Technical Bulletin T-95

Quantitative Relationships In The Cotton Economy With Implications For Economic Policy

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May, 1962

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Acknowledgment

Research for the study was conducted under Southern Regional Research Project No. SM-14, "Effects of Price Support, Acreage Adjustment, and Surplus Removal Programs Upon the Marketing of Southern Agricultural Products". States cooperating in this project are Arkansas, Georgia, Kentucky, Mississippi, Oklahoma, Texas, and Virginia.

Portions of the study have been reported in an unpublished Ph.D. dissertation of the same title submitted by the author to the Department of Economics, University of Chicago, 1961.

The contributions to this research by many persons are gratefully acknowledged. Special thanks are extended to Zvi Griliches, Carl F. Christ, and D. Gale Johnson of the University of Chicago, James S. Plaxico and Nellis A. Briscoe of Oklahoma State University, and George G. Judge of the University of Illinois.

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by Leo V. Blakley*

There has been much concern both in the United States and abroad about the past and potential effects of the various United States Government programs for cotton. A new program, if formulated, must depend in part on knowledge of the interrelationships of economic and institutional factors.

The study reported herein had two major objectives: (1) to construct an economic model depicting the operation of the cotton economy, and then employ econometric techniques to obtain parameter estimates for each of the postulated structural relationships; and (2) to evaluate the impact of specific types of governmental programs for cotton by analyzing the direction and magnitude of effects of individual economic factors which are important in the cotton economy.

The Statistical Model

The economic model developed for this study includes three groups of variables: (1) endogenous variables which are generated by the system which the model characterizes, listed as Y_i for actual prices or quantities and as y_i for deflated prices or per capita quantities; (2) exogenous variables, which affect the cotton economy but are not appreciably affected by it; and (3) predetermined variables, for which the observed values are determined independently of current relationships. Exogenous and predetermined variables are grouped together and listed

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Research reported herein was conducted under Oklahoma Agricultural Experiment Station Project No. 876.

as Z_i for actual units or as z_i for deflated or per capita series. Random residuals are designated by U_i.

The model is as follows:

Domestic Mill Demand

$$\log y_{1t} = \beta_{12} \log y_{2t} + \alpha_{11} \log z_{1t} + \alpha_{12} \log z_{2t} + \alpha_{13} \log z_{3t} + \alpha_{14} \log z_{4t} + \alpha_{15} \log z_{5t} + \beta_{10} + U_{1t} \quad (1.1)$$

Export Demand

$$Y_{3t} - Y_{7t} + Z_{6t} + Z_{12t} - Z_{7t} = U_{2t} \quad (1.2)$$

Inventory Demand

$$\log y_{4t} = \beta_{32} \log y_{2t} + \alpha_{3,10} \log z_{10t} + \alpha_{3,11} \log z_{11t} + \alpha_{3,13} \log z_{13t} + \beta_{30} + U_{3t} \quad (1.3)$$

Expected Price

$$\log y_{6t} = \beta_{41} \log y_{1t} + \beta_{42} \log y_{2t} + \beta_{40} + U_{4t} \quad (1.4)$$

World Price

$$Y_{5t} - Y_{2t} - K = U_{5t} \quad (1.5)$$

Foreign Mill Demand

$$\log y_{7t} = \beta_{65} \log y_{5t} + \beta_{66} \log y_{6t} + \alpha_{68} \log z_{8t} + \alpha_{69} \log z_{9t} + \beta_{60} + U_{6t} \quad (1.6)$$

Supply

$$Z_{10t} - Y_{1t} - Y_{3t} - Z_{12t} - Y_{4t} = O \quad (1.7)$$

The variables and specific series of data used are:

y_1 = Domestic mill consumption of cotton, per capita
y_2 = U.S. 10 spot price of Middling 15/16-inch cotton, deflated
y_3 = Commercial exports of cotton from the United States, per capita
y_4 = Domestic ending inventory of cotton, per capita
y_5 = World price of cotton, deflated
y_6 = U.S. expected price of cotton, deflated
y_7 = Foreign mill consumption of cotton, per capita
z_1 = Index of U.S. wholesale price of cotton broadwoven goods, deflated
z_2 = U.S. disposable personal income, per capita, deflated
z_3 = Change in U.S. disposable personal income, per capita, deflated

z_4 = Domestic production of man-made fibers, per capita
z_5 = Domestic mill consumption of cotton in the previous year, per capita
z_6 = Foreign supply of cotton, per capita
z_7 = Foreign ending inventory of cotton, per capita
z_8 = Foreign production of man-made fibers, per capita
z_9 = Foreign mill consumption of cotton in the previous year, per capita
z_{10} = U.S. supply of cotton, per capita
z_{11} = U.S. loan rate on Middling 15/16-inch cotton, deflated
z_{12} = U.S. grants and gifts of cotton, per capita
z_{13} = U.S. cotton production estimate for the following year, per capita
K = A constant representing a transfer cost for exporting cotton from the United States to the foreign market

All data are based on the cotton crop year August 1 through July 31. When reported data were based on other time periods, they were converted to crop year estimates. The average of the monthly data for the period August through the following July was used when monthly estimates were available for the complete series. For the remaining series, calendar year data were converted to crop year estimates by using five-twelfths the value in year t plus seven-twelfths the value in year $t + 1$.

All quantity series used in the behavior equations are expressed in per capita terms, based on population estimates adjusted to December 31 by using midpoints between adjacent July 1 estimates. All price series used in behavior equations are deflated for changes in the general price level, using appropriate price level indicators. Data for each variable are included in Appendix A, and sources are shown in Appendix B.

Two periods are involved in the study: (1) the cotton crop years 1921 through 1940 and 1947 through 1956; and (2) the 20-year interwar period alone. The crop years 1941 through 1946 are omitted because of the disruption of international trade and the rationing and price-control policies imposed on the domestic economy during World War II.

Parameter Estimates

Three methods were used to estimate parameters for the equations in the system. These are (1) least-squares method, (2) limited-information, single-equation, maximum-likelihood method, and (3) Theil-Bas-

mann method.[1] The theoretical development of these methods, their application to specific problems, and the computational procedures are available in other sources.[2]

Domestic Mill Consumption

The estimated coefficients for the variables in the equation for domestic mill consumption are included in Table 1.

30-year L.I.S.E.—For the 30-year period, the estimates from the limited information method agree in sign with *a priori* expectations. All of the estimates are larger than their respective standard errors with the exception of lagged consumption (z_{5t}). There is no evidence of serial correlation in the residuals, but there is some basis for rejecting the hypothesis that the over-identifying restrictions are valid. The probability of obtaining a larger chi-square value is 30 percent.

The estimated price elasticity of demand is less than unity. A 1.00 percent change in the relative cotton price is associated with a change in per capita domestic mill consumption of 0.86 percent in the opposite direction. The estimate of price elasticity is considerably higher than the —0.30 obtained by Cromarty (*1*) and the —0.23 obtained by Lowenstein (*6*).

The estimated parameter for lagged consumption is not statistically significant. This appears to substantiate the hypothesis that this coefficient of price is an estimate of both the short run and the long run price elasticity of demand for cotton. However, the price elasticity estimate applies to domestic mill consumption, and may reflect a speculative production schedule rather than final consumer demand as such.

The coefficient for the index of prices of cotton broadwoven goods indicates an elastic response of mill consumption to prices of the finished products.[3] This indicates that some variation in mill con-

[1]These methods and the estimates obtained by using them are hereafter referred to as L.S., L.I.S.E., and T.-B. or as least squares, limited information, and Theil-Basmann, respectively.

[2]Wallace and Judge (*20, 21*), Friedman and Foote (*3*) and Christ (*2*).

[3]The index of wholesale prices of cotton broadwoven goods is assumed in the model to be exogenous. This assumption is more reasonable when viewed from the standpoint of the individual firm or mill than from the standpoint of the industry. For the individual firm, the wholesale prices of cotton broadwoven goods are determined by the relative demand and supply conditions for the finished products. These prices form one basis for the firm's action in jointly determining the price paid for raw cotton and the quantity of raw cotton utilized. Usually some lag is involved between mill consumption of the raw cotton and the final sale as broadwoven goods. From the industry standpoint, some lag also exists even though the lag may be less than a complete crop year. Since the response of raw cotton consumption presumably does not immediately affect the price or the quantity of broadwoven goods placed on the market, the prices of these goods are considered as exogenous.

Table I.—Principal Statistical Estimates for Domestic Mill Consumption of Cotton (log y_1), United States, Crop Years 1921-40 and 1947-56

	Coefficients* for:										
	Price		Income								
	10 Spot log y_2	Cotton Goods log z_1	Level log z_2	Change log z_3	Man-Made Fibers log z_4	Lagged Cons. log z_5	Constant	$\hat{\sigma}^2$	$\frac{d^2}{s^2}$	T $\log_e$ (1+v)	R^2
30-Year Period											
L.I.S.E.	—.8608 (.1839)	1.4406 (.3196)	.6911 (.1830)	.4005 (.0820)	—.1493 (.0356)	.1139 (.1627)	—3.8601	.0013	1.81**	8.42 (P=.30)	
T.-B.	—.8009 (.1789)	1.3434 (.3112)	.6597 (.1794)	.3922 (.0804)	—.1412 (.0349)	.1234 (.1596)	—3.6551	.0013	1.85**		
L.S.	—.6561 (.1510)	1.1107 (.2693)	.5724 (.1678)	.3733 (.0779)	—.1200 (.0317)	.1524 (.1556)	—3.1358	.0012			.75
20-Year Inter-War Period											
L.I.S.E.	—.8375 (.4221)	1.4505 (.9394)	.9291 (.4669)	.3598 (.2014)	—.1518 (.0567)	—.0649 (.3316)	—4.3837	.0021	2.09**	21.98 (P<.01)	
L.S.	—.5290 (.2271)	.8132 (.5420)	.8675 (.3594)	.3671 (.1562)	—.1201 (.0366)	—.0497 (.2571)	—3.4662	.0013			.81

* The estimated standard errors appear in parentheses below each coefficient.
** Insignificant serial correlation at the .05 level.

sumption is probably caused by variations in inventories of stocks of finished products. It also indicates that the elasticity of final consumer demand for cotton could be different from that indicated by the coefficient of y_{2t}.

The estimated income elasticity of demand is also less than unity. A 1.00 percent increase in the level of disposable personal income per capita is associated with an increase in domestic mill consumption of 0.69 percent. However, the short run effects of changing income on consumption are greater than unity. The estimate of short run income elasticity is based on the coefficients for both income (z_{2t}) and change in income (z_{3t}), since z_{3t} includes z_{2t}, z_{2t-1}, and a constant for coding purposes. The estimated short run income elasticity of demand is computed as the ratio of the percentage change in quantity to the percentage change in income at particular values for the variables. In this computation, domestic mill consumption is first estimated at mean values of all variables except z_{3t} which is assumed at a level representing no change in income.

In order to estimate the effect of a change in income, income is assumed to increase 1.43 percent from the mean level of income, the mean value for z_{3t}. The combined effect of the larger income and the change in income from the previous year results in an increase of 3.77 percent in the domestic mill consumption of cotton. The ratio of these series indicates a short run income elasticity of 2.64. Based on these estimates, the elasticity of demand for cotton is greater than unity in an empirical framework only if income continually increases from one year to the next.

The relationship between the availability of competitive fibers and the consumption of cotton is important, but the substitution is considerably less than unity. A 1.00 percent increase in the quantity of competitive fibers is associated with a decrease of 0.15 percent in the domestic mill consumption of cotton when both series are on a per capita basis.

30-yr. T.-B.—The estimated parameters for the 30-year period using the Theil-Basmann method are slightly lower than those obtained using the limited information method, but the inferences are similar.

30-yr. L.S.—The signs of all coefficients estimated by least squares are the same as obtained by the limited information and Theil-Basmann methods. However, the magnitudes of the coefficients differ. The co-

efficient for lagged consumption in this equation is not statistically significant, although the standard error is only slightly larger than the coefficient itself. Even if this coefficient were used in determining the coefficient of adjustment in Nerlove's (*7*) simple adjustment model of distributed lags, the long run price elasticity for domestic mill consumption would be estimated at only —0.77, which is lower than the direct estimate from either of the two preceding methods.

20-yr. L.I.S.E.—In the inter-war period, the parameter estimates from the limited information method are consistent with the estimates for the total 30-year period. All the coefficients except the coefficient for z_{5t} are greater than their standard errors. There is no evidence of serial correlation in the residuals, and the hypothesis of valid over-identified restrictions is accepted on the basis of the statistical chi-square test of T $\log_e$ (1+v). The estimate of price elasticity of domestic mill consumption is somewhat less than unity (—0.84). The coefficient for lagged consumption is not statistically significant; therefore, the short run and long run price elasticity of domestic mill consumption may be about the same. The response of mill consumption to the price of broadwoven goods is elastic (+ 1.45).

The income elasticity estimate for domestic mill consumption is higher during the inter-war period than during the total period. A 1.00 percent increase in disposable personal income per capita is associated with a 0.93 percent increase in domestic mill consumption of cotton per capita. The difference in the estimates for the two time periods suggests that income elasticity may have declined in the post-World War II period. Such an interpretation would be consistent with the post-World War II decline in per capita consumption. However, the introduction of new products such as wash-and-wear materials and the increased use of home appliances could have resulted in a decrease in consumers' desired levels of stocks of cotton goods. Also, the clothing expenditure units (population adjusted for age-sex composition) developed by Simon (*10*) might have indicated different results if they had been used to develop the per capita quantity estimates.

The impact of competitive fibers on domestic mill consumption is important but quite inelastic. A 1.00 percent increase in the production of man-made fibers is associated with a decrease of 0.15 percent in the per capita domestic mill consumption of cotton.

20-yr. L.S.—The least squares estimates of the parameters are consistently lower than the limited information estimates for the inter-war period, the same situation as for the total period. However, the esti-

mates do confirm the generalization that the income elasticity may have been higher in the inter-war period than in the total 30-year period. The price elasticity of demand estimated by the least squares method is about —0.53 and the coefficient for lagged consumption is not significant.

Inventory Demand

30-yr. L.I.S.E.—The estimated coefficients for the variables in the equation for carryover of cotton in the domestic market are included in Table II.

The signs of the limited information estimates for the 30-year period agree with theoretical specifications, and each estimate is greater than its standard error. However, there is no statistical basis for accepting the hypothesis of valid overidentifying restrictions. The price elasticity of inventory demand is quite high, though less than unity. A 1.00 percent increase in the deflated price of cotton is associated with a 0.84 percent decrease in the per capita quantity of cotton entering inventory positions. This is about the same as the estimated price elasticity of domestic mill demand. Governmental loan rates for cotton also influence the inventory demand for cotton but the coefficient is small. Loan rates were in effect only about one-half the period. A 1.00 percent increase in the deflated loan rate is associated with a 0.04 percent increase in the per capita quantity of cotton in ending inventory.

The ending inventory of cotton is highly dependent on the total supply of cotton available during the crop year. A 1.00 percent increase in the supply of cotton per capita is associated with a 1.47 percent increase in the per capita carryover of cotton. Also, the anticipated size of the next crop influences inventory demand. A 1.00 percent increase in expected per capita production in the subsequent crop year is associated with a decrease of 0.48 percent in per capita stocks in ending inventory.

Separate estimates for the private and government sectors were not made in the present study, but a positive elasticity of government demand would be consistent with the parameters in the inventory equation. For example, assume that support prices were increased 10 percent from a given level. The direct effects in the equation of the higher support prices and the higher market prices are lower inventory stocks. However, any decrease would be more than offset by the effect of increasing total supply through the indirect effects of lower domestic and foreign consumption and of larger domestic production.

Table II.—Principal Statistical Estimates for Inventory Demand (log y_4), United States, Crop Years 1921-40 and 1947-56

	Coefficients* for:								
	10 Spot Price log y_2	Supply log z_{10}	Loan Rate log z_{11}	Estimated Production log z_{13}	Constant	$\hat{\sigma}^2$	d^2 — s^2	T $\log_e$ (1+v)	R^2
30-Year Period									
L.I.S.E.	—.8353 (.2491)	1.4652 (.4807)	.0447 (.0108)	—.4755 (.3459)	.5747	.0133	1.35**	10.12 (P=.37)	
T.-B.	—.8046 (.2484)	1.5132 (.4795)	.0446 (.0108)	—.4706 (.3453)	.4713	.0133	1.67†		
L.S.	—.7343 (.2405)	1.6229 (.4693)	.0443 (.0108)	—.4592 (.3446)	.2352	.0132			.84
20-Year Inter-War Period									
L.I.S.E.	—1.2697 (.2372)	—.1379 (.6145)	.0608 (.0120)	.0528 (.4284)	2.5482	.0071	2.54**	12.20 (P=.15)	
L.S.	—1.2024 (.2327)	.0107 (.6078)	.0595 (.0120)	.0163 (.4268)	2.0574	.0071			.93

* The estimated standard errors appear in parentheses below each coefficient.
** Test inconclusive at the .05 level.
† Insignificant serial correlation at the .05 level.

30-yr. T.-B.—The parameter estimates obtained by the use of the Theil-Basmann method are about the same as the limited information estimates. The coefficient for price is slightly lower and the coefficient for supply is slightly higher than comparable estimates in the first method.

30-yr. L.S.—The least squares estimates of parameters for loan rates and estimated production as related to inventory demand are about the same as in the two previous analyses of this equation. The parameter for the effect of price on inventory demand is lower than either of the estimates by the other methods, but the difference is less than one standard deviation of the regression coefficient. A similar difference exists for supply, except that the parameter is somewhat higher than in the other equations. The four variables apparently account for about 84 percent of the variation in inventory demand.

20-yr. L.I.S.E.—Only two of the parameter estimates from the limited information method are significant for the inter-war period. In addition, the hypothesis of valid overidentifying restrictions would be accepted only at the 85 percent confidence level. Interpretations from this equation are that only the price and the loan rate are of statistical importance in explaining ending inventories of cotton in the inter-war period. A 1.00 percent increase in the current deflated 10 spot price of cotton, with the loan rate given, results in a decrease of 1.27 percent in per capita ending inventories. On the other hand, an increase of 1.00 percent in the deflated loan rate for cotton results in an increase of 0.06 percent in per capita ending inventories. The coefficients for price and for the loan rate are greater than similar estimates obtained for the total 30-year period.

20-yr. L.S.—Approximately the same interpretations are made for the least squares estimates of the parameters as for the limited information estimates for the inter-war period. Only the coefficients for the price of cotton and the loan rate are statistically significant.

Expected Price

Estimated parameters in the equation for the expected price of cotton in the subsequent crop year, based on the October futures, are included in Table III.

30-yr. L.I.S.E.—The standard errors of the coefficients obtained by the use of the limited information method for the 30-year period are small relative to the parameter estimates. The test for serial correlation

Table III.—Principal Statistical Estimates for Expected Price (log y_6), United States, Crop Years 1921-40 and 1947-56

	Coefficients* for:		Constant	$\hat{\sigma}^2$	T $\log_e(1+v)$	R^2
	10 Spot Price log y_2	Consumption log y_1				
30-Year Period						
L.I.S.E.	.6564 (.1142)	1.1421 (.3903)	—.3857	.0041	39.99 (P<.01)	
T.-B.	.8472 (.0681)	.2988 (.1817)	—.0339	.0023		
L.S.	.8586 (.0515)	.2579 (.1267)	—.0197	.0015		.93
20-Year Inter-War Period						
L.I.S.E.	.7990 (.0638)	.3893 (.1549)	—.0428	.0018	143.41 (P<.01)	
L.S.	.8140 (.0624)	.2814 (.1480)	.0146	.0017		.92

* The estimated standard errors appear in parentheses below each coefficient.

in the residuals was not made but there is no evidence that the hypothesis of valid overidentifying restrictions should be rejected.

Both the present price and the present level of domestic mill consumption appear to be important determinants of the expected price of cotton.[1] A 1.00 percent increase in the 10 spot price is associated with a 0.66 percent increase in the expected price. An increase of 1.00 percent in domestic mill consumption per capita is associated with a 1.14 percent increase in price expected in the subsequent crop year.

30-yr. T.-B.—Estimates obtained by Theil-Basmann method are considerably different from the limited information estimates. They indicate a more direct relationship between present price and expected price and a less direct relationship between the level of consumption and expected price. A 1.00 percent increase in the 10 spot price is associated with a 0.85 percent increase in the expected price, and a 1.00 percent increase in domestic mill consumption per capita is associated with only a 0.30 percent increase in the October futures price applicable to the subsequent crop year.

30-yr. L.S.—The least squares estimates for the 30-year period are approximately the same as the estimates obtained from use of the Theil-Basmann method.

20-yr. L.I.S.E.—The relationship between the current price and the expected price is more nearly direct in the 20-year period than for the 30-year period, based on limited information estimates. A 1.00 percent increase in the deflated 10 spot price of cotton is associated with a 0.80 percent increase in the deflated futures price for October delivery in the following year. With respect to the level of current mill consumption of cotton, a 1.00 percent increase is associated with a 0.39 percent increase in the expected price.

20-yr. L.S.—The least squares estimates are closer to the limited information estimates for the 20-year period than for the 30-year period. For the shorter period, essentially the same effect is indicated for current price on expected price in each estimating method. However, the coefficient for the effect of current consumption on expected price is somewhat lower in the least squares equation.

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[1]Estimated production (z_{13t}) was included in this equation in initial tests. However, the coefficient was not statistically significant and the variable was omitted from this equation in the final computations.

Foreign Consumption

The coefficients estimated by the different methods for the two time periods for foreign mill consumption of cotton are included in Table IV.

30-yr. L.I.S.E.—The parameter estimates from the use of the limited information method for the 30-year period are larger than their standard errors for all variables except the production of competitive fibers (z_{8t}). The test for serial correlation in the residuals is inconclusive, but the hypothesis of valid overidentifying restrictions is accepted at the 99 percent confidence level.

The estimated price elasticity of foreign mill consumption of cotton is only —0.13, considerably lower than the estimate for the domestic market. However, consumption in the previous year apparently is a more important determinant of current mill consumption in foreign countries than in the United States. If the coefficient for lagged consumption can be used to determine the coefficient of adjustment of consumption to prices in a long run context, the long run price elasticity estimate would be —0.66. Even at this level the estimate is lower than for the domestic market.

Expectations of lower U.S. prices of cotton in the subsequent crop year influence foreign mill consumption of cotton. A 1.00 percent increase in the New York October futures price is associated with an increase of 0.12 percent in foreign mill consumption of cotton. This could represent a substantial short run increase in the demand for cotton from the United States if inventory stocks were available only from this source. Undoubtedly a portion of this increase would result from the expansion of inventory stocks of finished products in anticipation of higher price levels. The converse would be true for prices expected to be lower in the next crop year.

The increased availability of fibers competitive with cotton influence the market for cotton, particularly for some uses. However, the coefficient is not statistically significant in this equation and, in addition, it is small.[1]

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[1]An indicator of the level of foreign income was used in preliminary analyses of the foreign demand for cotton. The foreign income indicator was based on an index of manufacturing (industrial) production, weighted by cotton consumption, for the United Kingdom, Germany, France, and Japan. The simple correlation coefficients for the income indicator and other selected variables are as follows: foreign consumption (0.76), lagged foreign consumption (0.78), exports (—0.59), and world price (—0.66). With world price, lagged foreign consumption, and the income indicator included in the foreign demand equation, the sign of the regression coefficient for the income indicator was usually negative or the regression coefficient for world price was not significant, or both. The sign of the regression coefficient for the income indicator was also negative in preliminary analyses of the demand for cotton exports from the United States. Therefore, the indicator of foreign income was not included in the model.

Table IV.—Principal Statistical Estimates for Foreign Mill Consumption of Cotton (log y_7), United States, Crop Years 1921-40 and 1947-56

	Coefficients* for:				Constant	$\hat{\sigma}^2$	d^2 / s^2	T $\log_e$ (1+v)	R^2
	World Price log y_5	Expected Price log y_6	Man-Made Fibers log z_8	Lagged Cons. log z_9					
30-Year Period									
L.I.S.E.	—.1327 (.0822)	.1241 (.0471)	—.0162 (.0186)	.7995 (.1289)	.1995	.0008	1.27**	33.99 (P<.01)	
T.-B.	—.0710 (.0788)	.0943 (.0454)	—.0059 (.0180)	.7951 (.1258)	.1664	.0008	1.33**		
L.S.	—.0530 (.0740)	.0853 (.0435)	—.0029 (.0175)	.7934 (.1254)	.1574	.0008			.76
20-Year Inter-War Period									
L.I.S.E.	.5541 (.2170)	—.4526 (.1678)	.0021 (.0372)	.4741 (.3178)	.4797	.0009	2.00†	30.11 (P<.01)	
L.S.	.0154 (.0453)	—.0149 (.0384)	—.0213 (.0373)	.8529 (.2950)	.1650	.0009			.59

* The estimated standard errors appear in parentheses below each coefficient.
** Test inconclusive at the .05 level.
† Insignificant serial correlation at the .05 level.

30-yr. T.-B.—The parameter estimates from the Theil-Basmann method are generally lower than the limited information estimates. The coefficient for world price is smaller than its standard error and even if it is accepted as a valid estimate of the indicated price elasticity, it is very low in both a short run and a long run context (—0.07 and —0.35, respectively). On the basis of this method, apparently only the New York October futures price for the subsequent crop year and the quantity of cotton consumed in the previous crop year are important determinants of foreign mill consumption of cotton.

30-yr. L.S.—The least squares estimates are consistent with the Theil-Basmann estimates in both magnitude and apparent lack of statistical significance of variables representing world prices and the production of man-made fibers. Lagged consumption is quite important in determining the level of current consumption. If this coefficient is used to obtain a coefficient of adjustment, it would indicate quite a difference between long run and short run price elasticity (—0.26 and —0.05, respectively). However, based on the coefficient of price, the adjustment for the long run concept still indicates a low long run price elasticity at the foreign level of aggregation.

20-yr. L.I.S.E.—The estimated parameters in the equation representing foreign mill consumption of cotton in the inter-war period do not conform to either *a priori* specifications or to estimates for the total 30-year period. The limited information estimate for the effect of current price on current consumption is positive, which is inconsistent with the negative slope of a demand schedule. The coefficient for expected price is negative, which does not conform to the postulated relationship between current mill consumption and prices expected in the following crop year. The estimated parameter for lagged consumption is lower than for the total period and is larger than its standard error. The availability of man-made fibers is not statistically significant.

20-yr. L.S.—The least squares estimates are quite similar to the limited information estimates with respect to divergence from results specified in the economic model. However, only the coefficient for lagged consumption is larger than its standard error.

A problem of inter-correlation of variables in the foreign consumption equation existed for the inter-war period which did not exist for the total period. In this 20-year period, the correlation between world price (y_{5t}) and expected price (y_{6t}) was 0.94. This compares with a correlation coefficient for the same variables of only 0.39 for the total 30-year period. High inter-correlation of variables in the inter-war period

appears to justify lack of confidence in the estimated parameters insofar as generalizations about price elasticity of foreign demand are concerned. Consequently, no generalizations are made for foreign consumption in this period.

Production Acreage

Production

In the economic model, cotton production is specified as predetermined which is a part of the predetermined variable of supply. However, in order to evaluate the impacts of governmental programs on the cotton economy, parameters were estimated by **least squares** for both production and acreage for the period 1921-40 and 1947-56. Production (P_t) is specified as a technical equation linear in logarithms except for time which is linear in natural units. The least squares estimates of the parameters are:

$$\log P_t = \underset{(.08019)}{+.90578} \log A_t \underset{(.02137)}{-.05993} \log B_t \underset{(.06600)}{-.41210} \log R_t + \underset{(.00097)}{.00825} T_t + .44367 + u_{1t} \qquad (2.1)$$

$$\hat{\sigma}^2 = .0009$$

$$R^2 = .90$$

$$\text{adj } R = .94$$

The coefficient for acreage (A_t) indicates that a 1.00 percent increase in acreage is associated with only a 0.91 percent increase in production, although the coefficient is not significantly different from 1.00. The coefficient for abandonment (B_t) is quite small, with a 1.00 percent increase in abandoned acreage associated with a 0.06 percent decrease in production. Yield reduction from weather and insect factors (R_t) is inversely related to production. The positive coefficient for time (T_t) reflects the increased technology which has occurred in the cotton economy.

Acreage

Pre-allotment (1921-32)—Acreage equations are specified as behavior equations and all data are expressed in logarithms for estimation of parameters. Least squares estimates of acreage in the pre-allotment period (1921-32) are:

$$\log A_t = \underset{(.04000)}{+ .27052 \log y'_{2t-1}} \underset{(.08156)}{- .06772 \log R_{t-1}} \underset{(.13531)}{+ .33347 \log A_{t-1}} +$$
$$\underset{(.02338)}{.11641 \log T_t} + .79344 + u_{2t} \qquad (3.1)$$
$$\hat{\sigma}^2 = .0003$$
$$R^2 = .95$$
$$\text{adj. } R = .96$$

The estimated price elasticity of acreage during this period is 0.27, based on price in the previous year deflated by the index of prices paid by farmers (y'_{2t-1}). If this coefficient is interpreted as an estimate of the short run price elasticity and if the coefficient for lagged acreage (A_{t-1}) is used to determine a coefficient of adjustment, the long run price elasticity would be estimated at about 0.41. The coefficient for time (T_t) is positive and statistically significant, reflecting the upward trend in acreage during this period. The coefficient for the effect of a good or bad year from the standpoint of deviations from normal or potential yield in the previous year (R_{t-1}) is not statistically significant. With this variable omitted from the analysis, approximately the same coefficients are obtained.

Non-allotment (1944-49) (1951-53) — In the period after 1933, allotments or payments for acreage reduction were not effective during nine years. These are 1944 through 1949 and 1951 through 1953. The least squares estimates for acreage in these years are:

$$\log A_t = \underset{(1.07473)}{.75001 \log y'_{2t-1}} \underset{(.31646)}{- .12894 \log R_{t-1}} \underset{(.59597)}{+ .37055 \log A_{t-1}} +$$
$$\underset{(.91323)}{.90186 \log T_t} - 1.10657 + u_{3t} \qquad (3.2)$$
$$\hat{\sigma}^2 = .0034$$
$$R^2 = .74$$
$$\text{adj. } R = .69$$

The coefficients in this equation are not statistically significant even though the R_2 value is 0.74. However, there are only four degrees of freedom for testing significance. If these parameter estimates are indicative of non-allotment years after 1933, the short run price elasticity might be higher now (.75) than in the period prior to the initiation of governmental acreage controls. Also, it might be slightly higher than Nerlove's (*8*) estimated long run price elasticity of 0.67 for the pre-

allotment period. The coefficient for lagged acreage is about the same as in the pre-allotment period. If it is used to obtain a coefficient of adjustment, it would indicate a long run price elasticity greater than 1.0. The coefficient for time is much higher than in the pre-allotment period. Although these results are not significant in the usual statistical sense, they do conform with theoretical specifications and perhaps indicate relative magnitudes of parameters for post-1933 years.

Allotment Years — Acreage allotments were in effect during 12 years of the 1934-1956 period. These include 1934, 1935, 1938-43, 1950, and 1954-56. Two of these years, 1942 and 1943, are omitted from the analysis. For the 10 remaining years, the least squares estimates of the parameters are:

$$\log A_t = + \underset{(.0878)}{1.0420} \log G_t + \underset{(.0634)}{.1554} \log y'_{2t-1} - .2527 + u_{4t} \qquad (3.3)$$

$\hat{\sigma}^2 = .0004$

$R^2 = .96$

adj. $R = .97$

The coefficients in this equation are statistically significant at the 95 percent confidence level. As expected, there is an approximate proportional relationship between allotments (G_t) and the acreage of cotton in cultivation July 1. The specific coefficient indicates a 1.00 percent increase in allotments associated with a 1.04 percent increase in acreage.

Under acreage allotments there is some flexibility in planting cotton even though, characteristically, allotments have been underplanted. This analysis indicates that the level of price in the previous year, which is approximately the same as the loan rate, is an important determinant of acreage planted. A 1.00 percent decrease in the deflated 10 spot price is associated with a decrease of 0.16 percent in acreage with allotments held constant. This would be reflected primarily in underplantings.

Estimated and Actual Values of Selected Endogenous Variables in 1957-59

The primary objective in this study is not to devise equations for forecasting subsequent changes in endogenous variables in the cotton economy. However, it may be useful in the interpretation of the results if a comparison of predicted and observed values for years after 1956 were made. Three equations were selected for this comparison and quantities were estimated for each equation based on actual values of

exogenous and certain endogenous variables. The equations are domestic mill consumption, inventory demand, and foreign mill consumption.

The predicted and observed values for domestic mill consumption compare closely for the years 1957 and 1958 (Table V). The high predicted values in 1959 were caused in part by the relatively large divergence which occurred in the increasing deflated prices of cotton broadwoven goods and the decreasing deflated price of raw cotton (16 percent). Although a divergence of this magnitude was within the range of data used in the analysis, it was greater than had occurred in any year since 1937.

The predicted and observed values for inventory demand were approximately the same in 1957, but moved in opposite directions in 1958 and again in 1959. Apparently, new barter and special financial arrangements for exports of cotton from governmental stocks represented

Table V.—Estimated and Actual Values for Domestic and Foreign Utilization of Cotton, 1957-1959

	Quantity		
	1957	1958	1959
		(million bales)	
Domestic Mill Consumption (Y_1)			
Limited information estimates	8.1	8.9	11.5
Theil-Basmann estimates	8.2	9.0	11.4
Least squares estimates	8.4	9.1	11.2
Actual data	8.0	8.7	9.0
Inventory Demand (Y_4)			
Limited information estimates	8.8	8.0	9.2
Theil-Basmann estimates	8.8	7.9	9.2
Least squares estimates	8.6	7.7	9.0
Actual data	8.7	8.9	7.5
Foreign Mill Consumption (Y_7)			
Limited information estimates	32.8	35.1	36.1
Theil-Basmann estimates	32.1	34.2	35.5
Least squares estimates	31.8	33.9	35.3
Actual data	33.3	35.3	37.3

a change in the structure of the cotton economy, and these programs affected the relationships for determining the quantities of cotton in ending inventory positions.

The predicted levels of cotton consumption were more nearly comparable with the observed levels of foreign mill consumption than they were with the observed levels in the domestic market. The differences were less than 5 percent for both the limited information and the Theil-Basmann estimates, and were less than 6 percent for the least squares estimates. There was some tendency for the L. S. equation to underestimate the actual level by the greatest amount.

The results from the various comparisons indicate that the direction of change in actual mill consumption of cotton was predicted for each of the three years. The estimated magnitudes were also relatively close in two of the three years for domestic mill consumption and in all years for foreign mill consumption. The equations were less satisfactory in predicting the direction and magnitude of change in ending domestic carryover stocks of cotton than in predicting changes in mill consumption.

Analysis of Specific Disturbances

The initial step in an attempt to evaluate the probable effects of specific disturbances in the cotton economy is to develop a basis for defining equilibrium conditions in this economy. The estimated parameters and equations developed in the previous section provide the means by which such equilibrium conditions can be specified, given certain assumptions. Changes in these assumptions, of course, lead to alternative equilibrium conditions and to various magnitudes of effects of exogenous occurrences.

The statistical model of the cotton economy consists of seven endogenous variables and 13 exogenous variables. In addition, a subset of equations for acreage and production includes nine other variables. In order to simplify the establishment of equilibrium conditions, four equations are selected for further study. These include domestic mill demand (1.1), foreign mill demand (1.6), world price (1.5), and domestic production based on estimated acreage during non-allotment years after 1933 (3.2). In addition, foreign production of cotton is assumed for each equilibrium position. The estimated parameters in the demand equations are for the 30-year period.

Analysis Based on 1956 Conditions

The equations are modified in three ways. First, they are reduced to a form in which only quantities and prices of cotton are variables. This involves the use of estimated values for the other variables in these equations. Variables which had no upward or downward trend over time are used at mean values. Variables which had such a trend are used at 1956 or other specified values. The 1956 data are used for per capita production of man-made fibers (domestic and foreign), per capita disposable personal income, lagged per capita foreign consumption, and time. In the production equation, lagged acreage is assumed to equal the 1951-53 average acreage and the yield reduction factor is assumed to be about 24.3.

Second, the estimates of consumption and production are expanded from per capita quantities to total quantities. The 1956 population estimates are used to express quantity data in terms of millions of bales of cotton or cotton equivalent fibers.

Third, the prices are converted from a deflated basis to a more recent constant dollar basis. The crop year 1956 was selected as the base year, and the values of the various price levels in this year are used to express price data in terms of cents per pound.

The equations resulting from these adjustments, conversions, and assumptions are as follows:

Demand—Limited Information Estimates

$$\log Y_{1t} = 2.245208 - .860797 \log Y_{2t} \quad (4.1)$$

$$\log Y_{7t} = 2.533911 - .662149 \log Y_{5t} \quad (4.2)$$

Production

$$\log P_t = 0.286541 + .679344 \log Y_{2t} \quad (4.3)$$

Identities

$$Y_{1t} + Y_{7t} - P_t = K_1 \quad (4.4)$$

K_1 = Foreign production of cotton

$$Y_{5t} - Y_{2t} = K_2 \quad (4.5)$$

K_2 = Transfer cost for exporting cotton from the United States to a foreign market

Demand—Theil-Basmann Estimates

$$\log Y_{1t} = 2.517324 - .800866 \log Y_{2t} \quad (4.6)$$

$$\log Y_{7t} = 2.031269 - .346580 \log Y_{5t} \quad (4.7)$$

Equilibrium

Equations (4.1) and (4.3) or (4.6) and (4.3) in this modified system permit the establishment of an equilibrium level of price, production, and mill consumption for the domestic market under the assumption that no international trade can exist for cotton produced in the United States.[1] The results are illustrated graphically in Figure 1 for equations using the limited information estimates of coefficients for demand. At 1956 price and population conditions, the equilibrium level of price would be about 18.7 cents per pound with mill consumption of 14.1 million bales. The results are approximately the same for the Theil-Basmann estimates.

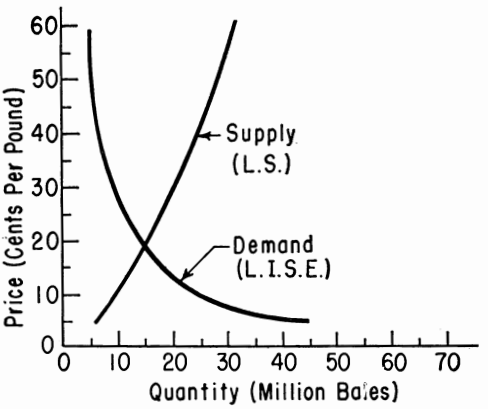

Figure 1. Estimated domestic demand and supply schedules for cotton, 1956 conditions.

Equations (4.2) and (4.4) or (4.7) and (4.4) permit the establishment of equilibrium in the foreign market in the absence of international trade in cotton between the United States and foreign countries. Equations (4.2) and (4.7) are adaptations of the estimates in Table IV for the coefficient of long run price elasticity rather than the short run price elasticity of foreign mill consumption. Technically, the precise level of price or consumption at which the adaptation is made will determine the position of this demand schedule. The decision was made to use the 1956 price of 37.64 cents per pound as the basis for positioning the long run demand schedule. The procedure involved two steps: (1) estimating the foreign mill consumption of cotton at this price from the foreign demand equation (with adjustment for price level, population,

[1] The estimate of price elasticity of supply in equation (4.3), although partially based on parameters which are not statistically significant in the acreage equation, compares favorably with Nerlove's long run price elasticity estimates of acreage response.

lagged consumption and man-made fiber production); and (2) using the derived estimate as the estimated consumption under long run elasticity conditions. The effect of the procedure is to increase the logarithmic intercept value in equation (4.2) from 1.699731 to 2.533911 and to increase the absolute value of the coefficient for price from 0.132730 to 0.662149. The demand schedules obtained from both the original short run estimates and the adapted long run estimates are presented in Figure 2. Similar procedures were employed for equation (4.7).

Equilibrium in the foreign market without trade will depend on the quantity of cotton produced in foreign countries and on the foreign demand for cotton. In 1956, the quantity of foreign cotton produced was 28.9 million bales. At this production level, the equilibrium price would be about 42 cents per pound on the basis of the limited information estimates and would be about 44 cents per pound on the basis of the Theil-Basmann estimates. In both cases, the estimated prices are considerably higher than the estimated equilibrium prices for the domestic market. If foreign production increased 20 percent to 34.7 million bales, the world price would drop to about 31.7 cents per

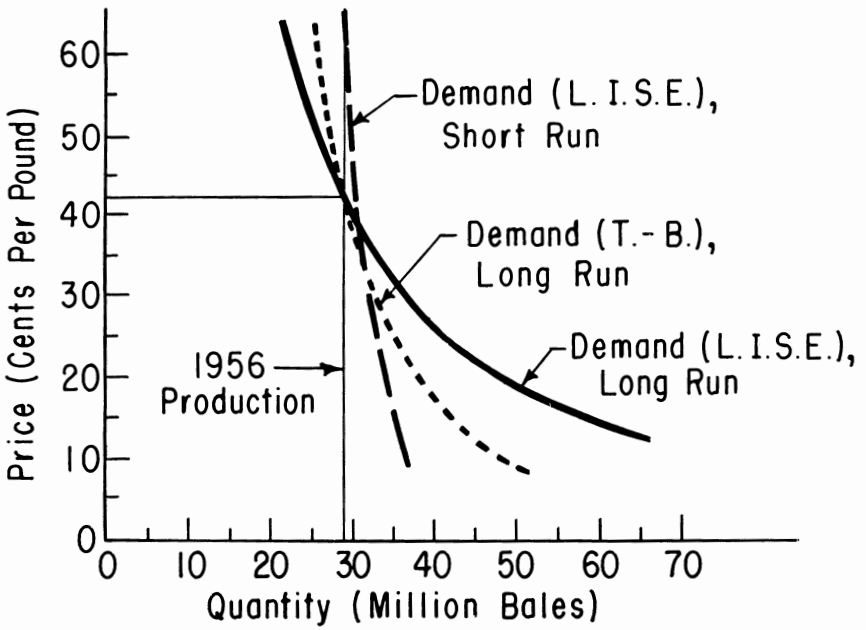

Figure 2. Estimated foreign demand schedules for cotton, 1956 conditions.

pound, using the long run estimate. A price change this large reflects the relatively inelastic demand for cotton even under the longer term conditions.

Equation (4.5) is needed to complete a system for the simultaneous determination of prices and quantities under conditions of international trade in cotton. Given the constants K_1 and K_2, a unique equilibrium level of price and consumption is determined for each market. Both foreign production and the transfer cost involved in exporting cotton from the United States are treated as exogenous variables in this study. Therefore, specific levels are assumed for these variables for the purpose of analysis. Foreign production of cotton is assumed to equal 28.9 million bales, and the transfer cost is assumed to be 4.0 cents per pound. Both assumptions approximate average data for the 1955 and 1956 crop years.

Given $K_1 = 28.9$ million bales and $K_2 = 4.0$ cents per pound, an equilibrium price for the world cotton economy can be developed from equations (4.1), (4.2), (4.3), (4.4), and (4.5). An iterative process for the solution is required, since three of the equations are linear in logarithms and two are identities in natural units. However, an approximate solution may be easily obtained from a graph of the relationships.

The demand and supply relationships for 1956 conditions using the limited information estimates for demand are presented graphically in Figure 3. The domestic market relationships are included in Sector A and the foreign market relationships are included in Sector B. Prices shown on the vertical scale are applicable to the domestic market only. Four cents is added to the domestic price to represent the world price; this addition is accomplished by positioning the horizontal scale for the foreign market at 4.0 cents below the zero point on the domestic price scale. This procedure permits the use of the domestic price as the base price in considering the effects of alternative disturbances initiated in the domestic cotton economy. The equilibrium price can be obtained by determining the specific price at which the excess of domestic production over domestic consumption just equals the deficit of foreign consumption over foreign production. This will be the equilibrium domestic price, and the world price will be this price plus 4.0 cents.

At 1956 free market conditions, the equilibrium domestic price of cotton would be about 26 cents per pound with international trade. At this price domestic producers would be willing to supply about 17.7 million bales of which about 10.6 million bales would be consumed by domestic mills. The world price would be about 30 cents per pound and

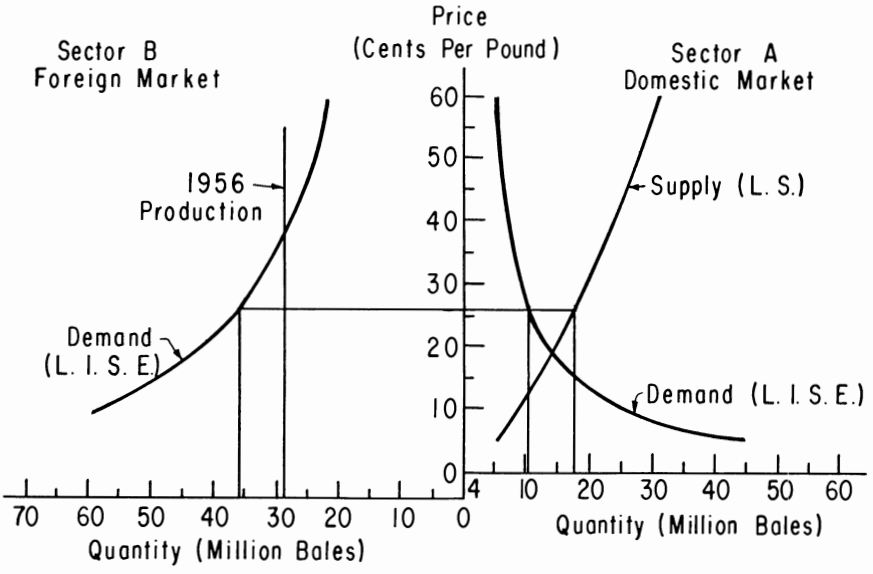

Figure 3. Estimated demand and supply schedules for the domestic and foreign markets, 1956 conditions.

foreign consumption would be almost 36 million bales. Commercial exports from the United States would approximate 7.1 million bales. Gross income from cotton lint to producers, measured at the 10 spot markets, would be about 2.2 billion dollars, which is slightly greater than the value of the 1956 crop actually produced. The estimates from equations (4.3) through (4.7) are: domestic price of 23.6 cents, production of 16.6 million bales, consumption of 11.4 million bales, exports of 5.1 million bales, and gross income of 1.9 billion dollars.

Alternative specifications for foreign production (K_1) and the transfer cost (K_2) result in various levels of equilibrium prices, quantities consumed, and quantities exported. For comparative purposes, foreign production is assumed to vary from 20 to 40 million bales in 5.0 million bale intervals and the transfer cost is assumed to vary from 0.0 to 10.0 cents per pound in 2.0 cent intervals. Results from the use of these assumptions are presented in Table VI for 0.0, 4.0, and 8.0 cent transfer cost levels. The results using the limited information estimates are also presented in Figure 4. In Section A of Figure 4, the solid line shows the relationship existing between the level of foreign production, measured on the horizontal axis, and the domestic equilibrium price, measured on vertical axis, when the transfer cost is 4.0 cents per pound. The

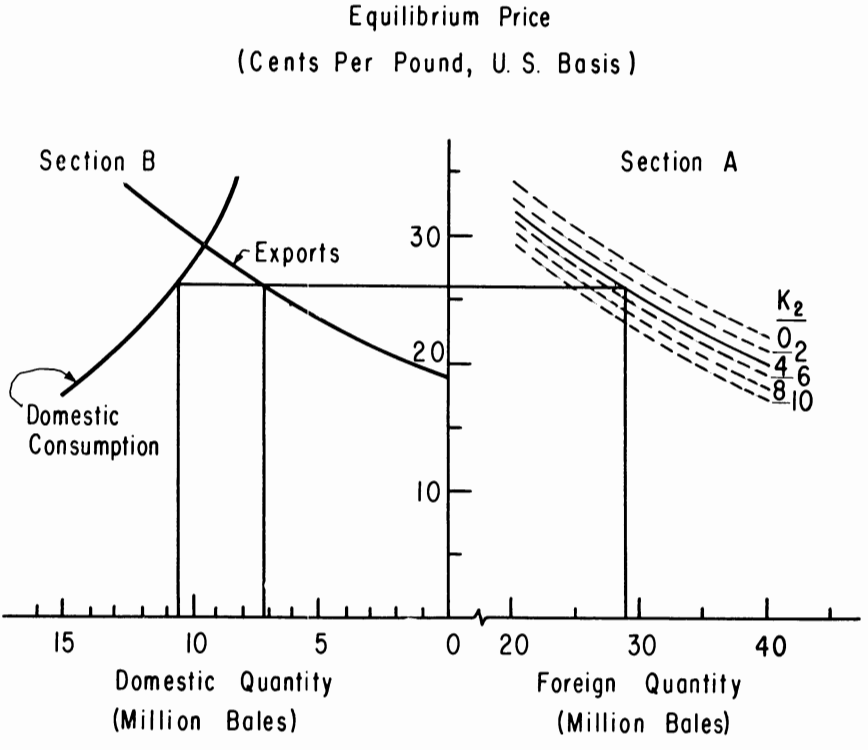

Figure 4. Equilibrium prices, exports, and domestic consumption for alternative levels of transfer cost and foreign production, limited information estimates, 1956 conditions.

dashed lines represent the same relationship for alternative levels of the transfer cost. In Section B, the solid lines represent the quantities of cotton exported and consumed domestically at alternative equilibrium prices.

At any particular level of foreign production and transfer cost, the equilibrium price, quantity consumed, and quantity exported can be determined approximately from the graph. For example, if foreign production is 30 million bales and if the transfer cost is 10.0 cents per pound, the equilibrium price would be 22.6 cents, exports would be 4.1 million bales, and consumption would be 12.0 million bales. Variations in the transfer costs result in less than proportional changes in the equilibrium prices. Generally a change of 1.0 cent in the transfer cost results in a change of 0.5 cent in the equilibrium price. With foreign production the same as in the previous example, a decrease in the

Table VI.—Estimated Equilibrium Prices and Quantities of Cotton Under Alternative Levels of Transfer Costs and Foreign Production, 1956 Conditions

Transfer Cost K_2	Foreign Production K_1	10-Spot Price Y_2	Domestic Consumption Y_1	Domestic Production P	U.S. Exports Y_3	Foreign Consumption Y_7
	Limited Information Estimates of Demand Coefficients					
0	20	34.25	8.40	21.34	12.94	32.94
	25	30.59	9.26	19.76	10.50	35.50
	28.9	28.08	9.97	18.64	8.68	37.58
	30	27.42	10.17	18.34	8.17	38.17
	35	24.67	11.14	17.07	5.93	40.93
	40	22.29	12.16	15.94	3.78	43.78
4	20	32.32	8.83	20.51	11.68	31.68
	25	28.58	9.81	18.87	9.05	34.05
	28.9	26.01	10.64	17.70	7.05	35.95
	30	25.34	10.89	17.38	6.50	36.50
	35	22.53	12.04	16.05	4.01	39.01
	40	20.10	13.29	14.86	1.57	41.57
8	20	30.54	9.27	19.74	10.47	30.47
	25	26.73	10.39	18.03	7.64	32.64
	28.9	24.13	11.35	16.82	5.46	34.36
	30	23.45	11.64	16.49	4.86	34.86
	35	20.61	13.00	15.11	2.11	37.11
	40	18.16	14.50	13.87	—0.63	39.37
	Theil-Basmann Estimates of Demand Coefficients					
0	20	32.92	8.75	20.77	12.02	32.02
	25	28.19	9.91	18.69	8.78	33.78
	28.9	25.00	10.91	17.23	6.32	35.22
	30	24.17	11.21	16.84	5.63	35.63
	35	20.78	12.65	15.20	2.55	37.55
4	20	31.60	9.04	20.20	11.16	31.16
	25	26.82	10.31	18.07	7.76	32.76
	28.9	23.59	11.43	16.56	5.13	34.03
	30	22.76	11.76	16.16	4.40	34.40
	35	19.34	13.40	14.47	1.07	36.07
8	20	30.40	9.33	19.68	10.35	30.35
	25	25.59	10.71	17.50	6.79	31.79
	28.9	22.35	11.93	15.96	4 03	32.93
	30	21.51	12.30	15.56	3.25	33.25
	35	18.10	14.13	13.83	—0.30	34.70

transfer cost to zero would result in a higher equilibrium price (27.4 cents), a larger quantity of exports (8.2 million bales), and a decrease in domestic consumption (10.2 million bales). This is an increase in the equilibrium price of almost 5.0 cents.

Exports are quite responsive to changes in the level of foreign production. At a transfer cost of 4.0 cents, exports would decrease from 11.7 to 6.5 million bales with an increase of foreign production from 20 to 30 million bales and would decrease to 1.6 million bales with an increase in foreign production to 40 million bales. The United States would export no cotton under 1956 free trade conditions if the transfer cost increased to 10 cents and if foreign production exceeded 37 million bales.

Alternative Price Combinations

Some insights into the probable impacts of price support and acreage adjustment programs upon the cotton economy can be obtained by comparing alternative solutions with the equilibrium conditions for free market conditions. For example, assume that an attempt is made to maintain the 1956 parity prices for cotton in the domestic economy. The parity price of cotton in 1956 averaged 36.40 cents per pound. The equivalent 10 spot price for Middling 15/16-inch cotton was slightly over 37 cents.

At 37 cents per pound, domestic mill consumption would decline from the equilibrium level of 10.6 million bales to 7.9 million bales and there would be an incentive to expand production to 22.5 million bales (Table VII). There would be little possibility for exports, since foreign consumption would exceed foreign production by only 0.3 million bales at the world price of 41 cents per pound. The lower level of cotton consumption in the domestic market and the loss of the export market at these prices would result in increasing inventories of cotton unless restraints were imposed on production. Production would need to be decreased to 8.2 million bales to prevent inventory accumulations. This is a decrease of almost half from the 1956 actual production and a decrease of almost two-thirds from the potential production at this price of cotton. The magnitude of these restraints would exceed any previously attempted in our economy. Gross income from cotton lint would decline to 1.5 billion dollars if production controls were effective at this level. Approximately the same magnitudes are indicated by the analysis using the Theil-Basmann estimates of demand.

Table VII.—Estimated Equilibrium Prices and Quantities Under Alternative Price Programs for Cotton, United States, 1956 Conditions

	Price		U.S. Production or Allotment		U.S. Consumption	U.S. Exports	U.S. Gross Income
	U.S.	World					
	Y_2	Y_5	P		Y_1	Y_3	
	(cents per pound)			*(million bales)*			*(billion dollars)*
Limited Information Estimates of Demand Coefficients							
Free market	26.0	30.0	17.7		10.6	7.1	2.2
100 percent of parity	37.0	41.0	8.2	(22.5)*	7.9	0.3	1.5
80 percent of parity	30.0	34 0	13.6	(19.5)*	9.4	4.2	2.0
Two-price plan	37.0	25.8	18.7		7.9	10.8	2.5
Theil-Basmann Estimates of Demand Coefficients							
Free market	23.6	27.6	16.6		11.4	5.1	1.9
100 percent of parity	37.0	41.0	8.8	(22.5)*	8.0	0.8	1.6
80 percent of parity	30.0	34.0	12.2	(19.5)*	9.4	2.8	1.8
Two-price plan	37.0	19.6	17.4		8.0	9.4	2.1

*The figure shown is the bale allotment necessary for equilibrium. The figure in parenthesis is estimated production at the weighted average price.

Similar conditions would exist in the cotton economy at lower levels of support prices, though the adjustments in production would be less severe. A support price of 80 percent of parity in 1956 would be approximately 30 cents per pound. At this price, domestic consumption is estimated at 8.8 to 9.4 million bales, production is estimated at 19.5 million bales, and there would be an export market for 2.8 to 4.2 million bales. Production and consumption of these quantities would result in an increase of about 6 million bales in inventory unless production controls were effective. The control of production at 12 to 13 million bales would be sufficient for utilization in both markets at these prices. Apparently production would need to be decreased at least 30 percent from the potential level to establish this temporary equilibrium. Gross income to producers from cotton lint would total 1.8 to 2.0 billion dollars, considerably higher than would exist under 100 percent of parity price conditions.

The possibilities for equilibrium conditions under a two-price system are infinite and would depend on the precise levels of prices established in the two markets. For comparative purposes, a set of prices is assumed to exist such that parity prices are effective in the domestic market and world prices drop to the level at which exports are equal to the difference between domestic consumption and domestic production. For the limited information estimates, equilibrium would be established at 26 cents per pound in the foreign market or an export price of 22 cents per pound. Assuming that domestic producers used the weighted average price of cotton in the two markets as the appropriate price in determining production, they would produce about 18.7 million bales of cotton at a weighted average price of 28.2 cents per pound. About 10.8 million bales would be exported and the two markets would yield a gross income from cotton lint of 2.5 billion dollars. Similar quantity estimates, but lower world price and gross income estimates, are indicated by the Theil-Basmann estimates.

The increase under this particular two-price system is only 300 million dollars more than would be obtained under free market conditions. This is a relatively small gain to be obtained from the price discrimination process. However, the total quantity of cotton produced would be significantly higher under the two-price system, and domestic consumers would be paying a higher price for a smaller volume commensurate with 100 percent of parity. The gross farm income from the sale of cotton lint under the two-price plan as compared with income under a strict marketing quota at 90 or 100 percent of parity corresponds with the ranking established in Senate Document No. 12 (*19*).

There is no basis in this study for evaluating the potential effect of the lower world price on foreign production under the two-price system. If it is assumed that the lower world cotton price level would act as an incentive to decrease foreign production, then the export prices would be somewhat higher than those reported in Table VII. The exact level would depend on the price elasticity assumed for the foreign supply and on the concurrent adjustments in foreign consumption and domestic production.

Estimated Equilibrium Prices Under Governmental Programs

An attempt was made to determine the relative increase in prices which resulted from price supports on cotton for the inter-war and post-World War II periods. The same general model formed the basis

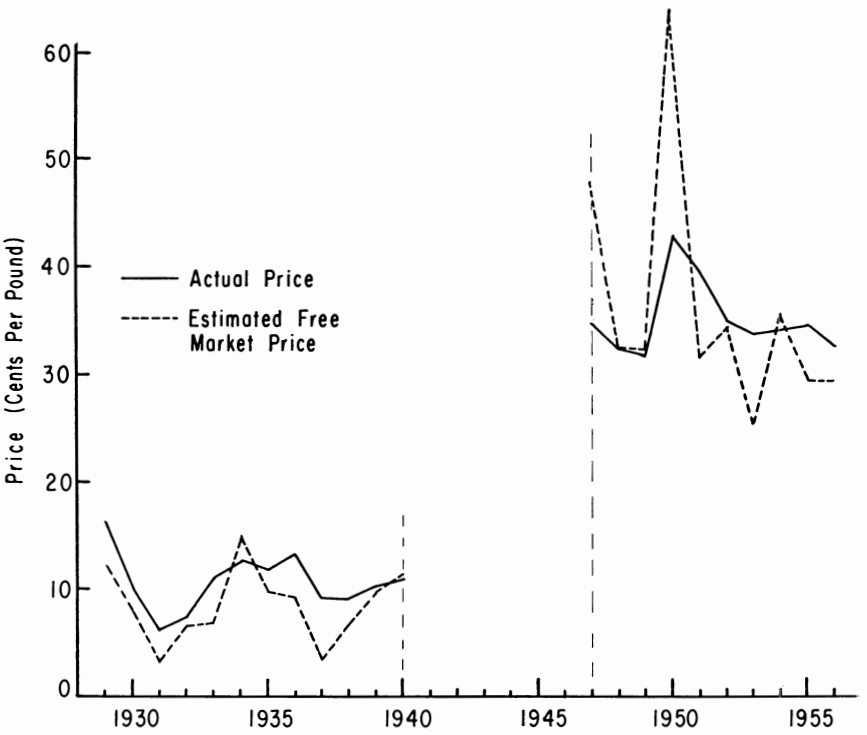

Figure 5. Actual prices and estimated free market prices of cotton in the United States, selected years.

for this analysis as was used in establishing equilibrium prices and quantities under 1956 conditions. However, the specific assumptions are different. Instead of using mean or assumed trend values in equations (1.1), (1.6), (2.1), (3.2), (4.4) and (4.5), the actual values applicable to a given year are used to estimate the demand and supply schedules for that year. In addition, it is assumed that no net additions to, or withdrawals from, government stocks would be made. The process is repeated for each year in the period 1929 through 1940 and 1947 through 1956.

The comparison of the actual price and estimated free market price for each year is illustrated in Figure 5. Three distinct periods are evident in this comparison. The first period is the inter-war period. In only one year of this period is the estimated free market price above the support price; this is the 1934 drought year. For all of the first period, gross receipts to farmers from the sale of cotton lint averaged 30 percent above the receipts that would have been forthcoming for the actual production at the estimated free market prices.

The second period apparently began during World War II and continued through 1950. The actual prices are below the estimated free market prices during most years in this period. The reason for this is the fact that governmental stocks were being used for both consumption and export. During four years of this period, 1947-1950, gross receipts to farmers averaged about 17 percent below the level which would have been received at the estimated free market prices.

The last period includes the years after 1950. During this period, conditions were similar to those in the inter-war period in that the government was removing some cotton from the market. Based on estimated free market prices, cotton producers received 13 percent more gross income because of the price support operations for cotton.

Approximately the same net changes in gross incomes for the three periods are indicated when deflated prices are used for the computations as when actual prices are used. However, in both cases the indicated changes probably overstate the gains to producers from the price support operations. Presumably some of the long run increase in foreign production is attributable to the higher market prices resulting from price support activities. To this extent, the export market for United States cotton has become progressively smaller and the equilibrium prices progressively lower than would have existed in the absence of these programs.

Summary and Conclusions

This study was designed to provide information on the effects of economic factors on the demand for and supply of cotton. An economic model of the cotton economy was developed, with primary emphasis on demand relationships. Seven equations and identities are used for domestic demand, export demand, inventory demand, expected price, world price, foreign demand, and domestic supply. A subset of equations was developed and used for domestic production, cotton acreage prior to 1933, acreage under effective allotments, and acreage after 1933 when allotments were not effective. Data are specified to represent each of the 29 variables included in both the general model and subset of equations for domestic production.

The algebraic form for variables in the equations is specified as linear in logarithms. The parameters in four equations in the general model are estimated by three statistical methods for the 30-year period 1921-40 and 1947-56. These are the limited-information, single-equation, maximum-likelihood method; the Theil-Basmann method; and

the least-squares single-equation method. Parameters for these equations are also estimated for the inter-war period, 1921-40, by the limited information and least squares techniques.

The price elasticity of domestic demand for cotton, as represented by domestic mill consumption, is estimated at less than unity in the results from all statistical methods for both periods. The limited-information, single-equation estimate for the 30-year period is —0.86 and the other estimates are somewhat lower. There is no evidence that this elasticity is different in the long run than in the short run; however, domestic mill consumption is quite responsive to changes in the wholesale prices of finished cotton products. Apparently changes in the wholesale prices of finished goods lead to fluctuations in inventories of processed cotton which are reflected in the absolute levels of domestic mill consumption in any given year.

The income elasticity of domestic demand for cotton is estimated at less than unity by all methods for the 30-year period. Differences in the estimates for the 20-year and 30-year periods indicate that the income elasticity may have been less in the post-World War II period than in the inter-war period.

The availability of competitive fibers is an important determinant of the level of cotton consumption. An increase of 1.00 percent in the production of man-made fibers is associated with a decrease of from 0.12 to 0.15 percent in the domestic mill consumption of cotton.

Domestic inventory demand increases as governmental loan rates and quantities of cotton available increase. It decreases as either current prices or the expected size of the following year's crop increases. The price elasticity of inventory demand is estimated by the limited information method at —0.84.

The estimated price elasticity of foreign mill consumption is less than in the domestic market. The short run estimate is —0.13 and the long run estimate is —0.66 for the 30-year period, based on the limited information method. The Theil-Basmann estimates are —.07 and —.35, respectively. Both the availability of competitive fibers and the domestic price of cotton expected to prevail in the subsequent crop year are important determinants of the level of foreign mill consumption. These results, however, are not substantiated by the results from analyses for the 20-year inter-war period.

Exports of cotton from the United States are specified as residuals in the foreign market sector. The domestic price has been an important

factor in determining the world cotton price, but throughout the period the domestic price was determined primarily through the price support mechanism. Given this relatively fixed support price, cotton available from foreign countries would move into foreign mills ahead of United States cotton if it were priced slightly below the support rate plus transfer cost.

A subset of equations, adjusted for 1956 population, income, price level, and competitive fiber conditions, is used to estimate equilibrium prices and quantities of cotton in the domestic market both with and without international trade in cotton. In a closed domestic market, the equilibrium price in 1956 is estimated at 18 to 19 cents per pound with domestic mill consumption of 14 million bales. With trade, the price would increase to 24 to 26 cents per pound, domestic consumption would decrease to about 11 million bales, exports would range from 5 to 7 million bales, and gross farm income from cotton lint would range from 1.9 to 2.2 billion dollars, depending on the particular estimates used.

Production controls could be imposed at approximately 8 million bales to push domestic prices up to 100 percent of parity, but the export market would virtually disappear and gross income from cotton lint would decline substantially. Production controls at 80 percent of parity support prices would yield higher gross incomes, but the level would be slightly less than would be received under free market conditions. A two-price plan with the domestic price set at 100 percent of parity and a world price set sufficiently low to move the excess production into the world market would result in higher estimated gross incomes than any of the other price combinations computed.

The domestic cotton economy during the time period used for estimation of parameters and equilibrium conditions for 1956 conditions appears to have changed with the advent of new programs to dispose of surplus agricultural commodities. In the 1957-59 period, for example, differences between world and domestic prices of cotton used in the study were negative for the first time during peace-time conditions. In addition, large quantities of cotton were exported through barter or special financial arrangements. Such prices and quantity movements are not adequately accounted for in the inventory and foreign consumption equations.

Several areas in the economic model used in this study need additional research and refinement of data. Foreign production of cotton, though predetermined in a given year, undoubtedly depends on the

price of cotton and the specific governmental policies in the individual countries. An evaluation of alternative domestic price programs for cotton in the absence of more information of this dependence is crude at best. Additional refinement of data and concepts for the foreign consumption equation also would be desirable, particularly the world price and an indicator of income appropriate to the quantity of cotton consumed in foreign markets.

Recently refined estimates of consumption, the development of a potentially more appropriate population estimate, and the availability of more frequent estimates of consumer income appear to warrant additional research on determining price and income elasticity estimates for final consumer demand for cotton. A similar situation exists with respect to the development of a more adequate series for expected prices and the appropriate explanatory variables, and for the separate consideration of the governmental and private sectors in the demand for inventory stocks based on the new types of governmental export policies. In addition, consideration should be given to the possibility of developing a model for the total fiber market, of which cotton is only one sector.

Appendix A

Appendix Table A-I

United States Income and Population and Foreign Population, Selected Crop Years

Year	Income	Population	
	Disposable Personal Income Z_2	United States N_1	Foreign N_2
	(billion dollars)	*(million persons)*	
1920	61.2	107.5	1,712.5
1921	57.7	109.3	1,730.7
1922	65.1	111.0	1,750.0
1923	69.3	113.0	1,768.0
1924	72.0	115.0	1,787.0
1925	75.3	116.6	1,805.4
1926	76.6	118.2	1,823.8
1927	77.9	119.8	1,842.2
1928	81.3	121.2	1,860.8
1929	78.0	122.4	1,880.6
1930	68.2	123.6	1,900.4
1931	55.0	124.4	1,923.6
1932	47.0	125.2	1,946.8
1933	49.4	126.0	1,968.0
1934	55.7	126.8	1,991.2
1935	62.9	127.6	2,014.4
1936	69.0	128.4	2,035.6
1937	67.9	129.3	2,058.7
1938	68.4	130.4	2,080.6
1939	73.7	131.5	2,102.5
1940	86.0	132.8	2,125.2
1946	166.1	142.8	2,253.2
1947	181.3	145.4	2,272.6
1948	189.5	147.9	2,294.1
1949	200.2	150.4	2,313.6
1950	219.2	153.0	2,345.0
1951	234.0	155.7	2,384.3
1952	246.7	158.3	2,425.7
1953	255.1	161.0	2,465.0
1954	267.1	163.8	2,506.2
1955	283.8	166.8	2,545.2
1956	299.0	169.7	2,586.3

Source: See Appendix B.

Appendix Table A-II

Prices of Cotton and Price Level Indicators, United States and World, Selected Crop Years

Year	Prices				Indexes			
	10 Spot Middling 15/16-inch Y_2	World Average Y_5	October Futures for t+1 Crop Y_6	Loan Rate Middling 15/16-inch Z_{11}	Price of Cotton Goods Z_1	Consumer Price Index CPI	Price Paid by Farmers PPI	Statist Index SI
	(cents per pound)				*(1947-49=100)*		*(1910-14=100)*	
1920	17.21	----	----	----	----	80.6	175	----
1921	18.64	23.01	17.98	----	52.3	72.9	147	165.7
1922	26.39	29.74	24.38	----	58.4	72.0	155	156.8
1923	30.47	35.15	26.69	----	59.8	73.3	146	161.3
1924	24.73	32.18	23.83	----	57.3	73.8	146	169.2
1925	20.40	25.70	17.73	----	54.2	76.1	146	155.2
1926	15.08	19.03	15.02	----	48.2	74.7	143	151.0
1927	20.22	24.99	19.62	----	52.4	73.5	144	147.4
1928	19.13	22.98	19.14	----	51.2	73.1	145	140.8
1929	16.31	19.66	15.57	----	47.8	73.0	141	126.5
1930	9.99	12.78	10.70	----	37.8	67.8	125	103.9
1931	6.09	8.46	6.57	----	29.0	61.1	105	98.9
1932	7.29	9.61	7.75	----	29.0	55.4	95	95.3
1933	11.00	13.44	11.66	10.00	45.2	56.7	107	97.8
1934	12.68	15.02	11.71	12.00	43.2	58.2	116	100.2
1935	11.88	14.63	10.73	10.00	41.3	58.8	115	103.7
1936	13.25	16.23	12.17	----	45.3	60.5	122	120.0
1937	9.09	12.06	8.58	9.00	35.7	61.1	119	116.2
1938	9.00	11.06	7.86	8.60	33.0	59.6	120	107.3
1939	10.09	13.88	9.41	8.95	36.7	59.8	122	141.9
1940	11.00	16.63	11.42	9.15	41.2	60.8	124	165.2
1941	18.31	----	----	14.22	---	---	---	----
1943	20.65	----	----	----	---	---	171	----
1944	21.86	----	----	----	---	---	177	----
1945	25.96	----	----	21.09	---	---	185	----
1946	34.82	----	----	24.38	---	91.6	218	----
1947	34.58	41.50	31.77	27.94	108.6	100.4	246	299.1
1948	32.15	44.70	28.70	30.74	93.8	102.8	246	319.4
1949	31.83	41.84	30.76	29.43	90.1	101.4	240	359.0
1950	42.58	71.86	38.61	29.45	114.7	108.1	263	466.2
1951	39.42	53.90	37.64	31.71	98.3	112.6	274	467.7
1952	34.92	43.14	33.95	31.96	94.3	114.1	266	446.1
1953	33.55	39.84	33.51	32.70	88.5	115.0	262	434.2
1954	34.02	40.76	34.34	33.23	88.0	114.5	263	443.0
1955	34.47	37.44	31.54	33.50	91.0	115.1	261	452.1
1956	32.47	37.64	33.73	31.59	88.9	118.6	270	465.3

Source: See Appendix B.

Appendix Table A-III

Domestic Quantities of Cotton and Man-made Fibers, Selected Crop Years

Year	Cotton							Man-made Fibers
	Mill Consumption	Commercial Exports	Grants and Gifts	Ending Carry-over	Production	Total Supply	Estimated Production in t+1	Prod. (cotton equiv.)
	Y_1	Y_3	Z_{12}	Y_4	P	Z_{10}	Z_{13}	Z_4
	(1,000 bales)							
1920	4,893	----	----	----	----	----	----	----
1921	5,910	6,184	----	2,832	7,954	14,875	10,202	63.9
1922	6,666	4,823	----	2,325	9,762	13,031	10,595	95.8
1923	5,681	5,656	----	1,556	10,140	12,788	11,905	112.3
1924	6,193	8,005	----	1,610	13,628	15,508	12,616	140.8
1925	6,456	8,051	----	3,543	16,104	18,059	14,290	181.6
1926	7,190	10,927	----	3,762	17,977	21,699	14,030	220.3
1927	6,834	7,542	----	2,536	12,956	16,883	13,072	277.2
1928	7,091	8,044	----	2,312	14,478	17,291	14,704	350.9
1929	6,106	6,690	----	4,530	14,825	17,238	15,455	393.5
1930	5,263	6,760	----	6,370	13,932	18,394	15,056	445.3
1931	4,866	8,708	----	9,678	17,096	23,131	13,369	447.3
1932	6,137	8,419	----	8,165	13,002	22,518	12,803	571.8
1933	5,700	7,534	----	7,744	13,047	20,977	14,348	666.7
1934	5,361	4,799	----	7,208	9,637	17,323	10,532	753.9
1935	6,351	5,973	----	5,409	10,638	17,783	10,679	868.2
1936	7,950	5,440	----	4,499	12,399	17,803	12,007	991.2
1937	5,748	5,598	----	11,533	18,945	22,910	13,144	994.1
1938	6,858	3,327	----	13,033	11,944	23,306	10,646	1042.4
1939	7,784	6,163	----	10,564	11,816	24,682	10,736	1319.2
1940	9,722	1,112	----	12,166	12,565	23,055	11,525	1620.5
1946	10,025	----	---	----	-----	-----	-----	-----
1947	9,354	1,391	577	3,080	11,857	14,331	11,571	3510.7
1948	7,795	2,589	2,159	5,287	14,868	17,833	12,435	3584.4
1949	8,851	2,307	3,464	6,846	16,128	21,450	15,585	4014.5
1950	10,509	2,146	1,962	2,278	10,014	16,945	10,265	4587.7
1951	9,196	4,628	891	2,789	15,148	17,433	15,713	4589.3
1952	9,461	1,946	1,102	5,605	15,139	17,939	15,479	4739.2
1953	8,576	2,776	985	9,728	16,465	22,067	14,405	4765.1
1954	8,841	2,303	1,143	11,205	13,697	23,497	11,343	5285.7
1955	9,210	1,443	771	14,529	14,721	25,884	10,471	5620.3
1956	8,608	6,226	1,367	11,323	13,310	27,817	11,117	5823.1

Source: See Appendix B.

Appendix Table A-IV

Domestic Acreage of Cotton and Yield Reduction, Selected Crop Years

Year	Acreage			Yield Reduction
	In Cultivation July 1 A	Abandoned B	Allotment G	Percentage Reduction-All Causes R
		(million acres)		
1920	35,872	-----	-----	38.2
1921	29,716	1,038	-----	52.4
1922	32,176	815	-----	44.9
1923	37,000	1,450	-----	45.3
1924	40,690	1,189	-----	34.1
1925	45,968	1,582	-----	36.0
1926	45,839	1,231	-----	29.5
1927	39,471	1,129	-----	38.5
1928	43,737	1,303	-----	36.0
1929	44,448	1,216	-----	42.1
1930	43,329	885	-----	45.4
1931	39,110	406	-----	26.5
1932	36,494	603	-----	39.5
1933	40,248	10,865	-----	26.7
1934	27,860	994	28,146	40.7
1935	28,063	554	28,146	34.7
1936	30,627	872	*	36.6
1937	34,090	467	*	21.8
1938	25,018	770	27,493	30.1
1939	24,683	878	27,863	32.9
1940	24,871	1,010	27,545	28.9
1943	21,900	-----	-----	29.6
1944	19,956	-----	-----	20.0
1945	17,533	-----	-----	31.3
1946	18,157	-----	-----	37.0
1947	21,560	230	-----	29.7
1948	23,253	342	-----	22.4
1949	27,914	475	-----	32.8
1950	18,629	786	21,000	42.9
1951	28,195	1,246	-----	34.7
1952	27,185	1,264	-----	35.4
1953	25,244	903	-----	27.8
1954	19,791	540	21,400	35.7
1955	17,506	578	18,113	20.2
1956	16,833	1,218	17,391	27.3

Source: See Appendix B.

* Although acreage allotments were not effective, payments for acreage reductions were available to producers.

Appendix Table A-V

Foreign Quantities of Cotton and Man-made Fibers, Selected Crop Years

Year	Cotton			Man-made Fibers
	Mill Consumption Y_7	Total Supply Z_6	Ending Carryover Z_7	Production (Cotton Equivalent) Z_8
		(1,000 bales)		
1920	12,258	-----	-----	----
1921	13,868	15,467	7,662	139.6
1922	14,671	15,914	5,246	193.0
1923	14,346	13,873	5,058	285.9
1924	16,541	15,200	6,338	390.5
1925	17,712	16,632	6,930	457.7
1926	18,489	16,704	8,892	604.4
1927	18,608	19,114	7,999	769.2
1928	18,687	19,046	8,229	930.3
1929	18,769	19,554	7,362	1022.7
1930	17,169	18,874	8,438	1071.3
1931	18,023	18,156	8,658	1190.2
1932	18,514	19,279	8,951	1379.7
1933	19,902	22,205	9,796	1707.7
1934	20,119	23,259	7,864	2212.7
1935	21,178	23,430	8,240	2777.1
1936	22,688	26,575	9,196	3694.2
1937	21,825	27,530	11,169	4316.6
1938	21,649	26,905	8,605	4730.5
1939	20,712	24,282	9,698	5155.7
1940	16,873	25,927	10,001	5602.7
1946	16,500	-----	-----	2810.1
1947	18,900	28,969	11,900	3574.0
1948	19,900	25,467	10,100	4455.3
1949	21,000	25,650	10,100	5653.4
1950	23,500	29,455	9,900	6947.0
1951	24,600	31,967	12,700	6982.2
1952	25,700	35,861	12,900	7543.7
1953	28,600	36,433	11,400	8969.2
1954	29,400	37,003	10,800	10199.4
1955	30,000	38,116	10,000	11317.7
1956	32,600	36,983	9,100	12317.1

Source: See Appendix B.

Appendix Table A-VI

Logarithmic Mean Values of Variables used in the General Model and in the Subset of Equations for Production and Acreage, Selected Crop Years.

Variables	Crop Years				
	1921-40 and 1947-56	1921-40	1921-32	Non-Allotment years after 1933	Allotment years
y_1	.73238	.71904	--	--	--
y_2	1.39257	1.33856	1.08672*	1.14155*	1.03910*
y_3	.52672	.68979	--	--	--
y_4	.60075	.60648	--	--	--
y_5	1.09917	1.13167	--	--	--
y_6	1.36476	1.30654	--	--	--
y_7	.99288	.98125	--	--	--
z_1	1.86263	1.82532	--	--	--
z_2	2.99113	2.92042	--	--	--
z_3	2.33051	2.32457	--	--	--
z_4	—.16329	—.47791	--	--	--
z_5	.73021	.70873	--	--	--
z_6	1.05404	1.01799	--	--	--
z_7	.62880	.61997	--	--	--
z_8	1.01819	.78727	--	--	--
z_9	.98352	.97900	--	--	--
z_{10}	1.15744	1.18235	--	--	--
z_{11}	— .96690	—2.17641	--	--	--
z_{12}	—2.69883	--	--	--	--
z_{13}	.97443	1.00824	--	--	--
P	1.12112	--	--	--	--
A	1.47766	--	1.59651	1.35951	1.34797
A_{t-1}	--	--	1.59589	1.33314	--
B_t	2.94879	--	--	--	--
R_t or R_{t-1}	1.52545	--	1.58458	1.48676	--
T	17.5**	--	.72351	1.44990	--
G	--	--	--	--	1.38118

* Mean for Y'_{2t-1}

** Natural number.

Appendix B

Specific Series, Sources, and Description of Data

Var.	Coded Variable	Source*	Description
Y_{1t}	$y_{1t} = \frac{100Y_{1t}}{N_{1t}}$	*(ref. 12, Table 20)*	U.S. mill consumption of commercial cotton, all growths (American in running bales, foreign in bales of 500 pounds equivalent).
Y_{2t}	$y_{2t} = \frac{100Y_{2t}}{CPI_t}$ $y'_{2t} = \frac{100Y_{2t}}{PPI_t}$	*(ref. 12, Table 129)*	U.S. average spot price of American Middling 15/16-inch cotton at 10 markets. Prices for 1920-22 are prices of Middling 7/8-inch plus 55 points, the average premium in three spot markets during the 1923-27 period. Prices for 1923-29 are prices of Middling 7/8-inch plus reported premiums for three spot markets. Processing taxes of 4.0 cents per pound for 1933 and 1934 and 2.0 cents per pound for 1935 are added to reported prices. Data for 1955 and 1956 are based on the simple average of prices reported for the 10 individual markets.
Y_{3t}	$y_{3t} = \frac{100Y_{3t}}{N_{1t}}$	*(ref. 12, Table 15)*	U.S. commercial exports of cotton, running bales, defined as total exports minus the grants and gifts reported as Z_{13t}.
Y_{4t}	$y_{4t} = \frac{100Y_{4t}}{N_{1t}}$	*(ref. 12, Table 20)*	U.S. carryover of commercial cotton, all growths (American in running bales, foreign in bales of 500 pounds equivalent)
Y_{5t}	$y_{5t} = \frac{100Y_{5t}}{SI_t}$	*(ref. 5, Table 19; 15, 1951, Table 104; 12, 1939, p. 65)*	World price of cotton, defined as the simple average of prices of four growths reported for Liverpool, England. The four growths are: American Fair Staple, Middling, or Texas Middling 15/16-inch (7/8-inch plus actual or computed premiums prior to 1947); Brazilian Sao Paulo, Fair or Type 5; Peruvian Tanguis, Good or Type 5; and Egyptian Uppers, Fully Good Fair or Ashmouni Fully Good.

***Source refers to tables or pages in the reference, see Literature Cited, page 51.**

Y_{6t}	$y_{6t} = \frac{100Y_{6t}}{CPI_t}$	*(ref. 9, p. 73)*	Expected price of cotton for the following year, defined as the midpoint between high and low prices reported for future contracts with delivery dates in October of crop year t+1. The simple average of the midpoints for the months November through July in crop year t is assumed to be the price expected to prevail in crop year t + 1.
Y_{7t}	$y_{7t} = \frac{1000Y_{7t}}{N_{2t}}$	*(ref. 12, Table 20)*	Foreign mill consumption of commercial cotton, all growths (American in running bales, foreign in bales of 500 pounds equivalent).
Z_{1t}	$z_{1t} = \frac{100Z_{1t}}{CPI_t}$	*(ref. 12, 1951, Table 207)*	Index of wholesale prices of cotton goods, 1947-49=100. Data for early years were converted to this base period by using a factor which would equate the average 1947-49 calendar year values for the 1926 and the 1947-49 base periods.
Z_{2t}	$z_{2t} = \frac{100Z_{2t}}{N_{1t}\ (CPI_t)}$	*(ref. 15, Table 624; 17, Table 9)*	U. S. disposable personal income. Data were converted from calendar year to crop year estimates by using 5/12ths of income in year t plus 7/12ths of income in year t + 1.
Z_{3t}	$z_{3t} = 200 + \frac{100Z_{2t}}{N_{1t}(CPI_t)} - \frac{100Z_{2t-1}}{N_{1t-1}(CPI_{t-1})}$	Z_{2t}	Change in U.S. disposable personal income from the previous year.
Z_{4t}	$z_{4t} = \frac{100Z_{4t}}{N_{1t}}$	*(ref. 14, Table 13)*	U.S. production of man-made fibers, cotton equivalent. Data were converted from calendar year to crop year estimates by using 5/12ths of production in year t plus 7/12th of production in year t + 1.
Z_{5t}	$z_{5t} = y_{1t-1}$	Y_{1t}	U.S. mill consumption of commercial cotton in the previous year.

Z_{6t}	$z_{6t} = \frac{1000Z_{6t}}{N_{2t}}$	*(ref. 12, Table 20)*	Foreign supply of commercial cotton, all growths (American in running bales, foreign in bales of 500 pounds equivalent), defined as world supply minus Z_{10t}.
Z_{7t}	$z_{7t} = \frac{1000Z_{7t}}{N_{2t}}$	*(ref. 12, Table 20)*	Foreign carryover of commercial cotton, all growths (American in running bales, foreign in bales of 500 pounds equivalent).
Z_{8t}	$z_{8t} = \frac{10{,}000Z_{8t}}{N_{2t}}$	*(ref. 14, Table 13)*	Foreign production of man-made fibers, cotton equivalent. Data were converted from calendar year to crop year estimates by using 5/12ths of production in year t plus 7/12th of production in year t + 1.
Z_{9t}	$z_{9t} = y_{7t-1}$	Y_{7t}	Foreign mill consumption of commercial cotton in the previous year.
Z_{10t}	$z_{10t} = \frac{100Z_{10t}}{N_{1t}}$	*(ref. 12, Table 1 & 2)*	U.S. supply of commercial cotton, all growths (American in running bales, foreign in bales of 500 pounds equivalent), defined as total production, plus gross imports and carry-in stocks (Y_{4t-1}).
Z_{11t}	$z_{11t} = \frac{100Z_{11t}}{CPI_t}$	*(ref. 12, Table 154)*	U. S. loan rates on Middling 15/16-inch cotton at average locations.
Z_{12t}	$z_{12t} = \frac{100Z_{12t}}{N_{1t}}$	*(ref. 14, May, 1955) p. 23)*	U.S. grants and gifts of cotton defined as fiscal year quantities of cotton exported under Lend-Lease, UNRRA, Mutual Security Programs, Army Civilian Relief, I.C.A., and Title II plus one-third of Title I exports under Public Law 480.
Z_{13t}	$z_{13t} = \frac{100Z_{13t}}{N_{1t}}$	A_t and *(ref. 12, Table 35)*	July 1 estimate of U. S. cotton production defined as A_t multiplied by the previous five-year average yield per acre of cotton in cultivation July 1.
N_{1t}	— —	*(ref. 12, Table 12)*	U.S. population (including the continental U. S. and Armed Forces overseas), December 31. Data were converted to year-end estimates by using the midpoints between the adjacent July 1 estimates.

N_{2t}	—	—	*(ref. 11)*	Foreign population, December 31, defined as world population minus N_{1t}. World population data were available for 1920, 1930, 1940, 1950 and 1955; data for intermediate years were interpolated by using the annual rate of change between adjacent estimates. The data were adjusted to approximate December 31 estimates.
CPI_t	—	—	*(ref. 18)*	Consumer price index, 1947-49 = 100, defined as the simple average of monthly values for August of year t through July of year t + 1.
SI_t	—	—	Duplicated material obtained from AMS, USDA	Statist Index (England: Index numbers of wholesale prices of 45 commodities, by months, January 1885-), 1910-14=100, defined as the simple average of monthly values for August of year t through July of year t + 1.
PPI_t	—	—	*(ref. 4, Table 97, 16, Table 43)*	Index of prices paid by U. S. farmers for commodities used in farm production and family living, defined as the simple average of monthly values for August of year t through July of year t + 1.
P_t	10^{-6}	bales	*(ref. 12, Table 2)*	U. S. production of cotton, bales of 500 pounds equivalent.
A_t	10^{-6}	bales	*(ref. 12, Table 35)*	U. S. acreage of cotton in cultivation July 1.
A_{t-1}	—	—	A_t	U. S. acreage of cotton in cultivation July 1 in the previous year.
B_t	10^{-3}	acres	*(ref. 12, Table 35)*	U. S. abandonment of cotton acreage, defined as acreage in cultivation July 1 minus acreage harvested.
B_{t-1}	—	—	B_t	U. S. abandonment of cotton acreage in the previous year.
G_t	10^{-6}	acres	*(ref. 14)* and personal correspondence	U. S. government acreage allotments.

R_t	—	—	*(ref. 12, 1951, Table 52; 13, p. 36)*	Percentage reduction from full yield per acre of cotton, total of all stated causes. For 1954 and subsequent years, data on October 1 indicated conditions (weighted by production), subtracted from 100, were adjusted upward for the difference between this series for 1953 and the reported reduction data for 1953.
R_{t-1}	—	—	R_t	Percentage reduction from full yield per acre of cotton in the previous year.
T	1921 = 1		— —	Time.

Literature Cited[1]

(1) Bonnen, James T., and Cromarty, William A. "The Structure of Agriculture," *Agricultural Adjustment Problems in a Growing Economy.* Edited by Earl O. Heady, Howard G. Diesslin, Harald R. Jensen, and Glenn L. Johnson. Ames: The Iowa State College Press, 1958.

(2) Christ, Carl F. "Aggregate Econometric Models," *American Economic Review,* XLVI, No. 3 (June, 1956).

(3) Friedman, Joan, and Foote, Richard J. *Computational Methods for Handling Systems of Simultaneous Equations.* U. S. Department of Agriculture, Agricultural Marketing Service, Agriculture Handbook No. 94 (November, 1955).

(4) Hedges, Trimble R., and Blood, K. D. *Oklahoma Farm Price Statistics 1910-38.* Oklahoma Agricultural Experiment Station Bulletin No. 238, 1939.

(5) International Cotton Advisory Committee. *World Cotton Statistics,* Quarterly Statistical Bulletin, Vol. 9, No. 3 (1956*).

(6) Lowenstein, Frank, and Simon, Martin S. "Analysis of Factors That Affect Mill Consumption of Cotton in the United States," *Agricultural Economics Research,* VI, No. 4 (October, 1954).

(7) Nerlove, Marc. "Distributed Lags and Estimation of Long-Run Supply and Demand Elasticities: Theoretical Considerations," *Journal of Farm Economics,* XL, No. 2 (May, 1958).

(8) ----------. *The Dynamics of Supply.* Baltimore: The Johns Hopkins Press, 1958.

(9) New York Cotton Exchange. *Cotton Yearbook of the New York Cotton Exchange.* Prepared under the direction of Elmer S. Bonner. New York: Prospect Press, Inc., 1959*.

(10) Simon, Martin S. "Clothing Expenditure Units: A New Time Series," *Agricultural Economics Research,* X, No. 2 (April, 1958).

(11) United Nations, Department of Economic and Social Affairs. *Demographic Yearbook 1956.* New York: United Nations, 1956.

(12) U. S. Department of Agriculture, Agricultural Marketing Service. *Statistics on Cotton and Related Data, 1920-1956.* Statistical Bulletin No. 99 (Revised February, 1957*).

(13) ----------. *Crops and Markets,* 1957*. Vol. 34.

(14) ----------. *The Cotton Situation,* (July, 1958*).

(15) U. S. Department of Agriculture. *Agricultural Statistics,* 1957*.

(16) ----------. *Major Statistical Series of the U. S. Department of Agriculture, Vol. 1, Agricultural Prices and Parity.* Agriculture Handbook 118, 1957.

(17) U. S. Department of Commerce. *Survey of Current Business,* Vol. 38, No. 7 (July, 1958*).

(18) U. S. Department of Labor, Bureau of Labor Statistics. *Consumer Price Index —U. S.: All Items, 1913 Forward,* Series A-1.

(19) U. S. Senate, Committee on Appropriations. *Report on Various Methods of Supporting the Price of Cotton.* Document No. 12. 85th Cong., 1st Sess., 1957.

(20) Wallace, T. D., and Judge, G. G. *Discussion of the Theil-Basmann Method for Estimating Equations in a Simultaneous System.* Oklahoma Agricultural Experiment Station Processed Series P-301. Stillwater, Oklahoma: Oklahoma State University of Agriculture and Applied Science, 1958.

(21) ----------. *Econometric Analysis of the Beef and Pork Sectors of the Economy.* Oklahoma Agricultural Experiment Station Technical Bulletin No. T-75. Stillwater, Oklahoma: Oklahoma State University of Agriculture and Applied Science, 1958.

[1] An asterisk following the year of publication indicates that subsequent supplements or reports for earlier years were also used.

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