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I. Introduction

India is one of the major producers of cotton in the world and cotton is a major commercial crop in Indian agriculture. India has the largest acreage planted to cotton of any country and is the fourth largest producer, exceeded only by the United States, Communist China, and the U.S.S.R.[1/] Gross area planted to cotton increased sharply between 1950-51 and 1955-56, from about 6 million to 8 million hectares. Since 1955-56, area planted has fluctuated about the 8 million hectare level.[2/] Of the total gross sown area in 1965-66, 5.8 percent was planted to cotton.[3/]

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1/ FAO Production Yearbook, 1970, Vol. 34, Food and Agricultural Organization of the United Nations, Rome.

2/ P. Ramaswamy and M. V. V. Peri Sastry, "Recent Trends in and Relationship Between Area, Production and Productivity of Cotton in India," Agricultural Situation of India, Directorate of Economics and Statistics, Ministry of Food and Agriculture, May 1970.

3/ Computed from data in Estimates of Area and Production of Principal Crops in India, 1968-69, Directorate of Economics and Statistics, Ministry of Food and Agriculture, 1969.

Cotton and cotton manufactures are also important in India's foreign trade. Between 1960 and 1969 average annual imports of cotton were Rs 625 million with a high of Rs 902 million in 1969.[4/] Imports are largely of longer staple cotton. At the same time, India exports some cotton, mostly short staple, and a considerable amount of cotton manufactures. Between 1960 and 1969 annual average exports of cotton were Rs 123 million and of cotton manufactures Rs 668 million.[5/] In value terms, exports of cotton and cotton manufactures accounted for 8.9 percent of total exports in 1966 and 7.4 percent of total exports in 1970.[6/]

This paper analyses the domestic and import demands for cotton in India. Earlier economic studies of cotton can be classified into two broad categories. One group describes the trends in production, imports and use by mills.[7/] The other category represents estimates of income and expenditure elasticities of demand, based on cross-section data.[8/]

[4/] Data on the Indian Economy, 1951-1969, The Ford Foundation, New Delhi, January 1970.

[5/] Ibid.

[6/] Rokuro Sase, V. G. Pande, and Martin E. Abel, Projections of India's Exports in the 1970's, The Ford Foundation, New Delhi, September 1970.

[7/] An example of this approach is Nilkanth Rath and V. S. Patvardhan, Impact of Assistance Under PL 480 on the Indian Economy, Gokhale Institute Studies No. 4, Asia Publishing House, 1967.

[8/] Long-term Projections of Demand for and Supply of Selected Agricultural Commodities, 1960-61 to 1975-76, National Council of Applied Economic Research, 1962. This study estimated income elasticities of demand for various kinds of cotton clothing for rural and urban areas. The estimates were based on National Sample Survey data of consumer expenditure. The estimates of income elasticity were obtained as the product of expenditure

We report the results of an econometric investigation of the demand for cotton in India, based on time series data. As such, we view it as a contribution to the growing body of time series analyses of demand, or price behavior of agricultural commodities.[9/] We concern ourselves with (1) the demand for lint cotton by mills and the demand for cotton seed -- the two products of raw cotton; (2) the import demand for lint cotton -- total PL 480, and non-PL 480; and (3) an attempt to explain changes in cotton stocks. The parameters of each of the relationships considered are estimated by the least squares method. It was our intention to employ a simultaneous system of equations to estimate the parameters of interest, but in the course of our investigation we uncovered problems with some of the data series which made the use of a simultaneous system of equations impractical. These problems are discussed at some length. The data used in our analyses are presented in Annex A.

In the manufacture of cotton products, cottons of various staple length are mixed together. While one might be interested in estimating separately the demands for cotton of different staple lengths, we did not feel that the data available would permit us to do this. Therefore cotton is treated as if it were of a uniform quality. For example, cotton imports are of a longer staple length than the average for domestic production, but we treated cotton from both sources as the same product.

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elasticity of demand (estimated from a double log function) and the income elasticity of expenditure. In practice, the expenditure elasticities were reduced by 15 percent to obtain income elasticities.

9/ Some recent examples are R. Thamarajakshi, "Determinants of Rice Prices," Agricultural Situation in India, Directorate of Economics and Statistics, Ministry of Food and Agriculture, March 1970; and R. Thamarajakshi, "Determinants of Wheat Prices," Agricultural Situation in India, Directorate of Economics and Statistics, Ministry of Food and Agriculture, May 1970.

Domestic Demand for Lint Cotton

Estimates of the mill demand relations for lint cotton are presented in this section. Two measures of mill demand are employed. The first is the quantity of cotton used by mills for domestic consumption of cotton manufactures. This is obtained by subtracting from total mill consumption of lint cotton the lint cotton equivalent of cotton manufactures exported from India.[10/] The second measure of mill consumption is total consumption which includes cotton manufactures produced for both the domestic and export market. The quantity of lint cotton demanded by mills is expressed as a function of the price of lint cotton, the price of rayon which reflects the price of man made fibers, the price of cotton manufactures, and either total net national product or per capita net national product and population. The demand equations were specified as linear in actual values. Inspection of our data indicated that this was an appropriate form for the demand relationships. The regression results are given in Table 1. Equations (1) and (2) are in terms of domestic demand for lint cotton. Equations (3) and (4) are in terms of total mill demand which consists of both domestic demand plus lint cotton equivalent of exported cotton manufactures.

In none of the equations are the coefficients of the price of lint

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10/ The quantity of cotton cloth exported was converted to lint cotton equivalent using a conversion factor reported by James R. Donald, Frank Lowenstein and Martin S. Simon, The Demand for Textile Fibers in the United States, ERS Technical Bulletin 1301, U.S. Department of Agriculture, November 1963. This conversion factor, including allowances for waste in manufacture, is 1,000 square meters of cloth equals 0.866 bales of lint cotton for 180 kg. bales.

Table 1. Demand Equations for Lint Cotton, India, 1952-68.

Equation Number	Dependent Variable	Independent Variables							R^2	D.W.
		Constant	$p_t^{l.c.}$	p_t^{r}	$p_t^{c.m.}$	Y_t	$(Y/H)_t$	H_t		
(1)	$q_t^{lcd} - q_t^{lcex}$	-1081.772	1.343 (0.151)	0.535 (0.197)	12.165 (1.423)	37.007* (8.997)			0.961	2.042
(2)	$q_t^{lcd} - q_t^{lcex}$	-5009.163	1.585 (0.167)	1.241 (0.429)	6.102 (0.519)		18.174** (2.895)	8.744** (2.251)	0.959	2.168
(3)	q_t^{lcd}	-1325.651	1.908 (0.241)	-0.037 (0.015)	19.603** (2.564)	37.975* (10.324)			0.963	1.771
(4)	q_t^{lcd}	-5192.438	1.718 (0.207)	0.832 (0.329)	11.062 (1.078)		20.510* (3.743)	7.848** (2.315)	0.964	1.879

Notes: (1) Numbers in parentheses are t- values.

(2) Significance levels:
* = 1 percent level of significance.
** = 5 percent level of significance.

(3) Definition of variables:
q^{lcd} = total mill consumption of cotton, thousand 180 kg. bales.
q^{lcex} = mill consumption of cotton used to produce exports of cotton cloth, thousand 180 kg. bales.

(continued)

Table 1. (continued)

$p^{l.c.}$ = price index for lint cotton (1961-62 = 100) divided by wholesale price index for all commodities.

p^{r} = price index for rayon yarn (1961-62 = 100) divided by wholesale price index.

$p^{c.m.}$ = price index for cotton manufactures (1961-62 = 100) divided by wholesale price index.

Y = total net national product at 1960-61 prices, billion rupees.

(Y/H) = per capita net national product at 1960-61 prices, rupees.

H = population, millions.

R^2 = multiple correlation coefficient.

D.W. = Durbin-Watson statistic.

cotton or the price of rayon significantly different than zero, indicating that consumption of lint cotton by mills in India has been insensitive to the level of real prices of lint cotton[11/] or man made substitutes. Since these coefficients are not significantly different from zero the fact that the coefficients of p^{lc} in all four equations and the coefficients of p^{r} in equation (3) are of the wrong sign is of no great importance. Also, we have data on rayon prices only for the period 1962-63 to 1967-68 -- a small part of the total time period. The fact that we have so few observations for this variable could account for the statistical insignificance of rayon prices in our regression equations.

The price of cotton manufactures is included in the demand equations as a demand shifter since the demand for lint cotton is derived from the demand for cotton manufactures. The price of cotton manufactures generally seems to have more of an effect on mill consumption of cotton than either the price of lint cotton or the price of rayon. However, the coefficient of cotton manufactures was significantly different from zero at the 10 percent level only in equation (3). Equation (3) would indicate that a one unit increase in the price index for cotton manufactures would increase total mill consumption of cotton by 19 thousand bales.

In equations (1) and (3) total real net national product is used, reflecting the combined effects of population and per capita income changes. In equations (2) and (4) per capita real net national product

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[11/] This statistical insignificance could also result from an improper specification of our model; i.e., the mill demand for lint cotton is one relation in a system of simultaneous equations and some form of simultaneous estimation techniques, rather than least squares, should be used to estimate this equation as part of a larger system.

and population are used as separate variables. For all the equations, the coefficients of these three variables are highly significant.

There is very little difference in explanatory power among the four equations, all explaining 95 to 96 percent of the total variance of mill consumption of cotton. Furthermore, it seems to make little difference whether total mill consumption of lint cotton or that part which goes for domestic use is used as the dependent variable.

Demand for Cotton Seed

Since data are available, we also estimate a set of demand relations for cotton seed. The demand relations for cotton seed and lint cotton, along with knowledge of cotton ginning and marketing costs (margins), would enable one to derive a demand relation for seed cotton as part of a system of equations describing the demand for cotton and cotton seed. However, we have not gone this far in our analysis because of data problems concerning the estimation of a simultaneous system of equations. These problems are discussed in a later section of the paper.

Cotton seed is processed into two products -- cottonseed oil and cottonseed meal (cake). The oil goes for human consumption and the meal is fed to animals, primarily cattle. Thus, our demand relation for cotton seed is derived from the demands for cottonseed oil and cottonseed cake and should contain variables which reflect both the human and animal demands for these products.

The supply of cotton seed is determined strictly by the level of cotton production in India. To our knowledge there are no carryover stocks of cotton seed or imports. Therefore, we can treat the supply of

cotton seed as predetermined in each year and use the price of cotton seed as the dependent variable. The price of cotton seed, p_t^{cs}, is expressed as a linear function of the quantity of cotton seed, q_t^{cs}, the price of oilseeds, p_t^{op}, and one or more of the following variables -- total net national product, Y_t, per capita net national product, $(Y/H)_t$, population, H_t, and cattle numbers, N_t. Although the price of oilseeds includes cotton seed, cotton seed is such a small part of total oilseeds that there should be no significant biases resulting from the use of this price variable.

Estimates of several demand equations for cotton seed are presented in Table 2. As one might suspect, there are very high correlations between cattle numbers on the one hand and total net national product and population on the other. The zero-order correlation coefficients are 0.974 and 0.978, respectively. These high intercorrelation coefficients result in large standard errors of the coefficients and, therefore, small t-values, which are evident in equations (2) and (3).

It would appear that equations (4) and (5) in Table 2 are the most satisfactory. In spite of the fact that there is extremely high intercorrelation between H_t and N_t, omitting N_t from the analysis in equation (5) did not yield results different from equation (4), which contained both H_t and N_t. All the coefficients have the expected sign except N_t in equations (3) and (4), and H_t in equation (5). However, the coefficients with the wrong signs are not significantly different from zero. The coefficients of the quantity of cotton seed and per capita income are significant at the 10 and 5 percent levels, respectively, while the coefficient of the price of other oilseeds is significant at the 1 percent level in both equations (4) and (5).

Table 2. Demand Equations for Cotton Seed, India, 1952-68.

Equation Number	Dependent Variable	Independent Variables								
		Constant	q_t^{csd}	p_t^{op}	Y_t	$(Y/H)_t$	H_t	N_t	R^2	D.W.
(1)	p_t^{cs}	- 47.510	-0.007 (0.519)	1.082* (3.316)				2.695 (0.732)	0.780	2.079
(2)	p_t^{cs}	- 8.815	-0.016 (1.044)	0.978* (3.242)	0.332 (1.312)				0.798	2.057
(3)	p_t^{cs}	45.148	-0.016 (1.051)	1.035* (3.201)	0.575 (1.203)			-0.403 (0.605)	0.804	2.056
(4)	p_t^{cs}	-123.649	-0.030*** (1.853)	1.078* (3.596)		0.694** (2.207)	0.005 (0.029)	-0.145 (0.207)	0.848	2.430
(5)	p_t^{cs}	-134.777	-0.030*** (1.935)	1.066* (3.779)		0.675** (2.344)	-0.027 (0.281)		0.847	2.410

(continued)

Table 2. (continued)

Notes: (1) Numbers in parentheses are t-values.

(2) Significance levels:
* = 1 percent level of significance.
** = 5 percent level of significance.
*** = 10 percent level of significance.

(3) Definition of variables:

p^{cs} = price index of cotton seed divided by wholesale price index for all commodities.

p^{op} = price index for oil seeds divided by the wholesale price index for all commodities.

q^{csd} = quantity of cotton seed produced in thousand tons.

N = number of cattle and buffaloes in millions of head.

All other variables are the same as in Table 1.

Equations (4) and (5) explain 85 percent of the variation in cotton seed prices during the 1952-68 period.

Import Demand for Cotton

India has been a substantial importer of lint cotton. During the period 1951-68, total cotton imports have varied from a high of nearly 1.3 million bales (180 kg.) to a low of 562 thousand bales. (See Annex A.) And, in many years, imports represent a large part of total availability. Imports come from two distinct sources during the period of analysis. One is from the United States under PL 480 assistance, q^{lcma}. This source represented a large part of cotton imports from the mid-1950's onward. The other sources of cotton are grouped together as a non-PL 480 source, q^{lcmc}. However,we feel that the terms of purchase for PL 480 cotton are sufficiently different from non-PL 480 cotton to warrant separate treatment.

The dependent variables are total cotton imports, q^{lcm}; imports under the PL 480 program, q_t^{lcma}; and non-PL 480 cotton imports, q_t^{lcmc}. Each of these variables is expressed as a linear function of the domestic price of lint cotton in the current year, p_t^{lc}; price of lint cotton in the previous year, p_{t-1}^{lc}; the price of rayon in the current year, p_t^r; either total real net national product, Y_t, or per capita real net national product, $(Y/H)_t$, and population, H_t, in the current year; the level of beginning stocks of cotton in the current year, S_t^{lc}; production of lint cotton in the current year, q_t^{lcp}; production of lint cotton in the previous year, q_{t-1}^{lcp}; and in the cases where we wish to estimate q_t^{lcma} and q_t^{lcmx} separately, one or the other of these two variables is used as an independent variable. The regression results are presented in Table 3.

for Lint Cotton Imports, India, 19 52-68.

Independent Variables								
$(Y/H)_t$	H_t	S_t^{lc}	q_t^{lcp}	q_{t-1}^{lcp}	q_t^{lcmc}	q_t^{lcma}	R^2	D.W.
		0.695***	-0.195	-0.426*			0.738	1.988
		(1.988)	(1.3877)	(3.451)				
13.146	8.840***	0.713***	-0.214	-0.422*			0.749	2.064
(1.265)	(1.868)	(1.908)	(1.330)	(3.393)				
		-0.168	0.125	-0.040	0.458		0.823	2.398
		(0.718)	(1.373)	(0.430)	(1.700)			
3.461	2.624	-0.148	0.114	-0.053	0.433		0.830	2.435
(0.629)	(0.990)	(0.586)	(1.108)	(0.531)	(1.527)			
		0.533**	-0.234**	-0.171***		0.579	0.819	2.255
		(2.712)	(2.989)	(1.952)		(1.700)		
3.072	1.740	0.536**	-0.237**	-0.173		0.577	0.817	2.252
(0.479)	(0.544)	(2.455)	(2.574)	(1.751)		(1.527)		

(continued)

Table 3. (continued)

Notes: (1) Numbers in parentheses are t- values.

(2) Significance levels:
* = 1 percent level of significance.
** = 5 percent level of significance.
*** = 10 percent level of significance.

(3) Definition of variables:

S^{lc} = stocks of lint cotton, thousands of 180 kg. bales.

q^{lcp} = quantity of lint cotton produced, thousands of 180 kg. bales.

q^{lcm} = total lint cotton imports, thousands of 180 kg. bales.

q^{lcma} = P.L.480 lint cotton imports, thousands of 180 kg. bales.

q^{lcmc} = non-P.L. 480 lint cotton imports, thousands of 180 kg. bales.

All other variables are as defined in Table 1.

Equations (1) and (2) explain nearly 75 percent of the variation in total cotton imports. The level of cotton production in the previous year is a highly significant variable in explaining current year's cotton imports. The level of beginning stocks is also a significant variable. Total real net national product is a highly significant variable. But it would appear from equation (2) that it is the population component of net national product and not per capita income which has the strongest explanatory power. The domestic price of lint cotton either in the current or previous year had no significant influence on the level of total imports. The price of rayon was significant at the 10 percent level in equation (1). However, the sign of the coefficient is negative, which is not what one would expect on a priori grounds. Rather, a decline in the price of rayon, because it is a substitute for lint cotton, should reduce the domestic demand for lint cotton and, therefore, the demand for imports.

The demand equations for PL 480 cotton are given in equations (3) and (4), and the demand equations for non-PL 480 cotton in equations (5) and (6) of Table 3. These equations explain between 82 and 83 percent of the variation in each of these import components. We note that in the demand equations for PL 480 cotton none of the coefficients is significant at the 10 percent level. However, several variables have t-values which indicate that they are significantly different from zero at levels between the 10 and 20 percent level of significance. In the demand equations for non-PL 480 cotton, beginning stocks, current production, and production in the previous year are statistically significant variables. It would also appear that PL 480 and non-PL 480 cotton imports move in the same direction.

In other words, if the demand for cotton imports increases, both PL 480 and non-PL 480 imports increase.

Stocks of Lint Cotton

An attempt was made to explain variations in levels of cotton stocks in India, since stocks represent a significant part of available cotton in any one year. And changes in stock levels can affect both price and consumption of lint cotton. The statistical results are given in Table 4. In general, they are not overly encouraging. The equations explain only about 50 percent of the variations in stock levels. The only variable which is consistently significant in explaining changes in stock level during the current year, ΔS_t^{lc}, is the level of beginning stock, S_t^{lc}. In two of the equations, (4) and (5), the level of production in the previous year was statistically significant at the 10 percent level.

The accuracy of the data on cotton stocks is highly suspect and some reasons for this are discussed in the next section. Therefore, it is not surprising that we obtained statistically poor explanations of changes in cotton stocks.

Problems of Data and Analyses

It was our original intention to formulate and estimate a system of simultaneous equations which would explain the various demands for cotton and cotton seed in India. By such a model it was hoped that we could arrive at the demand for seed cotton at the farm level. Such a model would have been similar to the one developed by Houck and Mann[12/] for soybeans.

12/ J. P. Houck and J. S. Mann, An Analysis of Domestic and Foreign Demand for U.S. Soybeans and Soybean Products, Technical Bulletin 256, University of Minnesota Experiment Station, 1968.

Table 4. Regression Equations for Changes in Stocks of Lint Cotton, India, 1952-68.

Equation Number	Dependent Variable	Independent Variables							R^2	D.W.
		Constant	p_t^{lc}	p_{t-1}^{lc}	S_t^{lc}	ΔS_{t-1}^{lc}	q_t^{lcp}	q_{t-1}^{lcp}		
(1)	ΔS_t^{lc}	103.936	3.677 (0.316)	6.453 (0.621)	-1.018** (2.644)	0.222 (0.620)	0.007 (0.054)	0.139 (1.285)	0.494	1.769
(2)	ΔS_t^{lc}	354.796		7.643 (0.823)	-1.022** (2.771)	0.269 (0.866)	-0.010 (0.092)	0.145 (1.415)	0.489	1.717
(3)	ΔS_t^{lc}	373.857	6.288 (0.597)		-0.955** (2.646)	0.158 (0.476)	0.008 (0.065)	0.123 (1.204)	0.474	1.880
(4)	ΔS_t^{lc}	99.365	6.157 (0.522)	3.242 (0.312)	-0.877** (2.309)	-0.024 (0.077)	0.107 (1.065)		0.410	2.016
(5)	ΔS_t^{lc}	133.941	3.412 (0.340)	6.461 (0.652)	-1.015** (2.795)	0.229 (0.738)		0.142*** (1.770)	0.494	1.765
(6)	ΔS_t^{lc}	333.207		7.783 (0.887)	-1.028** (2.958)	0.261 (0.914)		0.139*** (1.808)	0.488	1.719
(7)	ΔS_t^{lc}	409.315	5.983 (0.664)		0.951** (2.788)	0.168 (0.580)		0.127 (1.692)	0.474	1.871

Notes: (1) Numbers in parentheses are t- values.

(2) Significance levels:
* = 1 percent level of significance.
** = 5 percent level of significance.
*** = 10 percent level of significance.

(3) Definition of variables: Same as those in Tables 1-3.

It is not at all unreasonable to assume that several variables which enter our single equation models are in fact jointly determined and, therefore, a system of simultaneous equations should be formulated and used in estimating the coefficients of these variables. We can reasonably expect domestic production to be predetermined for the consumption year following harvest and unaffected by current year's price. However, since the levels of cotton stocks and imports can be adjusted within the current year, we would expect the level of mill consumption of cotton, q_t^{lcd}; changes in the level of cotton stocks, ΔS_t^{lc}; the level of cotton imports, q_t^{lcm}; and the price of lint cotton, p_t^{lc}, to all be jointly determined. And, one should employ a system of simultaneous equations in trying to explain the variations in these variables.

For example, in none of our demand equations for domestic mill consumption or imports was the price of lint cotton a significant variable. Yet there has been significant variation in the real price of lint cotton during the period covered by the analysis (Table 5). The non-significance of this variable in our single equation models does not preclude the possibility that price would be significant in a properly specified model.

However, it became evident in our work that there are some serious inadequacies in some of the data series on cotton. It was decided, therefore, not to proceed with a simultaneous system of equations until these data problems are better understood. The results of our single equation models also have to be interpreted with a degree of caution in light of the data problems.

We can illustrate some of the major data problems through alternative

Table 5. Deflated Price Index for Lint Cotton, India, 1951-69.

Year	Index of lint cotton price (1960/61-1961/62=100) divided by index of wholesale prices (March 31, 1953=100)
1951	76.4
1952	79.2
1953	82.1
1954	76.3
1955	92.0
1956	88.2
1957	77.2
1958	72.4
1959	82.2
1960	76.9
1961	74.8
1962	83.3
1963	83.3
1964	74.9
1965	73.0
1966	67.9
1967	68.2
1968	74.2
1969	87.0

measures of lint cotton consumption. One measure of lint cotton consumption is the level of consumption by mills, q_t^{lcd}. These data are contained in Annex A and are used in estimating the demand equations presented in Table 1. Another way to measure consumption of lint cotton is given by the left hand side of the following expression:

$$q_t^{lcp} + q_t^{lcm} - q_t^{lcx} - \Delta S_t = \hat{q}_t^{lcd} \geq q_t^{lcd}$$

It says that the quantity of lint cotton produced in year t, q_t^{lcp}, plus the quantity of lint cotton imported in the same year, q_t^{lcm}, minus the quantity of lint cotton exported, q_t^{lcx}, minus the change in stocks, ΔS_t, gives an availability of lint cotton for consumption which should be greater than or equal to actual mill consumption. The inequality allows for consumption of cotton outside of mills -- a plausible situation for India.

The data for the above relationship are presented in Table 6 for the period 1951-52 to 1968-69. For this 18-year period the calculated amount of lint cotton available for consumption is less than levels of mill consumption in ten out of the 17 years. And, in some years the difference is quite significant, such as in 1955-56 when $\hat{q}_t^{lcd}$ was about 20 percent less than q_t^{lcd}.[13/]

We suspect the problems with the data are to be found primarily with either the production series or the stock data. Of the data that go into the estimates of cotton available for consumption we would expect the

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[13/] A set of demand equations for lint cotton like those given in Table 1 were estimated using $\hat{q}_t^{lcd}$ as the dependent variable instead of q_t^{lcd}. The statistical results are decidedly inferior to those presented in Table 1.

Table 6. Lint Cotton Available for Consumption and Actual Mill Consumption, India, 1951-52/1968/69.
(thousand bales)

Year	q_t^{lcp}	$+q_t^{lcm}$	$-q_t^{lcx}$	$-\Delta S_t$	= $\hat{q}_t^{lcd}$		q_t^{lcd}
1951-52	3095.4	1242.0	197	-112.6	4027.8	>	4022.5
1952-53	3155.7	681.0	305	+377.4	3909.1	<	4407.1
1953-54	3896.7	684.0	132	+ 56.3	4505.0	<	4552.4
1954-55	4199.0	607.4	315	-405.0	4086.4	<	4711.2
1955-56	3950.0	635.2	604	+ 14.4	3995.6	<	4908.9
1956-57	4650.5	796.2	295	+260.2	5411.9	>	5169.8
1957-58	4687.1	565.9	289	+ 68.2	5032.2	>	4938.2
1958-59	4609.0	562.5	396	-162.5	4613.0	<	5010.4
1959-60	3472.8	1277.1	198	+ 73.2	4625.1	<	5043.0
1960-61	5250.2	720.9	286	-439.2	5245.9	<	5308.8
1961-62	4581.4	1004.7	329	+347.1	5604.2	<	5619.8
1962-63	5229.5	1244.1	330	-325.4	5818.2	>	4614.4
1963-64	5373.7	901.6	269	- 67.3	5939.0	<	6009.3
1964-65	5609.9	1233.8	240	+ 31.7	6635.4	>	6294.2
1965-66	4761.2	649.4	182	+161.2	5389.8	<	5750.8
1966-67	4974.6	1074.0	245	+329.1	6132.7	>	5694.3
1967-68	5454.7	1190.3	232	-167.5	6245.5	>	6092.1

data on cotton imports and exports to be quite accurate. Also the calculated data for the lint cotton equivalent of exports of cotton manufactures should also be reasonably accurate. These judgements are based on the fact that in India the data on trade are generally sound. This would mean that there are serious errors in either the production data or the stock data.

There is some evidence to indicate that official data on cotton production underestimate the true level of production. If, instead of using Government data on cotton production in Table 6, we use the Trade estimates given in Table 7, our new estimates of lint cotton availabilities are significantly better than the ones given in Table 6. The new estimates of lint cotton availability are less than actual mill consumption in only one year out of the eleven-year period 1951-52 to 1961-62, whereas the estimated availabilities presented in Table 6 are less than mill consumption in eight out of the 11 years. This lends support to our contention that Government data on cotton production are considerably below actual production levels. We have no independent data on cotton stocks to compare with those used in our analysis. Therefore we have no basis for judging how well the data used reflect actual stock levels. It would also appear from Table 6 that the frequency and size of discrepancies between $\hat{q}_t^{lcd}$ and q_t^{lcd} have decreased in the 1960's compared with the 1950's. This could have resulted from improved accuracy of statistical reporting. It is suggested that persons familiar with these data series look into this problem.

In view of the data problems encountered, a few words about the

Table 7. Different Estimates of Cotton Production In India

Year	I.C.C.*	Trade**	Government***
	. . . . . 100,000 bales		
1951-52	38.1	37.6	31.3
1952-53	36.7	36.7	31.3
1953-54	45.8	45.8	39.7
1954-55	52.9	52.9	42.3
1955-56	44.6	46.0	40.0
1956-47	50.0	51.2	47.6
1957-58	51.7	54.2	47.4
1958-59	51.4	51.2	46.9
1959-60	42.3	41.0	36.8
1960-61	n.a.	56.7	53.9
1961-62	n.a.	50.0	45.0

Notes: * Estimates by the Indian Central Cotton Committee.

** Published in the Bombay Cotton Annual of the East India Cotton Association, Ltd., Bombay.

*** Published by the Directorate of Economics and Statistics, Ministry of Food and Agriculture.

Source: Nilakanth Rath and V. S. Patvardhan, Impact of Assistance Under PL 480 on Indian Economy, Gokhale Institute Studies No. 4, Asia Publishing House, 1967.

reliability of the relationships we have estimated are in order. We have no reason to suspect gross inaccuracies in the data on mill consumption of cotton. Therefore we feel that estimated equations for mill consumption of lint cotton are reasonably reliable. The same can be said for the cotton import demand equations, with one caveat. Cotton production enters our import demand equations and generally has statistically significant coefficients. Given what we have already said about inaccuracies in the production data, we would expect the coefficients of the production variables to be biased, as well as some of the other coefficient estimates in the import demand equations.

We do not place much stock in either the cotton seed demand or stock change equations. Production of cotton seed is tied directly to production of cotton. Since it would appear that the data on cotton production used in our analysis seriously underestimate actual production levels, the data used for cotton seed would also be an underestimate of cotton seed production. Therefore the coefficient estimates in Table 2 could contain a serious degree of bias. One must also view the validity of the equations explaining changes in cotton stocks with caution because of suspected, but unconfirmed, errors in the stock data.

Conclusions

We have presented the results of a statistical analysis of the demand for cotton in India. The focus of this analysis is on the mill demand for lint cotton, the demand for cotton seed, the import demand for lint cotton, and changes in cotton stocks.

The single equation models which have been estimated give reasonably

good and plausible results. However, there are a priori grounds for estimation of a simultaneous equation model. But serious inaccuracies seem to exist in some of the data series which would result in dubious estimates from a more complete model. Of course, some of the data problems are present in the single equation models which we have estimated and one should keep these in mind when interpreting the results.

The fact that we obtained reasonably good results from the point of view of economic and statistical criteria leads us to believe that further analysis of the demand for cotton in India represents a fruitful area of research. However, the best of econometric techniques cannot compensate for data inadequacy, and better understanding of the data problems in the cotton sector would prove most useful.

In spite of the problems discussed above, we feel that the demand relations estimated in our analysis for mill consumption of lint cotton and cotton imports can be used to make conditional predictions of the dependent variables, given actual or assumed values of the independent variables. Such predictions could be useful to those concerned with levels of cotton consumption or cotton imports. For example, one could evaluate the impact on imports of a change in the level of cotton production which might result from increased cotton yields. Or, one could assess the impact of alternative rates of economic growth on cotton consumption and imports.

ANNEX A

Table A.1: Data series related to analysis of the demand for cotton in India, 1950/51-1967/68.

Year**	q^{csd} Production of cotton seed	p^{cs} Index of price of cotton seed	p^{op} Index of price of oilseeds	Y Net national product 1960-61 prices	H Population	N Cattle and buffaloes	q^{lcd} Consumption of cotton by mills	q^{lcex} Consumption of cotton by mills equivalent of cloth exports	p^{lc} Index of price of lint cotton
	1,000 tons	1960/61-1961/62 =100	1960/61-1961/62 =100	million rupees	millions	millions	1,000 bales*	1,000 bales	1960/61-1961/62 =100
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
1950/51	1062	82.60	89.90	92.40	359.90	198.60	3580	303.80	91.70
1951/52	1151	66.50	63.30	95.50	365.90	199.60	4022	444.20	80.80
1952/53	1119	77.10	77.80	98.70	371.20	200.60	4408	556.50	85.40
1953/54	1380	69.80	63.90	104.70	377.40	201.60	4279	602.80	76.30
1954/55	1504	48.10	50.00	107.30	384.30	202.60	4710	538.50	84.60
1955/56	1400	80.70	72.80	109.40	391.70	203.60	4909	624.60	90.80
1956/57	1647	82.60	77.20	114.80	399.80	208.20	5170	701.40	84.20
1957/58	1659	74.60	78.50	113.60	409.00	212.80	4944	479.70	80.40
1958/59	1647	97.30	82.90	121.60	417.80	217.60	5011	702.50	95.40
1959/60	1287	107.20	91.80	123.80	427.60	222.60	5044	560.10	94.60
1960/61	1888	95.70	100.00	132.70	442.60	226.70	5359	456.70	94.20
1961/62	1859	104.30	101.50	138.00	453.00	228.60	5688	442.80	105.80
1962/63	1859	101.40	99.40	140.70	463.90	230.50	5670	491.10	109.60
1963/64	1843	164.30	119.80	148.80	475.20	232.50	6081	437.70	110.80
1964/65	2052	172.30	147.10	159.40	486.60	234.30	6371	482.40	117.50
1965/66	1684	193.60	183.10	150.40	498.90	236.00	5821	354.00	124.20
1966/67	1803	224.40	198.60	152.10	511.30	237.90	5763	394.90	144.60
1967/68	1967	168.10	162.10	165.60	524.10	239.90	6165	407.90	155.80

(continued)

ANNEX A, Table A.1 continued

Year**	p^r Index of price of rayon yarn	p^{cm} Index of price of cotton manufactures	S^{lc} Stocks of lint cotton	q^{lcp} Production of lint cotton	q^{lcm} Total imports of lint cotton	q^{lcma} Imports of lint cotton under PL 480	q^{lcmc} Imports of non-PL 480 lint cotton	W.P.I. Wholesale price index for all commodities	q^{lex} Exports of lint cotton
		1960/61-1961/62 =100	1,000 bales	1,000 bales	1,000 bales	1,000 bales	1,000 bales	Mar 31, 1953 =100	1,000 bales
	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)
1950/51			1518	2875	800.00		800.00	120	174
1951/52		84	1631	3095	1242.00		1242.00	102	197
1952/53		82	1254	3156	681.00		681.00	104	305
1953/54		91	1198	3897	684.00		684.00	100	132
1954/55		91	1603	4199	607.40	2.40	605.00	92	315
1955/56		87	1588	3950	635.20	1.20	634.00	103	604
1956/57		91	1328	4650	796.20	197.20	599.00	109	295
1957/58		100	1259	4687	565.90	143.90	422.00	111	289
1958/59		100	1422	4609	562.50	89.50	473.00	116	396
1959/60		100	1349	3473	1277.10	393.10	884.00	123	198
1960/61		100	1809	5250	1720.90	622.90	1098.00	126	286
1961/62		100	1459	4581	1004.70	194.70	810.00	127	329
1962/63	94.00	103	1788	5230	1244.10	341.10	903.00	132	330
1963/64	85.00	108	1856	5374	901.60	228.60	673.00	148	269
1964/65	78.90	110	1802	5610	1233.80	425.80	808.00	161	240
1965/66	90.20	114	1641	4761	649.40	100.40	549.00	183	182
1966/67	108.20	122	1311	4975	1074.00	323.00	751.00	212	245
1967/68	123.90	126	1479	5455	1190.30	411.30	779.00	210	232

ANNEX A, Table A.1 -- Footnotes and explanation of variables.

*Bale of lint cotton = 180 kgs.

**Data for cotton production, prices, consumption, stocks and trade are on a crop year basis, year ending August 31. Data for income, wholesale price index, price of oilseeds, price of rayon, and price of cotton manufactures are on a fiscal year basis, year ending March 31. Population is as of June 30. Cattle and buffalo data are as of April 15.

(1) q^{csd} = quantity of cotton seed produced in India, in thousand tons.
Source: Indian Central Cotton Committee, annual reports.

(2) p^{cs} = price index of cotton seed constructed by combining Maharashtra and Madras series.
Source: Directorate of Economics and Statistics, Ministry of Food and Agriculture, Government of India.

(3) p^{op} = price of oilseeds.
Source: Monthly Abstracts of Statistics, Vols. 13, 15 and 23, Central Statistical Organization, Government of India.

(4) Y = total net national product.
Source: Economic Survey, 1970-71, Ministry of Finance, Government of India.

(5) H = population of India.
Source: Indian Agriculture in Brief, Ministry of Food and Agriculture, Government of India.

(6) N = total number of cattle and buffaloes in India. Figures for 1951, 1956, 1961 and 1966 are actual census figures. For the remaining years figures were computed by using annual average rates of growth in order to complete the series.
Source: Eighth and Tenth All India Livestock Census, Government of India.

(7) q^{lcd} = total mill consumption of cotton in India.
Source: Textile Bulletin, a quarterly issued by the Textile Commissioner of India, Bombay.

(8) q^{lcex} = mill consumption of cotton used to produce exports of cotton cloth.
Source for cotton cloth exports: Monthly Abstracts of Statistics, Vols. 13 and 23, Central Statistical Organization, Government of India.

(9) p^{lc} = price index for lint cotton.
Source: FAO Production Year Book, Vols. 20 and 24.

ANNEX A, Table A.1 -- Footnotes and explanation of variables -- continued.

(10) p^r = price index for rayon yarn.
Source: Office of the Economic Adviser to Government of India.

(11) p^{cm} = price index for cotton manufactures.
Source: Reserve Bank of India Bulletins, Vols. 16, 23 and 25, Bombay.

(12) S^{lc} = stocks of lint cotton held by mills.
Source: Textile Bulletin, a quarterly issued by the Textile Commissioner of India, Bombay.

(13) q^{lcp} = lint cotton production in India.
Source: Estimates of Area and Production of Principal Crops in India, Directorate of Economics and Statistics, Ministry of Food and Agriculture, Government of India.

(14) q^{lcm} = total imports of lint cotton into India including PL 480 imports.
Source: Monthly Trade Statistics, Director General Commercial Intelligence and Statistics, Government of India; and unpublished data from United States Department of Agriculture, Washington, D. C.

(15) q^{lcma} = imports of lint cotton under PL 480.
Source: United States Department of Agriculture, unpublished data.

(16) q^{lcmc} = difference between total and PL 480 imports.

(17) W.P.I. = wholesale price index for all commodities.
Source: Data on the Indian Economy, The Ford Foundation, New Delhi, 1970.

(18) q^{lcex} = exports of lint cotton from India.
Source: Monthly Trade Statistics, Director General Commercial Intelligence and Statistics.