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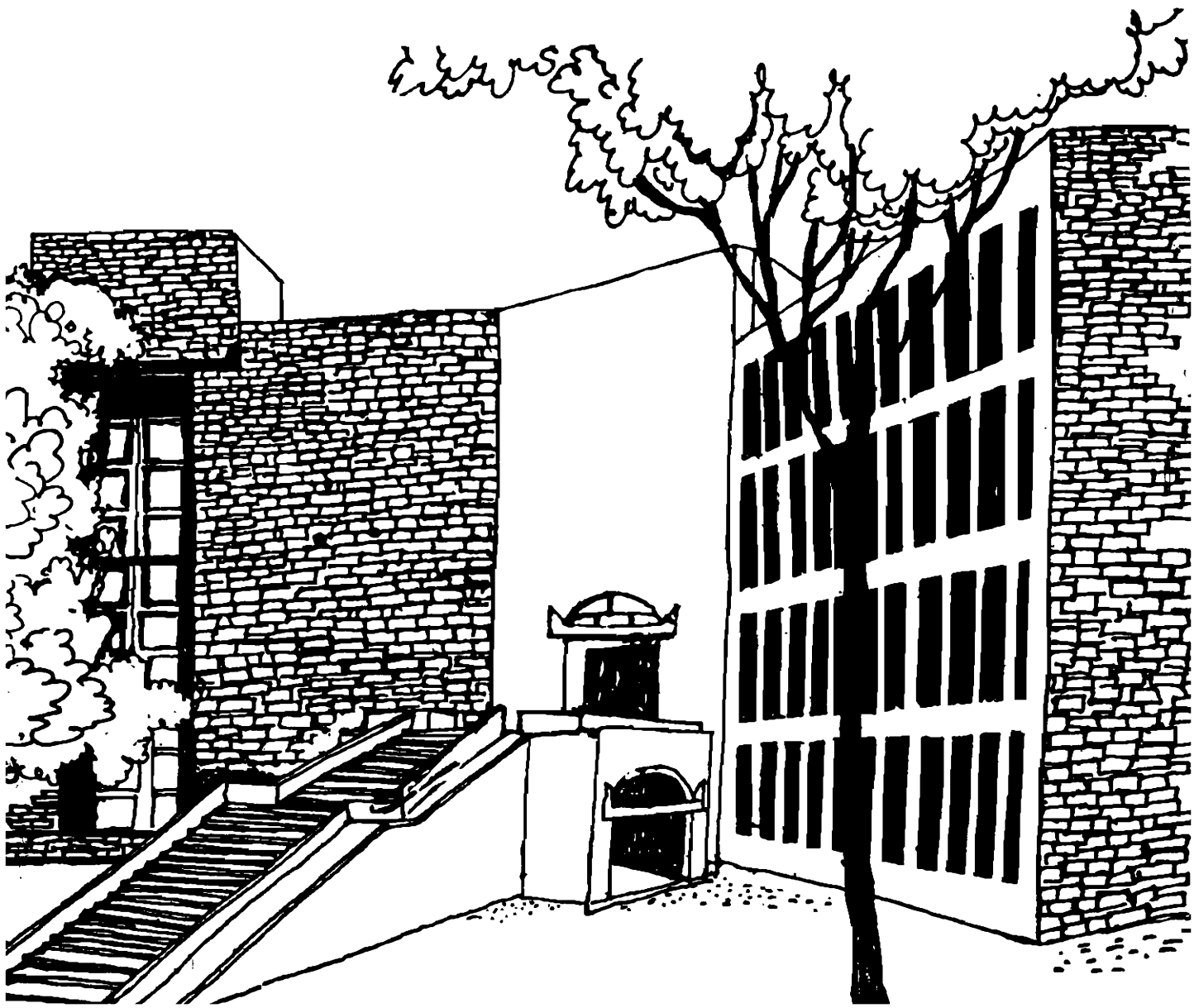

ECONOMETRIC MODELLING OF THE INDIAN COTTON SECTOR : REGIONAL PERSPECTIVE

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Sudhir Kumar Jain and Gopal Naik

Abstract

Since cotton is grown under different agroclimatic and local conditions of the northern, central and southern regions of the country, the performance of cotton production is influenced by the agroclimatic and region-specific factors. In this study, an econometric model has been developed for understanding and quantifying the magnitude of influence of major variables of this industry with the regional perspective of cotton production. This model explains interlinkages among the major variables of cotton farming, spinning and weaving sub-sectors through 16 equations. The estimated model performs satisfactorily in terms of goodness of fit, signs, significance of the coefficients, specifications and short and long term predictability of the model. The system is of oscillating convergence nature. The short and long term multipliers of the exogenous variables of the model have theoretically consistent signs and magnitudes. Forecasts have been made for the period 1995-96 to 2000-2001. The baseline forecasts indicate that the domestic consumption of cotton will increase at a rate higher than the total supply and the total production of cotton. Region-wise forecasts of cotton production show that the production of cotton in the central region will increase at a rate lower (1.5 per cent per annum) than those in other cotton growing regions. The growth rates of the production of cotton in other regions are also not very high. Weather variables, technology, lagged prices of cotton and competing crops, prices of pesticides and fertilizers have been identified as important variables in determining the production of cotton in different regions. In the spinning sector, the export of cotton yarn will increase at a substantially high rate. Therefore, the total demand for cotton yarn is expected to increase at a rate higher than its supply. As a result, the deflated price of cotton yarn will increase substantially during this period. The total consumption and the total production of cotton fabrics will remain almost stagnant. However, the export of the total cotton fabrics will increase at 4.36 per cent per annum.

Econometric Modelling of the Indian Cotton Sector: Regional Perspective

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Introduction

Cotton, an important cash crop and a major raw input for the textile industry, plays a vital role in both agricultural and industrial economy in India. India is one of the major cotton producing as well as consuming countries in the world and accouts for about 25 per cent of the world cotton area. Cotton cultivation generates substantial income and employment in the rural areas, and textiles, its ancillaries and related industries provide employment in the urban and the semi-urban areas in the country. Cotton alone accounts for more than 70 per cent of the total fibre consumption in the textile industry in India. Textile industry accounts for approximately 20 per cent of the total industrial production and 38 per cent of the total exports of the country. The growth of the cotton textile industry and export are directly linked with the performance of cotton crop. As cotton is grown under different agroclimatic and local conditions of the northern, the central and the southern regions of the country, the performance of cotton is influenced by the agroclimatic and region-specific factors. Furthermore, every cotton growing region has its own inherent advantages in and limitations to cotton production. Besides, cotton processing industries located in a particular cotton growing region also prefer to procure the major portion of their raw material from that region itself to minimise their transportation and other transactional costs. Thus, understanding of the behaviour of major variables of this sector with a regional view provides a valuable input for making the appropriate strategies, policies for research and development, investment, production, procurement, financing and marketing. Government's thrust to harness the potential of all cotton growing areas also generates interest in obtaining accurate information regarding the performance of cotton production in the different cotton growing regions. Therefore, this study aims at developing a econometric model with regional perspectives for this sector to generate long run forecasts .

Structure of the Indian Cotton Sector

In the process of converting cotton into fabric, raw cotton (kapas) is first ginned to separate lint and seeds. Cotton lint is spun into yarn either pure or blended with man-made fibres. A small part of total cotton lint produced is used for technical textiles. Cotton yarn is produced mainly in organised mills. In the recent years, Export Oiented Units (EOUs) have also been set up to produce yarn meant only for the export. As a result, major share of the export of cotton yarn comes from these units. Yarn is woven into fabric either pure or blended. Fabric production takes place in either organised mills or decentralised units which comprise powerlooms and handlooms. Organised mills also produce both yarn and fabric in the composite units. Structural changes that have been taking place in the organised mills in the recent years have resulted in the delinking of weaving units from spinning units. Now organised mills mainly confine themselves to the production of spun yarn and high value fabrics and fabrics meant for export to the sophisticated market. As a result, the production of mill cotton fabrics has been declining and the share of decentralised cotton fabrics in the total production of cotton fabrics has been increasing and contributes 94. 6 per cent of the total cotton fabric production in India. Khadi units produce about one per cent of the total production of fabrics.

Popularisation of synthetic fibres, structural and managerial changes in the textile industry, new industrial policy, new emerging economic environment and government's priorities and targets have been influencing the demand for and the supply of yarn and fabrics. Demand for cotton fabrics has also

been changing with the time due to varying preferences for clothes, incomes of the consumers and the thrust of the government on export promotion. There have been major changes in the demand for and the supply of raw inputs and products of cotton industry, viz., cotton staples, yarn count, types of fabrics in terms of source, quality, export and import.

A Regional Overview of the Production of Cotton

Major cotton growing areas comprise nine states of the country which have been grouped into three regions, namely, northern, southern and central regions. The northern region comprises the Punjab, Haryana, and Rajasthan and the central region Madhya Pradesh, Gujarat and Maharashtra states. The major cotton growing states in the southern region are Andhra Pradesh, Karnataka and Tamil Nadu. The central region alone accounts for nearly 56.54 per cent of the total area under cotton followed by the southern region 22.54 per cent and the northern region 20.92 per cent (1994-95). The central region also accounts for 41.33 per cent of the total production followed by the northern region 33.39 per cent and the southern region 25.28 per cent. Other non cotton growing areas contribute less than one per cent in both production and acreage of cotton. A large share of rainfed area under cotton lies in the central region (75 per cent) followed by the southern region (25 per cent). The northern region has almost 100 per cent irrigated area. Therefore, the production of cotton in the southern and the central regions are greatly influenced by rainfall. The northern region produces mainly medium and short staple cotton which are major raw materials for the medium count and hank yarn. In central region, mainly superior long, long and superior medium staples of cotton are grown. In some parts of Madhya Pradesh and Maharashtra, short staples cotton., viz., UP Deshi, MP Oomras are also grown. In the southern region, a score of cotton varieties of fine fibre thrive well. In this region, finest quality of cotton, viz., Suvin, DCH-32, MVS-5 and LRA-5166 which have high market value and suitable to the production of fine fabrics, are produced.

Development and promotion of new high yielding varieties, new technology for cotton and other competing agricultural crops, promotion of cotton cultivation in the new areas, changing farming systems and improvement in irrigation and marketing system have significantly influenced the supply of raw cotton in the country.

Framework of the Model

Indian cotton sector comprises mainly cotton farming, spinning and weaving sub-sectors. Therefore, this study considers these three sectors for the modelling purpose. Since cotton production is influenced by agroclimatic and other region specific factors, we have incorporated separate equations of production for each of the cotton growing region of India, i.e., northern, southern and central regions. However, in spinning and weaving sub-sectors, all equations are in aggregate form. Initially, a conceptual model was developed and it was modified later as per the availability of the data and other limitations. However, we have tried to retain all major equations and variables in the system which sufficiently explain the inter-linkages among the sub-sectors. The knowledge of the special characteristics of the sub-sectors has also been incorporated in the model. Data used in this model pertain to the period 1970-71 through 1994-95. Initial runs were made to remove some insignificant variables. The modified equations of the model are presented below.

Cotton Farming Sector

Total demand for cotton lint at time t (DC_t) is the cumulative demand for cotton lint for domestic consumption (DCC_t), export of cotton lint (EC_t) and domestic stock of cotton lint (DSC_t) at time t. Since inverse demand function of cotton has been used in this model, the market equilibrium identity has been used to explain the domestic consumption of total cotton. Domestic consumption of cotton has been explained as a difference between the supply of cotton and the domestic stock plus the export demand for cotton lint at time t.

$$DCC_t = SC_t - DSC_t - EC_t \quad (1)$$

The price of cotton lint is a function of the domestic consumption of total cotton and price of cotton yarn.

$$PC_t = f(DCC_t, PCY_t) \quad (2)$$

The export and the stock of cotton have been considered as exogenous variables.

Supply identity has been explained as a sum of production of cotton lint (PTC_t), import of cotton lint (IC_t) and domestic stock of cotton lint carried over from the previous year (DSC_{t-1}).

$$SC_t = P_dC_t + IC_t + DSC_{t-1} \quad (3)$$

Import of cotton lint has been considered as an exogenous variable in this model.

Total production of cotton lint at time t ($P_d C_t$) has been explained as a sum of the production of cotton in northern region (PCN_t), southern region (PCS_t), central region at time t (PCC_t) and cotton produced in the other parts of the country (PCOt).

$$P_dC_t = PCN_t + PCS_t + PCC_t + PCO_t \quad (4)$$

Since the production of cotton in other parts of the country constitutes a very small amount of the total production and mainly belong s to local varieties, it has been considered as an exogenous variable in this identity.

The production of cotton at time t in the northern region is a function of the one year lagged price of cotton lint at time t (PC_{t-1}) and price of fertilizers at time t (PF_t), monsoon rainfall (June to September) in the northern region (RNN1) and trend variable which represents the improvement in the technologies.

$$PCN_t = f(PC_{t-1}, TREND, PF_t, RNN1_t) \quad (5)$$

The production of cotton in the southern region at time t (PCS_t) is a function of one year lagged price of cotton at time t (PC_{t-1}), the price of pesticide (PP_t), winter rainfall (January to February) in the southern region (RNS3) and trend variable (TREND).

$$PCS_t = f(PC_{t-1}, PP_t, RNS3_t, TREND) \quad (6)$$

The production of cotton in the central region (PCC_t) is a function of one year lagged price of cotton at time t (PC_{t-1}), percentage area under hybrid cotton (PHC), one year lagged price of bajra at time t (PB_{t-1}), and pre-monsoon rainfall (March to May) in the central region ($RNC4_t$)

$$PCC_t = f(PC_{t-1}, PHC_t, PB_{t-1}, RNC4_t) \quad (7)$$

Spinning Sub-sector

As blended cotton yarn constitues a small share of total production of cotton yarn, this study confines to only pure cotton yarn.

Since cotton yarn is an input in the production of cotton fabrics, the demand for yarn can be represented by a factor demand equation. Total demand for cotton yarn at time t (DCY_t) is the cumulativve demand for the

domestic consumption of cotton yarn ($DCCY_t$), the domestic stock of cotton yarn ($DSCY_t$) and the export of cotton yarn at time t (ECY_t). As inverse demand function for cotton yarn has been specified instead of normal demand function, market equilibrium identity has been used to explain the domestic consumption of total yarn. The domestic consumption of total yarn at time t (DCY_t) has been explained as the difference between the total supply of yarn and the sum of domestic yarn stock and export demand for total yarn.

$$DCCY_t = SCY_t - ECY_t - DSCY_t \quad 8$$

The price of cotton yarn is specified as a function of domestic consumption of total cotton yarn, price of decentralised cotton fabric and export of cotton yarn.

$$PCY_t = f(DCCY_t, PDSCF_t, ECY_t) \quad 9$$

The export demand for cotton yarn at time t has been specified as a function of the price of export of cotton yarn, the stock of cotton yarn, and one year lagged of export of cotton yarn. World price of cotton yarn has not been considered due to its non availability.

$$ECY_t = f(EPCY_t, DSCY_t, ECY_{t-1}) \quad 10$$

Domestic stock of cotton yarn at time t has been considered as an exogneous variable.

The supply identity of cotton yarn is as follows.

$$SCY_t = P_dCY_t + DSCY_{t-1} \quad 11$$

The production of cotton yarn has been explained as the function of the price of cotton (PC_t), price and export of cotton yarn and one year lagged value of the production of cotton yarn at time t. In this equation one year lagged value of the production of cotton yarn has been incorporated to account for the asset fixity nature of the yarn production process.

$$P_dCY_t = f(PCY_{t-1}, PC_t, ECY_t) \quad 12$$

Weaving Sub-sector

Cotton fabrics comprises pure and blended. This study confines to only pure cotton fabrics. In this sub-sector also, inverse demand function has been specified. Hence, market equilibrium identity has been used to explain the domestic consumption of decentralised cotton fabrics. The total domestic consumption of cotton fabrics has been explained as the difference between its total production and its export demand.

$$DCCF_t = P_dCF_t - ECF_t \quad 13$$

Due to lack of data on the price of fabric as a whole, the price of decentralised cotton fabrics (powerloom cotton fabrics) has been considered as the price of fabric .

The price of cotton fabric at time t is a function of the total consumption of cotton fabric at time t ($DCCF_t$), difference of domestic incomes of consecutive periods (GY_t), total export of cotton fabric (ECF_t) and one year lagged price of cotton fabric (PCF_{t-1}) and the price of nylone and mixed cloths ($DNTMC_t$) at time t. Here, the difference of domestic incomes of consecutive period has been considered instead of level value of domestic income to reduce multicollinearity problem.

$PCF_t = f(DCCF_t, PCF_{t-1}, ECF_t, GY_t, DNTMC_t)$ 14

The total export demand for cotton fabrics is a function of the logarithm of export price of cotton fabrics ($LNEPCF_t$), logarithm of world (OECD countries) per capita income ($LNWY_t$) and logarithm of trend as a dummy variable (DV) representing the rapid increase in the export of fabrics after 1992. Logarithm forms of world income and the export price of cotton fabrics have been used instead of their level values to reduce the multicollinearity problem in the equation. Here, the export price of fabrics refers to the export price of powerloom fabrics.

$ECF_t = f(LNEPF_{t-1}, LNWY_t, DV)$ 15

There is no import of cotton fabric. Furthermore due to lack of data on the stock of fabrics, supply of cotton fabrics has been assumed to be equal to its production at time t.

The production of cotton fabrics at time t (P_dCF_t) is a function of the price of cotton fabrics (PCF_t), price of cotton yarn (PCY_t), export of cotton fabrics ($EDSCF_t$), price of the nylone and mixed clothes and dummy variable (DV) representing the rapid increase in the total production of cotton fabrics after 1992

$P_dCF_t = f(PCF_t, PCY_t, ECF_t, DV, DNTMC)$ 16

The identification of the system was done using rank and order conditions to examine the estimabilty of the model. All equations of the system are overidentified. Therefore, system method was used to estimate the model.

Data Adjustments

The data on consumption of total fabric was derived by subtracting the total export of cotton fabric from the total production of cotton fabric. All price variables were deflated by the wholesale price index (WPI) of all commodities (Base year 1970-71). The export prices of yarn and fabrics were adjusted by the exchange rate of rupees versus U.S. dollar (Base year 1980-81). Per capita income of OECD countries at constant prices (1987) was taken as the world income. Wholesale price indices were used for all price variables except for the export prices of yarn, and fabrics. These variables were computed per unit realisation values. Prefix D has been added to the name of all price variables to indicate deflation.

Estimation of the Model

The results of 3SLS estimates of this model is presented below.

Cotton Farming Sub- sector

$DPC_t = 18.95 - 0.240 * DCC_t + 0.864 * DPCY_t$ 2
(1.06) (-2.56) (5.35)
$\mathbf{R^2 = 0.67}$

$P_dCN_t = 8.31 + 0.150 * DPC_{t-1} - 0.035 * DPF_t + 1.340 * TREND - .012 * RNN1_t$ 5
(1.19) (1.44) (-0.34) (4.57) (-1.90)
$\mathbf{R^2 = 0.69}$

$P_dCS_t = 16.85 + 0.026 * DPC_{t-1} - 0.120 * DPP_t + 0.131 * RNS3 + 1.379 * TREND$
(2.10) (0.50) (-2.39) (3.96) (10.93) 6

$R^2 = 0.92$

$P_dCC_t = 14.37 + 0.273 * DPC_{t-1} + 0.249 * PHC_t - 0.159 * DPBT_{t-1} + 0.195 * RNC4_t$ 7
(1.39) (2.86) (3.91) (-2.48) (2.52)
$R^2 = 0.68$

Spinning Sub-sector

$DPCY_t = 67.24 - 0.043 * DCCY_t + 0.858 * DPDSCF_t + 0.214 * ECY_t$ 9
(2.38) (-2.91) (4.06) (6.33)
$R^2 = 0.69$

$ECY_t = 18.79 - 8.88 * DEPCY_t + 0.355 * DSCY_t + 0.915 * ECY_{t-1}$ 10
(0.59) (-0.99) (1.18) (5.06)
$R^2 = 0.91$

$PCY_t = 718.13 - 3.963 * DPC_t + 0.625 * PCY_{t-1} + 1.208 * ECY_t$ 11
(4.52) (-4.87) (5.28) (2.86)
$R^2 = 0.95$

Weaving Sub-sector

$DPCF_t = 48.12 - 0.0028 * DCCF_t + 0.012 * EDCF_t - 0.588 * DPCF_{t-1} + 0.124 * DNTMC_t$ 13
(3.25) (-2.69) (2.62) (-3.39) (0.92)
$+ 0.00023 * GY_t$
(1.12)
$R^2 = 0.75$

$ECF_t = -8863.2 - 90.512 * LNDEPPF_t + 978.240 * LNWY_t + 325.771 * DV$ 14
(-2.43) (-0.50) (2.49) (5.31)
$R_2 = 0.85$

$P_dCF_t = 16131 + 6.45 * DPCF_t - 51.95 * DPCY_t + 1.28 * ECF_t + 2701.6 * DV$ 15
(16.31) (0.37) (-3.90) (2.37) (10.48)
$-14.19 * DNTMC_t$
(-1.43)
$R^2 = 0.95$

(Figures in the parenthesis are asymptotic t-values)

Identities

$DCC_t = SC_t - DSC_t - EC_t$ 1
$SC_t = P_dC_t + IC_t + DSC_{t-1}$ 3
$P_dC_t = PCN_t + PCS_t + PCC_t + PCO_t$ 4
$DCCY_t = SCY_t - DSCY_t - ECY_t$ 8
$SCY_t = P_dCY_t + DSCY_{t-1}$ 11

$DCCF_t = P_dCF_t - ECF_t$ 16

Definitions of Variables Used

Endogenous Variables

DPC	Deflated wholesale price index of cotton	
DCC	Domestic consumption of cotton (Lakh bales)	
SC	Supply of cotton	(Lakh bales)
P_dC	Production of cotton	(Lakh bales)
PCN	Production of cotton in northern region	(Lakh bales)
PCC	Production of cotton in southern region	(Lakh bales)
PCS	Production of cotton in central region	(Lakh bales)
PCO1	Production of cotton in other region	(Lakh bales)
DPCY	Deflated wholesale price index of cotton yarn	
DCCY	Domestic consumption of cotton yarn	(Thousand tonnes)
ECY	Export of cotton yarn	(Thousand tonnes)
SCY	Supply of cotton yarn	(Thousand tonnes)
P_dCY	Production of cotton yarn	(Thousand tonnes)
DPCF	Deflated wholesale price index of cotton fabric	
DCCF	Domestic consumption of cotton fabric	(Million square metres)
ECF	Export of cotton fabrics	(Million square metres)
SCF	Supply of decentralised cotton fabrics	(Million square metres)
P_dCF	Production of decentralised cotton fabrics	(Million square metres)

Exogenous Variables

DSC	Total domestic stock of cotton	(Lakh bales)
EC	Total export of cotton	(Lakh bales)
IC	Total import of cotton	(Lakh bales)
DSCY	Domestic stock of cotton yarn	(Thousand tnnes)
RNN1	Monsoon rainfall in northern region (June to September)	

RNS3	Winter rainfall in southern region (January to February)	
RNC4	Pre-monsoon rainfall in central region (March to May)	
DPP	Deflated wholesale price index of pesticides	
PHC	Percentage area under hybrid cotton	
DPF	Deflated wholesale price index of fertilizers	
DPB	Deflated wholesale price index of bajra	
DEPCY	Deflated export Price of Cotton Yarn	(Dollar/Kg)
GY	Difference of domestic income (at costant price)	(Crores Rs./Annum)
DNTMC	Deflated wholesale price index of blended mixed cotton cloth	
LNWY	Logarithm of per capita income of OECD countries at constant prices (US Dollars)	
LNDEPPCF	Logarithm of deflated export price of powerloom cotton fabrics	(US Dollar per sq. metres)
TREND	Time trend	
DV	Dummy variable	

R^2 values of the equations of the model show that the estimated equations have reasonably good fit. The extent of variations in the dependent variables explained by explanatory variables are high. In the cotton farming sub-sector also, R^2 values of the estimated equations are reasonably good. The regression coefficients of all the explanatory variables have expected signs.

The estimated inverse demand equation of cotton reveals that about 67 per cent variability in the deflated price of the cotton has been explained by the consumption of cotton and the deflated price of cotton yarn. All explanatory variables are significant at one per cent level. One year lagged value of deflated price of cotton, deflated price of fertilizers, monsoon rainfall (June to Sept) in the northern region and trend variable representing the improvement in the technologies explain jointly 69 per cent variations in the production of cotton in the northern region. Trend and monsoon rainfall are significant at one per cent level. Lagged deflated price of cotton is significant at 10 per cent level. Deflated price of fertilizers is insignificant. Monson rainfall has negative sign as excess monsoon rain in this region might have adverse impact on the production of cotton The price of pesticides was not significant, it may be due to inelastic demand for pesticides as infestation of pests and diseases are significant in this region. The estimated production of cotton equation in the southern region has a very good fit as evident from its high R^2 values. Approximately 92 per cent variations in the production of medium staple cotton is explained by the explanatory variables namely, lagged price of cotton, deflated price of pesticides, winter rainfall in southern region and trend variable representing the improvement in the technologies. All explanatory variables except one year lagged deflated price of cotton are highly significant at one per cent level. The estimated equation of production of cotton in the central region also has fairly good fit. Lagged deflated price of cotton, percentage area under hybrid cotton, deflated price of bajra and pre-monsoon rainfall jointly explain about 68 per cent variations in the production of

cotton in the central region. All explanatory variables are significant at one per cent level. The significance of lagged deflated price of cotton and competing crop, bajra, implies that prices of cotton and its competing crop are important in the central region for the determing the area under cotton. High significance of the coefficient of pre-monsoon rainfall in this region also shows that pre-monson is a crucial for the good cotton crop in this region. Increasing area under hybrid cotton has also influenced the production of cotton in this region significantly. Overall, results show that weather variable, technology, prices of cotton and competing crop, pesticides, fertilizers are the important variables which influence the production of cotton. However, their importance in determing the production of cotton varies with the region.

The estimated inverse demand function of cotton yarn has a reasonably good fit. About 69 per cent of the variability in the price of cotton yarn has been jointly explained by the domestic consumption of cotton yarn, deflated price of fabric and export of cotton yarn. All explanatory variables are significant at one per cent level. The estimate indicates that price of cotton yarn is influenced significantly by the price of cotton fabric. In case of export of cotton yarn, the export price of cotton yarn, domestic stock of cotton yarn and one year lagged export of cotton yarn explain jointly approximately 91 per cent variations in the export of cotton yarn. However, only one year lagged value of export of cotton yarn is significant at one per cent level. The estimated equation of cotton production has a very good fit as evident from its high R^2 value. Deflated price of cotton, one year lagged production of cotton yarn and export of cotton yarn together explain about 95 per cent variations in its production. All the explanatory variables are significant at one per cent probability and have expected signs.

The estimated inverse demand function of cotton fabrics has reasonably good fit. R^2 value reveals that about 75 per cent variability in the price of cotton fabrics has been explained by total consumption of cottton, one year lagged deflated price of decentralised cotton fabrics, difference of domestic income of consecutive periods and export of cotton fabrics. All these explanatory variables except difference of domestic income of consecutive periods are significant at one per cent probability. About 85 per cent variations in total export of cotton fabrics has been explained by deflated export price of cotton fabrics, per capita income of OECD countries and dummy variable representing changes in the current years. All the explanatory variables except the deflated price of export of cotton fabrics are significant at one per cent level. The estimated equation of the production of cotton fabrics also has a very good fit. The deflated price of cotton fabrics, total export of cotton fabrics, deflated price of cotton yarn, dummy variables representing the rapid increase in the production and the deflated price of nylone terelene mixed cloth explain jointly about 95 per cent variations in the total production of cotton fabrics. All explanatory variables except deflatd price of cotton fabrics and the price of nylone and mixed clothes are significant at one per cent level. The coefficients of all explanatory variables have expected sings. The deflated price of the decentralised cotton fabrics is not significant. It implies that the production of cotton fabrics is determined by the price of cotton yarn, the export demand for cotton fabrics and the trend.

Overall, the signs and significance of coefficients are consistent with the theory and goodness of fit of the equations in the model, in general, has been satisfactory. Therefore, the estimated coefficients can be used for analysis of this industry for the further analysis.

Validation of the Model

The main purpose of the validation of the model is to ascertain the ability of the model to replicate the

real world situation accurately. For the present model, appropriateness of the theoretical specifications and the statistical tests of the estimated equations/parameters along with the performance of the model in tracking the historical period of fit have been used to test its validity. For validity the model as a dynamic system, evaluation of the stability of the model, its ability to simulate historical data have been examined. Stability condition of the model was examined by computing the latent roots of the matrix of the reduced form coefficients of the lagged endogenous variables. None of the latent roots of the matrix is greater than one which indicates that the system is stable. Since the dominant root of this matrix is negative (-0.92), the system will show oscillating convergence.

Predictive Performance of the Model

For the validation of the performance of the model both static and dynamic simulations[1] were done. Static simulation was done for the period 1972-73 to 1994-95. Dynamic simulation was done for two periods: twenty three-year period (1972-73 to 1994-95) and five-year period (1990-91 to 1994-95) using both actual and forecasted values of exogenous variables.

The model generated historical predictions was compared with the actual values of the endogenous variables using the following criteria.

(a) Percentage Root Mean Square Error (PRMSE)
(b) Theil Inequality Coefficients (U_2)

PRMSE

The PRMSE values show that the model gives reasonably good forecast of the endogenous variables

Table 1: PRMSE Values of Static and Dynamic Simulations

Endogenous Variables	Types of Simulations			
		Dynamic Simulation		
	Static Simulation	23 Yrs. (a)	5 Yrs (a)	5 Yrs (b)
DCC	7.74	9.47	9.53	8.96
SC	5.85	7.19	5.85	5.40
P_dC	7.98	9.88	7.54	6.95
PCN	20.90	19.60	14.82	15.65
PCS	13.42	13.43	7.26	5.89
PCC	14.22	17.95	10.92	9.92
DPC	15.72	16.35	15.69	13.95
DCCY	7.00	8. 43	5.73	6.42
ECY	75.73	100.54	9.98	7 .52
SCY	6.55	7.71	4.45	5.49
P_d CY	6.72	7.92	4.70	5.08
DPCY	8. 02	13.34	8.02	7.88
DCCF	5.99	6.48	5.30	4.90
ECF	25.94	25.94	11.13	11.95
P_dCF	5.75	6.53	5.23	4.88
DPCF	5.75	8.22	1.82	2.69

Note: (a) Dynamic simulation with actual values of exogenous variables
(b) Dynamic simulation with forecaste values of exogenous variables

[1] Static simulation generates one year ahead predictions of the endogenous variables for a given set of conditions, i.e., the values of the predetermined variables. In static simulation, the values of the exogenous variables and lagged endogenous variables are set at their actual values for each period. Dynamic simulation involves generating solutions for a system for more thaan one period of time. The values of exogenous variables and the initial period lagged endogenous variables are set at their actual values.

for the historical period (Table1). PRMSE of all price variables are sufficiently low in the static simulation. However, the price of cotton is relatively high. PRMSE values of quantity variables except the export variables are also sufficiently low. PRMSE values of production of cotton in northern, southern and central regions are relatively high. PRMSE value of export of cotton yarn is very high because of small quantity of export in the early periods and varying government policies. PRMSEvalues of the most of the endogenous variables in dynamic simulations for the complete historical period has increased marginally as compared to the PRMSE values in the static simulations. Increase in the PRMSE values of ECY, DPCY and DPCF is relatively larger. However, PRMSE value of the production of cotton in northern region has declined in the dynamic simulation for complete historical period. In case of dynamic simulation for the last 5 years of the historical period (1990-91 to 94-95) using actual values of exogenous variables, PRMSE values of the most of the endogenous variables have declined as compared to the corresponding PRMSE values in the static simulation for the complete historical period. The decline in the PRMSE values of export variables, the production of cotton in southern region and the deflated price of cotton fabric is considerably high. This further supports the model's tracking ability of the actual values of endogenous variables. However, PRMSE values of consumption of cotton has marginally increased. PRMSE values of most of the endogenous variables in dynamic simulation for the current five year period using the forecasted values of exogenous variables are also either close to or less than their corresponding PRMSE values in the dynamic simulation for five year period using actual values. However, in case of PCN,DCCY, SCY and P_dCY, PRMSE values have increased marginally.

Theil's Coefficient

Theil's Coefficients of all the endogenous variables are less than one in all four types of simulations except for domestic consumption of cotton in dynamic simulations (Table 2). This also indicates that the model performs reasonably well and are consistent with the findings of the PRMSE statistics.

Table 2: Theil Inequality Coefficients (U_2) of Static and Dynamic Simulations

Endogenous Variables	Types of Simulations			
		Dynamic Simulation		
	Static Simulation	23 Yrs (a)	5 Yrs (a)	5 Yrs (b)
DCC	0.71	1.14	1.36	1.20
SC	0.13	0.21	0.21	0.18
P_dC	0.13	0.21	0.19	0.16
PCN	0.43	0.38	0.24	0.26
PCS	0.21	0.22	0.27	0.17
PCC	0.18	0.26	0.13	0.11
DPC	0.35	0.29	0.27	0.23
DCCY	0.45	0.72	0.35	0.45
ECY	0.28	0.31	0.07	0.03
SCY	0.38	0.55	0.31	0.48
P_dCY	0.41	0.60	0.32	0.39
DPCY	0.27	0.72	0.26	0.25
DCCF	0.28	0.35	0.18	0.16
ECF	0.39	0.39	0.28	0.31
P_dCF	0.28	0.40	0.18	0.16
DPCF	0.33	0.66	0.06	0.13

Note: (a) Dynamic simulation with actual values of exogenous variables
(b) Dynamic simulation with forecasted values of exogenous variables

Adequacy of Model Specifications

The mean square simulation error is decomposed into bias, variance and covariance components to examine the adequacy of the model specifications. The values of these components indicate reasonably good specification of the model (Table 3). The bias components of the all endogenous variables in static and dynamic simulations are close to zero. The variance components of all endogenous variables except deflated price of cotton is also close to zero in static simulation. In dynamic simulation, variance components of most of the endogenous variables is also close to zero. However, the variance component of endogenous variables of spinning sector, namely DCCY, ECY, SCY, PdCY and deflated price of cotton and fabric is slightly higher than zeo in the dynamic simulation. Moreover, in case of the most of the endogenous variables, the proportion of the unsystematic error accounts for most of the inequality in the predicted and the actual values.

Table 3: Components of Mean Squared Error for Static and Dynamic Simulation as Proportion of Total

Endogenous Variable	Static Simulation			Dynamic Simulation		
	Ubias	Uvar	Ucov	Ubias	Uvar	Ucov
DCC	0.01	0.07	0.92	0.03	0.21	0.76
SC	0.00	0.00	1.00	0.02	0.04	0.94
P_dC	0.00	0.01	0.99	0.01	0.01	0.98
PCN	0.00	0.04	0.96	0.00	0.01	0.99
PCS	0.00	0.03	0.97	0.00	0.02	0.98
PCC	0.00	0.04	0.96	0.01	0.01	0.98
DPC	0.01	0.18	0.81	0.00	0.19	0.81
DCCY	0.00	0.03	0.97	0.01	0.23	0.76
ECY	0.00	0.01	0.99	0.06	0.26	0.68
SCY	0.00	0.00	1.00	0.00	0.15	0.85
P_dCY	0.00	0.00	1.00	0.01	0.14	0.85
DPCY	0.01	0.06	0.93	0.07	0.02	0.91
DCCF	0.00	0.00	1.00	0.03	0.08	0.89
ECF	0.00	0.05	0.95	0.00	0.05	0.95
P_dCF	0.00	0.00	1.00	0.03	0.07	0.90
DPCF	0.00	0.05	0.95	0.04	0.09	0.87

Note: (a) Dynamic simulation with actual values of exogenous variables
(b) Dynamic simulation with forecasted values of exogenous variables

Ex-post Forecast Performance

The ex-post forecasts of the model for the year 1995-96 for the available data shows that model's performance is satisfactory (Table 4).

Multipliers

Multipliers are potentially useful tools for analysis the impact of a change in the exogenous variable on the values of the endogenous variables in a dynamic system. The multipliers computed indicate that the domestic stock of cotton has a negative impact on the domestic consumption of cotton, consumption, supply and production of cotton yarn, and consumption, and production of cotton fabric (Table 5). It has positive impact on the deflated price of cotton, yarn and cotton fabric. Its impact is larger on the deflated price of cotton in the short run. Other endogenous variables have almost no impact in the short run. Impact of the domestic stock of cotton increases on almost all the endogenous variables of cotton farming, spinninga and weaving sub-sectors except domestic consumption of cotton in the long run. Its impact declines on the consumption of cotton in the long run (Table 6). The results of the short and

long run elasticity show that the domestic consumption of cotton has a relatively high responsiveness (0.30) to the domestic stock of cotton followed by the deflated price of cotton (-0.10) in short run whereas, in the long run, deflated price of cotton responds more than domestic consumption of cotton (appendix 1(a) and 1(b)). Other endogenous variables of the system also respond more to the change in the domestic stock of cotton in the long run than in the short run.

Table 4 : Ex-post Forecast Performance of the Model for the Year 1995-96

Endogenous Variables	Values of Endogenous Variables		Deviation from Actual Values in Per cent
	Actual	Forecast	
DCC	151.5	150.97	-0.35
SC	196.02	187.26	-4.47
PC	160.0	159.88	-0.08
PCN	39.90	48.66	21.95
PCS	44.05	48.73	10.62
PCC	74.80	61.74	-17.46
DPC		88.0	
DCCY	1464.6	1400.17	-4.40
ECY	262.61	267.13	1.72
SCY		1813.53	
PCY	1788	1683.47	-5.85
DPCY		121.85	
DCCF	17374.70	16357.32	-5.86
ECF	1525.29	1616.03	5.94
PCF	18900.00	17973.35	-4.90
DPCF		67.2	

Note: Simulated values for 1995-96 has been obtained through bsse line dynamic simulation

The short and long run impact of the export of cotton is same as the impact of domestic stock of cotton on the endogenous variables in the system. The short and long run impact multiplier of the lagged domestic stock, import of cotton and production of cotton in other states are similar to short and long term impact of domestic stock and export of cotton in terms of magnitude but in opposite direction. All endogenous variables in the system are almost inelastic to the export and the import of cotton in both short and long run. The endogenous variables in the system respond to lagged domestic stock of cotton similar to domestic stock of cotton in terms of magnitude in both short and long run.

Deflated price of fertilizers has a negative impact on the consumption, total supply, total production of cotton, production of cotton in the northern region, domestic consumption, supply and production of cotton yarn and consumption and production of total cotton fabric in the short run. It has a marginal positive impact on the other endogenous variables. Its impact on the production of cotton in the northern region is relatively high in the short run. In the long run, its impact declines marginally on total consumption, total supply, total production of cotton and the production of cotton in the northern region. Its impact increases in case of other endogenous variables. Its multiplier impact is larger in case of consumption and production of fabric in the long run. The results of the elasticities also show that the the production of cotton in the northern region responds to the change in the deflated price of

fertilizers relatively high in the short and long run. However, its responsiveness declines marginally in the long run.

Deflated price of pesticides have a relatively high negative impact on the consumption and production of cotton fabric followed by domestic consumption, supply and production of cotton yarn and total consumption, supply, production of cotton and production of cotton in the southern region. Its impact increases in the long run on the endogenous variables of spinning and weaving sectors and declines on the endogenous variables of cotton sector. Price variables of cotton, yarn and fabric experiences low impact in the both short and long run. Elasticities also indicate that the production of cotton in the southern region is highly sensitive to the price of the pesticides in both short and long run.

The short run multiplier of the percentage area under hybrid cotton in the central region has a positive impact on all the endogenous variables except price variables in both short and long run. It has relatively large impact on the consumption and production of cotton fabric and cotton yarn in both short and long run. Its impact increases on the endogenous variables of fabric and yarn in the long run. However, its impact declines marginally on the consumption, supply and production of cotton. The productions of cotton in the northern and the southern regions also experience in the long run. The deflated prices of cotton, yarn and fabric also experience relatively low negative impact in both short and long runs. The results of the elasticities also show that the production of cotton in the central region responds relatively high in the long run as compared to in the short run. The elasticities of other endogenous variables also increase in the long run.

The deflated price of bajra has a negative impact on all the endogenous variables except the price variables in the system. A unit change in the deflated price of bajra would bring a change of -0.16 unit in the total domestic consumption, total supply and total production of cotton and the production of cotton in the central region and -0.18 unit in the domestic consumption of cotton yarn, supply, and production of cotton yarn. The domestic consumption and production of fabric would experience a change of -0.46 unit as a result of one unit change in the deflated price of bajra in the short run. Its impact on the endogenous variables of cotton farming sector declines whereas, its impact increases substaintially on the endogenous variables of cotton yarn and fabric in the long run. However, the extent of increase in its impact in the long run is larger on the domestic consumption and production of cotton fabric. Elasticities of the endogenous variables also corroborate this findings.

The domestic stock of cotton yarn has a positive impacts on the export, supply,production of cotton yarn and deflated price of cotton,cotton yarn and cotton fabric. It has a large negative impact on domestic consumption of cotton yarn,and consumption and production of cotton fabric. The impact on these variables increase in the long run as compared to its multiplier impact in the short run. The domestic consumption, supply and production of cotton, productions of cotton in northern, southern and central regions experience positive impact in the long run. The elasticity also shows that the export of cotton yarn responds relatively high to the change in the stock of cotton yarn as compared to the other endogenous variables in the short run. In the long run, the consumption and the production of cotton fabric are highly elastic to the changes in the stock of cotton yarn as compared to other endogenous variables. However, export of cotton yarn shows high responsiveness to the change in the stock of the cotton yarn in the long run.

The deflated export price of cotton has a large negative impact on the export of cotton yarn, deflated

Table 6: Short run Multiplier of the Exogenous Variables for the Endogenous Variables

Endogenous Variables	Exogenous Variables																			
	DSC	EC	IC	DSC_{t-1}	PCO	DPF	TREND	RNS3	DPP	PHC	DPB	RNC4	DSCY	EPCY	$DSCY_{t-1}$	DEPF	WY	DI	DNTMC	DV	RNN1
DCC	-1.00	-1.00	1.00	1.00	1.00	-0.04	2.72	0.13	-0.12	0.25	-0.16	0.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01
SC	0.00	0.00	1.00	1.00	1.00	-0.04	2.72	0.13	-0.12	0.25	-0.16	0.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01
PC	0.00	0.00	0.00	0.00	1.00	-0.04	2.72	0.13	-0.12	0.25	-0.16	0.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01
PCN	0.00	0.00	0.00	0.00	0.00	-0.04	1.34	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01
PCS	0.00	0.00	0.00	0.00	0.00	0.00	1.38	0.13	-0.12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PCC	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.25	-0.16	0.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
DPC	0.29	0.29	-0.29	-0.29	-0.29	0.01	-0.78	-0.04	0.04	-0.07	0.05	-0.06	0.14	-2.15	-0.05	-1.01	10.94	0.00	0.16	-3.90	0.00
DCCY	-1.14	-1.14	1.14	1.14	1.14	-0.05	3.11	0.15	-0.14	0.29	-0.18	0.22	-1.47	6.68	1.20	4.01	-43.31	-0.00	-0.65	15.44	-0.01
ECY	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.36	-8.88	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SCY	-1.14	-1.14	1.14	1.14	1.14	-0.05	3.11	0.15	-0.14	0.29	-0.18	0.22	-0.11	-2.20	1.20	4.01	-43.31	-0.00	-0.65	15.44	-0.01
PCY	-1.14	-1.14	1.14	1.14	1.14	-0.05	3.11	0.15	-0.14	0.29	-0.18	0.22	-0.11	-2.20	0.20	4.01	-43.31	-0.00	-0.65	15.44	-0.01
DPCY	0.06	0.06	-0.06	-0.06	-0.06	0.00	-0.15	-0.00	0.00	-0.01	0.00	-0.01	0.16	-2.49	-0.06	-1.17	12.66	0.00	0.19	-4.51	0.00
DCF	-2.86	-2.86	2.86	2.86	2.86	-0.11	7.77	0.37	-0.34	0.71	-0.46	0.56	-8.16	127.23	3.01	28.01	-302.63	-0.01	-22.80	2998.72	-0.03
ECF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-90.51	978.00	0.00	0.00	326.00	0.00
PCF	-2.86	-2.86	2.86	2.86	2.86	-0.11	7.77	0.37	-0.34	0.71	-0.46	0.56	-8.16	127.23	3.01	-62.50	675.37	-0.01	-22.80	3324.72	-0.03
DPCF	0.00	0.00	-0.00	-0.00	-0.00	0.00	-0.02	-0.00	0.00	-0.00	0.00	-0.00	0.02	-0.36	-0.00	-1.17	12.58	0.00	0.19	-4.48	0.00

Table 7: Long Run Multiplier of the Exogenous Variables for the Endogenous Variables

Ecdogenous Variables	Exogenous Variables																			
	DSC	EC	IC	DSC_{t-1}	PCO	DPF	TREND	RNS3	DPP	PHC	DPB	RNC4	DSCY	EPCY	$DSCY_{t-1}$	DEPF	WY	DI	DNTMC	DV	RNN1
DCC	-0.81	-0.81	0.81	0.81	0.81	-0.03	2.19	0.11	-0.10	0.20	-0.13	0.16	0.57	-13.00	-0.04	-2.01	21.73	0.00	0.32	-7.75	-0.00
SC	0.20	0.20	0.81	0.81	0.81	-0.03	2.19	0.11	-0.10	0.20	-0.13	0.16	0.57	-13.00	-0.04	-2.01	21.73	0.00	0.32	-7.75	-0.00
PC	0.20	0.20	-0.20	-0.20	0.81	-0.03	2.19	0.11	-0.10	0.20	-0.13	0.16	0.57	-13.00	-0.04	-2.01	21.73	0.00	0.32	-7.75	-0.00
PCN	0.07	0.07	-0.07	-0.07	-0.07	-0.04	1.16	-0.00	0.00	-0.02	0.01	-0.01	0.19	-4.34	-0.01	-0.67	7.26	0.00	0.11	-2.59	-0.01
PCS	0.01	0.01	-0.01	-0.01	-0.01	0.00	1.35	0.13	-0.12	-0.00	0.00	-0.00	0.03	-0.75	-0.00	-0.12	1.26	0.00	0.02	-0.45	0.00
PCC	0.12	0.12	-0.12	-0.12	-0.12	0.00	-0.32	-0.02	0.01	0.22	-0.14	0.17	0.35	-7.90	-0.03	-1.22	13.21	0.00	0.20	-4.71	0.00
DPC	0.43	0.43	-0.43	-0.43	-0.43	0.02	-1.18	-0.06	0.05	-0.11	0.07	-0.08	1.27	-28.95	-0.10	-4.48	48.40	0.00	0.72	-17.25	0.00
DCCY	-4.58	-4.58	4.58	4.58	4.58	-0.18	12.44	0.60	-0.55	1.14	-0.73	0.89	-4.40	59.18	2.00	47.30	-511.15	-0.01	-7.63	182.16	-0.05
ECY	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.50	-111.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SCY	-4.58	-4.58	4.58	4.58	4.58	-0.18	12.44	0.60	-0.55	1.14	-0.73	0.89	1.10	-51.82	2.00	47.30	-511.15	-0.01	-7.63	182.16	-0.05
PCY	-4.58	-4.58	4.58	4.58	4.58	-0.18	12.44	0.60	-0.55	1.14	-0.73	0.89	1.10	-51.82	1.00	47.30	-511.15	-0.01	-7.63	182.16	-0.05
DPCY	0.28	0.28	-0.28	-0.28	-0.28	0.01	-0.76	-0.04	0.03	-0.07	0.04	-0.05	1.63	-37.12	-0.12	-5.74	62.06	0.00	0.93	-22.12	0.00
DCF	-13.82	-13.82	13.82	13.82	13.82	-0.55	37.58	1.81	-1.66	3.45	-2.21	2.69	-80.92	1847.12	6.04	245.14	-2648.87	-0.06	-57.82	3834.87	-0.16
ECF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-90.51	978.00	0.00	0.00	326.00	0.00
PCF	-13.82	-13.82	13.82	13.82	13.82	-0.55	37.58	1.81	-1.66	3.45	-2.21	2.69	-80.92	1847.12	6.04	154.63	-1670.87	-0.06	-57.82	4160.87	-0.16
DPCF	0.09	0.09	-0.09	-0.09	-0.09	0.00	-0.26	-0.01	0.01	-0.02	0.02	-0.02	0.55	-12.61	-0.04	-4.32	46.71	0.00	0.70	-16.65	0.00

price of cotton and yarn and supply and production of cotton yarn and relatively less negative impact on cotton fabric in the short run. It has a substantially high positive impact on the consumption, production of cotton fabrics and domestic consumption of cotton yarn. In the long run, the impact of on these endogenous variables increases.The endogenous variables total domestic consumption, total supply, total production of cotton and productions of cotton in northern, southern and central regions also experience its negative impact in the long run. The extent of increase of long run impact on theconsumption and production of cotton fabrics is substantially high as compared to other endogenous variables. The export of cotton yarn is highly responsive to the change in the deflated export price of cotton as compared to other endogenous variables in the systems in the short run. In the long run, however, consumption and production of cotton fabrics shows marginally higher responsiveness.

The lagged stock of cotton yarn influences positively the domestic consumption, supply of cotton yarn and consumption and production of cotton fabrics in the short run. It has a marginal positive impact on the production of cotton yarn in the short run. In long run, the impact of lagged stock of cotton yarn increases on these variables. However, the extent of increase of its impact on the consumption and production of cotton fabrics is higher than on other endogenous variables. It has almost no impact on consumption, supply, production and productions of cotton in northern, central and southern regions. However, they experience its negative impact in the long run. Exports of cotton yarn and fabrics do not experience any impact neither in the short run nor in the long run.

The export price of cotton fabrics has a large negative impact on the consumption, production and total export of cotton fabrics and marginal negative impact on prices of cotton, yarn and cotton fabrics in both short and long run. It has a positive impact on the consumption, supply and production of cotton yarn in both short and long run. In the long run, its impact increases substantially on the consumption, the production of cotton fabrics whereas, in case of price of cotton, yarn and cotton fabrics, its impact declines. It has no impact on the domestic consumption, the supply and the production of cotton and productions of cotton in northern, southern and central regions. But they experience negative impact in the long run. It has no impact on the export of cotton yarn in both short and long run. The total export of cotton fabrics shows high responsiveness to the changes in the deflated export price of cotton fabrics in both short and long run.

The world per capita income has a large positive impact on the total consumption, the production and the export of cotton fabrics in both short and long run. It also influences positively the deflated price of cotton and cotton yarn in both short and long run. It has a negative impact on the consumption, the supply and the production of cotton yarn of equal amount in the both short and long run. However, its impact on the consumption, the production and the export of fabrics considerably increases in the long run. It has no impact on the consumption, the supply and the total production and the production of cotton in the northern, the southern and the central regions in the short run. These variables experiences its marginal positive impact in the long run. The export of cotton yarn has no impact of the change in the world per capita income. The results of elasticity in the both short and long run corroborate this findings. The elasticity results show that the

exports of cotton fabrics responds high to the change in the world per capita income in both short and long run.

The multiplier of the domestic income has negligible impact on the endogenous variables of the system in the both short and long run. The results of elasticities also corroborate this findings.

The deflated price of blended and nylon clothes has a high negative impact on the consumption and production of cotton fabrics and marginal positive impact on the price of cotton fabrics in both short and long run. It also has negative impact on the domestic consumption, the supply and the production of cotton in both short and long run. Prices of cotton and yarn also experience positive impact as a result of change in the deflated price of blended and nylon clothes. Multiplier of deflated price of blended and nylone cloth does not influence the consumption, the supply, the total production of cotton and the productions of cotton in northern, the southern and the central regions in the short run but they experience marginal its positive impact in the long run. The export of cotton yarn and fabrics do not experience any impact neither in the short run nor in the long run. The results of elasticities also corroborate this findings.

Simulation of the Model

Given the satisfactory performance of the model as a dynamic system, dynamic simulation was carried out for the period 1995-96 through 2000-2001. The actual values of the endogenous variables for the year 1994-95 were used as values for the initial year lagged endogenous variables. Forecasts of the exogenous variables were made using the best fit trend equations. However, the values of domestic stock of cotton, export of cotton and import of cotton were set at the mean value of the period from 1990-91 to 1994-95 as the trend regressions for these variables had a poor fit. Dynamic simulation for different policy options were also carried out to assess the impact of different policy option on the Indian cotton textile industry.

Base-line Simulation of the Model

The domestic consumption of cotton will increase at a compound growth rate of 2.81 per cent per annum and will reach a level of 169.38 lakh bales by 2000-2001 (Table 8). Total supply of cotton will increase at a growth rate of 2.28 per cent per annum which is less than the growth rate of the consumption. Total production of cotton will grow at a rate of 2.65 per cent per annum which is

Table 8: Base-line Simulatied Values of the Endogenous Variables for the period 1995- 96 through 2000-2001

Year	DCC	SC	P_dC	PCN	PCS	PCC	DPC
1995	150.97	187.26	.159.88	48.66	48.73	61.74	88
1996	144.01	180.3	152.92	46.74	49.65	55.78	95.83
1997	150.36	186.65	159.27	49.26	51.34	57.92	101.92
1998	155.92	192.21	164.83	51.53	52.97	59.58	109.78
1999	162.28	198.57	171.19	54.07	54.64	61.73	119.33
2000	169.38	205.67	178.29	56.85	56.35	64.34	130.75
CGR	2.81	2.28	2.65	3.66	3.03	1.55	8.06

Note: CGR : Compound Growth Rate

slightly higher than that of total supply of cotton but remains lower than the growth rate of consumption. It is expected that the production of cotton would reach the level of 178.29 lakh bales by 2000-2001. The region-wise forecasts of cotton production show that the production of in the

northern region cotton would increase at a rate of 3.66 per cent per annum from 48.66 to 56.85 lakh bales. The production of cotton in the southern region will grow at a rate of 3.03 per cent per annum. The production of cotton in the central region will increase relatively at a slower rate (1.55 per cent per annum). The deflated price of cotton is expected to grow at a rate of 8.06 per cent during this period. The export of cotton yarn will increase at a high rate (14.65 per cent per nnum) during the simulation period. It would reach 529.78 thousand tonnes by 2000-2201 AD. High growth rate of export of cotton yarn is achieved mainly due to the setting up of a large number of

...Continue Table 8: Base-line Simulation Values of the Endogenous Variables for the period 1995-96 through 2000-2001

Year	DCCY	ECY	SCY	P_dCY	DPCY	DCCF	ECF	PdCF	DPCF
1995	1400.17	267.13	1813.53	1683.47	121.85	16357.32	1616.03	17973.35	67.2
1996	1436.92	309.37	1910.64	1764.41	128.98	16595.29	1704.41	18299.7	66.81
1997	1470.86	356.19	2011.8	1847.45	137.79	16720.66	1789.53	18510.19	67.1
1998	1499.87	408.12	2115.66	1930.91	148.44	16695.8	1858.27	18554.06	68.02
1999	1523.37	465.75	2222.59	2014.91	161.26	16538.81	1933.43	18472.23	69.76
2000	1540.79	529.78	2333	2099.54	176.44	16234.82	2005.42	18240.23	72.36
CGR	1.94	14.65	5.17	4.52	7.70	-0.14	4.36	0.30	1.48

Note: CGR: Compound Growth Rate

export oriented units in the spinning sector. The supply and production of cotton yarn would grow at a rate higher than consumption of cotton yarn. The supply and the production of cotton yarn would increase at a rate of 5.17 and 4.52 per cent per annum, respectively whereas, the consumption of cotton yarn would increase at a rate of 1.94 per cent per annum. High export demand for cotton will increase the deflated price of cotton yarn inspite of low domestic consumption of cotton yarn during the simulation period as the total demand would be higher than the total supply due to high export demand for cotton yarn.. The consumption and the production of cotton fabrics will remain by and large stagnant in this period. The total export of cotton fabrics will increase at relatively high rate of 4.36 per cent per annum. The deflated price of cotton fabrics will also have a spiral tendency during this period.

Conclusions and Policy Implications

The econometric model developed for the Indian cotton sector considering regional aspects of the cotton production performs satisfactorily in terms of goodness of fit, signs and significance of the coefficients. Since cotton production is influenced by agroclimatic and other region specific factors, separate equations of production for all major cotton growing regions of India, i.e., the northern, the southern and the central region has been incorporated. However, in spinning and weaving sub-sectors, all equations are in aggregate term. This model, thus, explains the inter-linkages among the sectors along with regional variability in the production of cotton. It also explains the theoretical economic relationships among the variables and incorporates all important information gathered from our understanding of the cotton sector. The system is of oscillating convergence nature and can be used for long term forecasting and assessing the impact of the internal and external factors on cotton sector. The PRMSE values of the endogenous variables of the model in both static and dynamic simulations show that the model gives reasonably good forecasts of the endogenous variables for the historical period. Model's tracking ability of historical data is good for both static and dynamic simulations for the complete historical series as well as the recent past five year period using actual and forecasted values of the exogenous

variables. Theil's values of all the endogenous variables except consumption of cotton are less than one. The Ubias and Vbias values show that the model has been adequately specified.

The ex-post forecasts of the model for the year 1995-96 for the available data show that the model's performance is satisfactory. The short and long run multipliers of the exogenous variables of the model have theoretically consistent signs and magnitudes.

The base-line simulation of the endogenous variables for the period of 1995-96 through 2000-2001 reveals that the domestic consumption of cotton will grow at a rate faster than the supply of cotton during this period. However, the production of cotton will increase at a rate (2.65 per cent per annum) close to the growth of consumption of cotton (2.81 per cent per annum). Higher demand than supply will result in the upward spiral tendency in deflated price of cotton. The region-wise forecasts show that production of cotton in the northern region will increase at a rate higer than those in other cotton growing regions. It is forecaste that the production of cotton in the northern region will increase at a rate of 3.66 per cent and will reach 56.85 lakh bales, whereas, the production of cotton in the southern region will increase at a rate of 3.03 per cent per annum and the central region at a rate of 1.55 per cent per annum during this period. Therefore, share of the production of cotton in the central region to the total production of cotton will decline and shares of other regions will improve. The central region needs a proper attention and a definite programme for stepping up the production. In the spinning sector, the export of cotton yarn would increase at a substantially high rate (14.65 per cent per annum) and will reach 529.78 thousand tonnes by 2000-2001 AD. The supply and the production of cotton yarn will increase at a rate higher than the rate of increase in the consumption of cotton yarn. High export demand of cotton will increase the deflated price of cotton yarn inspite of low domestic consumption of cotton yarn during the simulation period. The total consumption and the total production of cotton fabrics will remain by and large stagnant during the simulation period. However, the total export of cotton fabrics will increase at a rate of 4.36 per cent per annum. The deflated price of cotton fabrics would also experience a spiral tendency.

Overall the results indicate that the growth rates of most of the endogenous variables except the export of yarn and to some extent export of fabrics are not very satisfactory. Low growth rate and declining share of the production of cotton in the central region in the total production causes concern. Growth rate of the production of cotton in other cotton growing regions are also not very statisfactory. Substaintially low growth of the total consumption and the total production of cotton fabrics is also matter of concern. It calls for an appropriate measures to accelerate the growth in weaving sub-sector.

Appendix 1 (a) : Short Run Elasticity of the Exogenous Variables for the Endogenous Variables																					
Endogenous Variables	Exogenous Variables																				
	DSC	EC	IC	DSC_{t-1}	PCO	DPF	TRND	RNS3	DPP	PHC	DPB	RNC4	DSCY	EPCY	$DSCY_{t-1}$	DV1	DEPF	WY	DI	DNTMC	DV	RNN1
DCC	-0.30	-0.05	0.02	0.30	0.02	-0.04	0.39	0.02	-0.16	0.14	-0.14	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SC	0.00	0.00	0.01	0.22	0.02	-0.03	0.29	0.02	-0.12	0.10	-0.11	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PC	0.00	0.00	0.00	0.00	0.02	-0.04	0.37	0.02	-0.15	0.13	-0.14	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PCN	0.00	0.00	0.00	0.00	0.00	-0.12	0.61	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PCS	0.00	0.00	0.00	0.00	0.00	0.00	0.73	0.08	-0.59	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PCC	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.31	-0.33	0.12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
DPC	0.10	0.02	-0.00	-0.10	-0.00	0.01	-0.13	-0.00	0.05	-0.04	0.05	-0.02	0.09	-0.07	-0.03	-0.00	-0.14	0.00	12.97	-2.43	0.00	-24.25
DCCY	-0.03	-0.00	0.00	0.03	0.00	-0.00	0.04	0.00	-0.01	0.01	-0.01	0.00	-0.06	0.02	0.05	0.00	0.04	-0.00	-3.64	0.68	-0.00	6.91
ECY	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.37	-0.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SCY	-0.03	-0.00	0.00	0.03	0.00	-0.00	0.03	0.00	-0.01	0.01	-0.01	0.00	-0.00	-0.00	0.04	0.00	0.04	-0.00	-3.35	0.63	-0.00	6.35
PCY	-0.03	-0.00	0.00	0.03	0.00	-0.00	0.03	0.00	-0.01	0.01	-0.01	0.00	-0.00	-0.00	0.00	0.00	0.04	-0.00	-3.48	0.65	-0.00	6.60
DPCY	0.02	0.00	-0.00	-0.02	-0.00	0.00	-0.02	-0.00	0.00	-0.00	0.00	-0.00	0.08	-0.07	-0.03	-0.00	-0.13	0.00	12.79	-2.39	0.00	-23.93
DCF	-0.00	-0.00	0.00	0.00	0.00	-0.00	0.00	0.00	-0.00	0.00	-0.00	0.00	-0.03	0.03	0.01	0.00	0.03	-0.00	-12.21	12.58	-0.00	131.54
ECF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.00	-1.36	0.00	0.00	22.66	0.00	237.32
SCF	-0.00	-0.00	0.00	0.00	0.00	-0.00	0.00	0.00	-0.00	0.00	-0.00	0.00	-0.03	0.03	0.01	-0.00	-0.05	-0.00	-11.52	13.15	-0.00	137.56
PCF	-0.00	-0.00	0.00	0.00	0.00	-0.00	0.00	0.00	-0.00	0.00	-0.00	0.00	-0.03	0.03	0.01	-0.00	-0.05	-0.00	-11.52	13.15	-0.00	137.56
DPCF	0.00	0.00	-0.00	-0.00	-0.00	0.00	-0.00	-0.00	0.00	-0.00	0.00	-0.00	0.01	-0.01	-0.00	-0.00	-0.16	0.00	15.61	-2.91	0.00	-28.41

Appendix 1 (b) : Long Run Elasticity of the Exogenous Variables for the Endogenous Variables																					
Endogenous Variables	Exogenous Variables																				
	DSC	EC	IC	DSC	PCO	DPFT	TRND	RNS3	DPPT	PHC	DPBT	RNC4	DSCY	EPCY	LDSCY	DV1	DEPF	WY	DI	DNTMC	DV	RNN1
DCC	-0.24	-0.04	0.02	0.24	0.02	-0.03	0.31	0.02	-0.13	0.11	-0.12	0.04	0.31	-0.38	-0.02	-0.00	-0.24	0.00	22.72	-4.25	-0.00	-38.16
SC	0.04	0.00	0.01	0.18	0.01	-0.02	0.23	0.01	-0.09	0.08	-0.09	0.03	0.23	-0.28	-0.02	-0.00	-0.18	0.00	16.74	-3.13	-0.00	-28.11
PC	0.06	0.00	-0.00	-0.06	0.02	-0.03	0.30	0.02	-0.12	0.10	-0.11	0.04	0.30	-0.37	-0.02	-0.00	-0.23	0.00	21.84	-4.09	-0.00	-36.68
PCN	0.06	0.01	-0.00	-0.06	-0.00	-0.11	0.53	-0.00	0.03	-0.03	0.03	-0.01	0.33	-0.41	-0.02	-0.00	-0.25	0.00	24.05	-4.51	-0.00	-40.75
PCS	0.01	0.00	-0.00	-0.01	-0.00	0.00	0.72	0.08	-0.58	-0.00	0.00	-0.00	0.07	-0.08	-0.00	-0.00	-0.05	0.00	4.95	-0.92	0.00	-8.41
PCC	0.08	0.01	-0.00	-0.08	-0.00	0.01	-0.11	-0.00	0.04	0.27	-0.29	0.10	0.44	-0.54	-0.03	-0.00	-0.33	0.00	31.86	-5.96	0.00	-53.18
DPC	0.15	0.02	-0.00	-0.15	-0.01	0.02	-0.19	-0.01	0.08	-0.07	0.07	-0.02	0.79	-0.97	-0.05	-0.00	-0.60	0.00	57.43	-10.74	0.00	-95.13
DCCY	-0.11	-0.02	0.00	0.11	0.00	-0.01	0.14	0.00	-0.06	0.05	-0.05	0.02	-0.19	0.14	0.08	0.00	0.45	-0.00	-43.01	8.04	-0.00	68.27
ECY	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.68	-6.23	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SCY	-0.10	-0.02	0.00	0.10	0.00	-0.01	0.13	0.00	-0.05	0.05	-0.05	0.02	0.04	-0.11	0.07	0.00	0.42	-0.00	-39.57	7.39	-0.00	62.80
PCY	-0.11	-0.02	0.00	0.10	0.00	-0.01	0.14	0.00	-0.06	0.05	-0.05	0.02	0.05	-0.12	0.04	0.00	0.43	-0.00	-41.07	7.68	-0.00	65.19
DPCY	0.08	0.01	-0.00	-0.08	-0.00	0.00	-0.10	-0.00	0.04	-0.04	0.04	-0.01	0.86	-1.06	-0.06	-0.00	-0.66	0.00	62.66	-11.72	0.00	-104.56
DCF	-0.03	-0.00	0.00	0.03	0.00	-0.00	0.04	0.00	-0.02	0.01	-0.02	0.00	-0.34	0.42	0.02	0.00	0.22	-0.00	-30.98	16.08	-0.00	161.48
ECF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.00	-1.36	0.00	0.00	22.66	0.00	237.32
SCF	-0.03	-0.00	0.00	0.03	0.00	-0.00	0.04	0.00	-0.02	0.01	-0.01	0.00	-0.32	0.39	0.02	0.00	0.13	-0.00	-29.21	16.46	-0.00	165.80
PCF	-0.03	-0.00	0.00	0.03	0.00	-0.00	0.04	0.00	-0.02	0.01	-0.01	0.00	-0.32	0.39	0.02	0.00	0.13	-0.00	-29.21	16.46	-0.00	165.80
DPCF	0.03	0.00	-0.00	-0.03	-0.00	0.00	-0.04	-0.00	0.02	-0.02	0.02	-0.00	0.36	-0.44	-0.02	-0.00	-0.61	0.00	57.87	-10.82	0.00	-97.47

References

Coleman J. and M E Thigpen (1991). An Econometric Model for the World Cotton and Cellulosic Fibres Markets, *World Bank Staff Commodity Working Paper*, No.- 24, World Bank, Washington, D.C. 20433, U.S.A.

CMIE (1995). *Agricultural Compendium*, Centre for Monitering Indian Economy Pvt. Ltd., Bombay.

CMIE (1996). *Indian Economy*, Centre for Monitering Indian Economy Pvt. Ltd., Bombay.

Government of India (1995). *Economic survey*, Economic Division, Ministry of Finance, Government of India, New Delhi.

Hamdy, M. E., S. Barghouti, F. Gillham and M. T. Al-Saffy (1994). Cotton Production Prospects for the decade to 2005, *World Bank Technical Paper* number 231,The world Bank,Washington, D.C.

Hitchings, J. A. (1985). The Economics of Cotton Cultivation in India: Supply and Demand for 1980-90, *Staff Working Papers*, The World Bank, No 618, Washington, D.C.

Kmenta, J. (1971). Elements of Econometrics, Macmillan Publishing Company, New York.

Naik, G., S. K. Jain and S. K. Singh (1997). Econometric Modelling of the Indian Cotton Industry, Report, IIM ,Ahmedabad

Naik, G. and S. K. Jain (1997). Econometric Modelling of the Indian Cotton Sector, *Working paper* No 1398, IIM, Ahmedabad.

Naik, G. and S. K. Jain (1998). Econometric Modelling of the Indian Cotton Textile Industry, *Working paper* No 98-03-04, IIM, Ahmedabad.

Pindyck, R.S. and D. L. Rubinfeld (1991). Econometric Models and Economic Forecasts, IIIrd Edition, McGraw Hill International Edition, New York.

Reutlinger, S. (1966). Analysis of a Dynamic Model with Particular Emphasis on Long Run Projections, *Journal of Farm Economics*, 48(1): 88-106.