time is a given in the analysis of economic relationships in agriculture. Bessler and Covey identified 63 articles published in the *American Journal of Agricultural Economics* between 1960 and 1993 that considered evidence of changing parameter estimates. In only 14 percent of these articles (nine of them) did the authors conclude that no structural change had occurred. Dramatic structural changes would likely cause forecasts from either a structural model or time series model to be biased, unless those models were re-estimated after the change had occurred. Structural models may be better able to accommodate such shifts through the incorporation of additional variables. If the time series pattern is altered by a structural shift, it may be several periods before a univariate time-series model could be re-specified accurately enough to account for the change.

Bessler and Covey examined the relative merits of structural versus time-series models for prediction. Their assertion is that the appropriate modeling technique depends on the intended use of one's model and that it is important to distinguish between associational inference, which summarizes regularities in the data (as in a univariate time-series model), and structural inference, which summarizes "causal" relations. They conclude that "To build a basic decision-making model, it is enough to demonstrate that one has good forecasts. Good forecasts can be made with observational data" (Bessler and Covey, p.46). However, the importance of the structural models is in their value as explanatory models. Next, we will compare the regional results of this study with those of the Duffy, Richardson, and Wohlgenant study.

Structural Model Comparison to Previous Literature

The Duffy, Richardson, and Wohlgenant model was first reconstructed on their original time period, 1959–1983, using the data and variables found in their study (Table 6). Our Southeastern structural model was estimated on the same time period for comparison. The Duffy, Richardson, and Wohlgenant model was then reconstructed for the extended time period of this study, 1945–1990, for comparison to the current Southeastern model. While the theory and formulas of Duffy, Richardson, and Wohlgenant were used to update the observations over the longer time span of the current data set, due to changes in government programs the reconstruction of the model can only be approximated.

The Southeastern model results indicate similar explanatory values in both time periods, but the Duffy, Richardson, and Wohlgenant model, with the inclusion of trend and lagged acreage, has a higher F-statistic. The mean absolute errors of the current model are somewhat lower, and the model from this study outperforms the forecasts of the Duffy, Richardson, and Wohlgenant model in terms of the Theil u-statistic and other forecasting values, although neither model is a valid forecasting tool on the 1959–1983 time period. The latter result appears to indicate that the longer the time period used, the more accurate the forecasts.

In the extended time period, 1945–1990, the explanatory power of the Duffy, Richardson, and Wohlgenant model declined somewhat from the results in their 1987 study. The Duffy, Richardson, and Wohlgenant model is still not a valid forecasting tool, as seen by its u-statistic, which is 1.38. The error values are also higher than those from the structural model postulated in this study. The results of this comparison indicate that the Southeastern structural model posited here provides improved forecasting performance compared to the Duffy, Richardson, and Wohlgenant model in most predictive statistics. The model in this study also provides more explanatory value, largely due to the inclusion of additional relevant decision variables and a longer time period.

Conclusions and Implications

The objective of this study was to develop structural models that would identify leading indicators and accurately forecast cotton acreage plantings in the Southeast U.S. Several variables in the current structural model serve as significant leading indicators for planted cotton acreage. Southeastern cotton acreage was found to be responsive to the cotton loan rate, cotton price, and the deficiency payment, as well as to lagged corn acreage, the PIK program, and previous cotton yield. The use of such indicators and forecasts enables producers and agribusiness firms in this region to respond to changes in supply with a better understanding of the changes in the cotton market in the Southeast.

The structural model tested was found to be superior to a naive forecast in its ability to project cotton acres planted. Comparable models were tested from the literature review to evaluate the success of this study's model. The results of this comparison have shown that the structural models evaluated here represent an improvement over previous work in cotton acreage response, both in the simplicity of the model and in its forecasting ability. Time series analysis also was performed on cotton acreage and the annual changes in cotton acreage plantings—effectively turning point analysis. Results of the Box-Jenkins analysis confirm that some ARIMA models can outperform the forecasting capabilities of structural models. The simple nature and ease of use of ARIMA models show promise for increase application of this type of forecasting tool in decision analysis. A well-specified ARIMA outperforms the structural model in forecast accuracy. However, the structural model better identifies leading indicators for cotton planting.

Results of the structural and time series forecast modeling provide evidence of tools which may prove useful to current and potential cotton producers, their input suppliers, and those considering investing in ancillary services in cotton and oilseed industries. Removing some uncertainty as to planting responses enables better decisions on following season planting for cotton and its substitutes, for agribusinesses ordering seed and chemical inputs for the area, and for scaling prospective services necessary to handle the planting and post-harvest activities. This type of forecasting analysis enables improved decision making throughout the industry under the lessening influence of government programs and policies. However, the effects of implementation of such policy changes again in the future could be more readily determined through the responses shown here.

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