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Dynamics of Inflation in India and their Modelling by Time Series Analysis

R. B. Barman, T. P. Madhusoodanan and G. P. Samanta*

Inflation control has been one of the major policy planks of Governments all over the world in view of its wide spread impact on standard of living and the linkage it has with other macro policy parameters. A reliable advance estimate of inflation provides an important input for formulation of policies considered appropriate to contain it. Time series analysis, spurred by the pioneering contribution of Box and Jenkins, attempts to exploit dynamic relationship in the time series data to develop stochastic models under different assumptions about the nature of relationships, and gives fairly satisfactory forecasts. In course of time, a number of non-linear models have also been developed to approximate the generating process of time series more closely. In this paper we set out the results of the exercise undertaken to forecast wholesale price indices for "all commodities" and selected groups making use of some of these time series models. In addition to Box-Jenkins models, we used five non-linear techniques viz., Bilinear, State Dependent, Random Coefficient Autoregression, ARCH and Self Exciting Threshold Autoregression (SETAR) models. In general, SETAR model performs well for most of the series for lead periods above 3 months. Box-Jenkins, Bilinear and State Dependent models gave higher forecast accuracy for shorter lead periods upto 3-4 months. Bilinear model generates good forecasts even for higher lead periods. However, it is difficult to say that any single method performs uniformly better than others in all cases.

Introduction

Inflation control has been one of the major policy planks of Governments all over the world in view of its wide spread impact on standard of living and the linkage it has with other macro policy parameters. A reliable advance estimate of inflation provides an important input for formulation of policies considered appropriate to contain it. Time series analysis, spurred by the pioneering contribution of Box and Jenkins (1970), attempts to exploit dynamic relationship in the time series data to develop stochastic models under different assumptions about the nature of relationships, and gives fairly satisfactory forecasts. In many complex time series, the underlying distribution

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may not approximate to a linear relationship and in order to deal with such situations, in course of time, a number of non-linear models have also been developed to approximate the generating process of time series more closely. These models which have often established their superiority over Box-Jenkins models have been found to be very useful for forecasting with satisfactory level of accuracy even though they are based on information contained in the past data of the series only. The reason for trying more than one model is that no single model is likely to give a more accurate forecast for all series and/or lead periods in a uniform manner. In this paper we set out the results of the exercise undertaken to forecast wholesale price indices (WPI) for "all commodities" and selected groups making use of some of these time series models. The forecasts of selected groups of items provide a broad idea about the sources of inflation and their likely impact on the vulnerable sections of the society.

The univariate time series models, being based on the generating process of the series itself, do not explicitly incorporate the cause and effect relationship; the forte of structural econometric models. Inspite of this, time series models often produce forecasts which are more accurate than large scale macroeconometric models. The time series models are easy to develop. Also, the models can be updated at monthly or even weekly intervals to take into account the very recent innovation process, which is not possible for macroeconometric models. In sum, it may be said that while structural models are very useful for policy analysis, time series models are quite handy for short-term forecasting and continuous monitoring of the evolving scenario. (See, Barman and Ray (1991))

A few attempts have been made in the past to develop time series models for forecasting inflation in India. A comparison of different models in terms of forecasting performance can be found in Ray (1988) and Madhusoodanan (1993). National Informatics Centre (1992) has also developed models for forecasting inflation. These studies relate to the forecast of WPI for 'all commodities'. We have examined certain non-linear models for the first time for not only WPI for all commodities but also for different groups of items of WPI with a view to showing how these forecasts are likely to be useful for monitoring inflation.

The paper is organised into the following sections. The data used in this exercise, tests of stationarity and non-linearity are described in Section 2. Section 3 briefly discusses the models employed for forecasting. Section 4 deals with the identification of the models and their estimation. The estimated models and their forecast performance form part of Section 5. Finally in Section 6, we give the major conclusions of the study.

2. Data Description

The wholesale price indices relate to the prices of commodities transacted in bulk. These prices are not the ones which the consumers pay at the retail level. Inspite of this, wholesale price indices have traditionally been used in India as the primary indicator of inflation. The main reason for this appears to be the availability of these data for a broad collection of 447 commodities with a time lag of two weeks. The changes in these indices are keenly watched by the Government, Reserve Bank of India, other official and private agencies and the public in general. The sources of inflation indicated by the wholesale price indices form the main basis for devising policy measures for keeping inflation under check.

We have taken monthly data of Wholesale Price Indices (Base 1981-82=100) from 1982-83 to 1992-93 for 11 series for the modelling exercise. Apart from the wholesale price indices for "All Commodities (ALL)", the selected groups include "Non-administered Items (NAD)", "Primary Articles (PRI)", "Manufactured Products (MAN)", "Essential Commodities (ESS)", "Major Items (MAJ)", "Seasonal Items (SEA)", "Food Articles (FAR)", "Non-food Articles (NFA)", "Food Products (FPR)" and "Textiles (TEX)". These 10 groups of items cover a wide spectrum of price movements, the forecast of which indicates the likely shape of future inflation.

The composition of items covered in different groups are given in Appendix 1.

Dynamics of Inflation

A number of factors interplay in a complex manner to create imbalances in the aggregate demand and supply which find their expression in the price changes. The main sources of pressure have been identified as supply bottleneck originating from agriculture, oil price hike, and demand pull due to overhang of budget deficits. Of late, devaluation of rupee and pulls of structural adjustments have also contributed to pressure on prices.

The annual growth rates (average basis) in WPI for "All commodities" and different subgroups during 1983-84 to 1992-93 are given in Table 1.

Table 1 : Annual Average Growth Rates of different groups of WPI

YEAR	Group Name										
	ALL	NAD	PRI	MAN	ESS	SEA	MAJ	FAR	NFA	FPR	TEX
1983-84	7.55	8.70	10.76	6.09	11.02	12.85	6.11	13.93	11.48	10.65	4.45
1984-85	6.42	6.86	6.17	6.99	4.43	6.67	3.11	4.12	10.83	5.67	9.59
1985-86	4.45	3.43	0.13	5.93	2.99	0.79	4.44	1.75	-3.32	2.93	-0.38
1986-87	5.80	6.36	9.00	3.77	8.18	10.62	3.87	10.23	11.33	10.12	-2.92
1987-88	8.17	9.56	11.43	7.22	9.09	12.77	7.76	9.02	21.58	8.88	9.13
1988-89	7.47	7.96	4.86	9.44	9.12	4.95	4.82	9.89	-1.72	5.15	10.23
1989-90	7.42	7.75	2.22	11.26	6.45	3.85	7.39	1.28	3.58	11.91	13.39
1990-91	10.24	10.35	13.01	8.37	10.97	13.15	9.90	11.86	17.00	9.86	8.18
1991-92	13.74	14.34	18.08	11.32	16.54	18.08	13.65	20.22	18.04	13.53	10.00
1992-93	10.05	9.57	7.45	10.90	10.49	7.55	11.08	12.35	-0.24	8.51	6.56

The shares of major groups, i.e., Primary Articles, Fuel, Power, Light and Lubricants and Manufactured Products in the overall inflation are shown in Chart 1. It seems that the inflation has been triggered, by and large, by pressure on primary articles, indicating the predominant role of supply shocks. The intrinsic inflationary pressure built into 'Manufactured Products' has also propelled the index to higher levels. It is apparent that once the inflationary pressure gets built up in the system, it takes time for the pent up expectation to wane.

The inherent pressure on wholesale prices appeared to be around 8 per cent during 1980's, a decade marked by high growth in GDP. The escalation of prices following Gulf crisis and pressure on foreign exchange reserves have pushed up this level to over 10 per cent from the beginning of 1990's. A trend effect has therefore provided a continuing force in the change of wholesale prices. Seasonal factors have got superimposed on the trend, at least for some groups of items. The transformation underlying each of the series to make it stationary, as given below, captures a large part of this price dynamics.

Stationarity

As the original series of price indices are marked by rising trend and at times seasonality, these data have to be transformed to make them stationary. The initial choice of transformation was based on a visual inspection of the series followed by a suitable transformation, as a trial, and then the estimation of spectral density function at different time points. If the structure of spectral density function appears to be uniform over time, then the transformed series is likely to be stationary. The transformation used for different data series are given in Table 2.

Table 2: Transformations used to make the series Stationary

	Series	Transformation
1.	All Commodities	$(1 - L)(\log WPI_t - \mu)$
2.	Non-administered Items	$(1 - L)(\log WPI_t - \mu)$
3.	Primary Articles	$(1 - L)(WPI_t - \mu)$
4.	Manufactured Products	$(1 - L)(\log WPI_t - \mu)$
5.	Essential Commodities	$(1 - L)(\log WPI_t - \mu)$
6.	Seasonal Items	$(1 - L)(\log WPI_t - \mu)$
7.	Major Items	$(1 - L)(\log WPI_t - \mu)$
8.	Food Articles	$(1 - L)(WPI_t - \mu)$
9.	Non-food Articles	$(1 - L^{12})(\log WPI_t - \mu)$
10.	Food Products	$(1 - L)(\log WPI_t - \mu)$
11.	Textiles	$(1 - L)(WPI_t - \mu)$

L indicates the lag operator and μ is the mean.

The original and transformed series are plotted in graph 1(a) to 11(b) to give a visual picture of the effect of transformation in each series. It may be observed from these graphs that original series show a continuous rising trend, but the transformed series are horizontal with fluctuation on both sides of the mean. The transformed series thus appeared to be stationary. We have also employed a test of stationarity suggested by Priestley and Subba Rao (1969) to test the overall stationarity of the complete second order properties of the series (Appendix 2). The results of the test, presented in Table 3, show that all the transformed series are stationary.

Table 3 : Priestley-Subba Rao Test For Stationarity

(h=12, k=12 and so $\sigma^2 = 4/3$)

Series Name* (1)	$(S_{I+R}/\sigma^2)^@$ (2)	$(S_T/\sigma^2)^@$ (3)
All Commodities	22.720	0.487
Non-Administered	26.910	0.595
Primary Articles	23.327	6.850
Manuf. Products	27.210	6.530
Essential Comm.	27.171	0.986
Seasonal Items	25.598	1.568
Major Items	26.075	3.853
Food Articles	21.346	3.405
Non-food Articles	10.054	9.640
Food Products	24.928	9.220
Textiles	19.735	4.134

Note : '*' Transformation on the series are given in Table 2.

'@' insignificant at 5 % level of significance (with 60 d.f. for col.(2) and 6 d.f. for col(3).

Nonlinearity Tests for Time Series

In recent years, significant efforts have been made in detecting the type of linear or non-linear behaviour of a time series. Accordingly several testing procedures are proposed in the literature. We have used a test procedure (Appendix 3) suggested by Tsay (1986).

The results of the test including the degrees of freedom, lags included and the levels are presented in Table 4. The test indicates that except for 'Primary Articles', 'Seasonal Items', 'Food Articles' and 'Non-food Articles', all other series are non-linear.

3. Models

Box-Jenkins (ARIMA) Model

The serially dependent relationship observed in many time series data can be represented by a linear univariate autoregressive moving average (ARMA) process of the form

$$\Phi(B)Z_t = \Pi(B)a_t \quad \dots \qquad (3.1)$$

where

$$\Phi(B) = 1 - \varnothing_1 B - \varnothing_2 B^2 - \dots - \varnothing_p B^p$$

and

$$\Pi(B) = 1 - \theta_1 B - \theta_1 B - \dots - \theta_q B^q$$

are the autoregressive and moving average polynomials in B of order p and q respectively. It is assumed that $\Phi(B)$ and $\Pi(B)$ have no common factor. The back shift operator B represents $B^p Z_t = Z_{t-p}$. Here Z_t is a series of observations in a given time series and a_t is a sequence of random variables identically and independently distributed as normal with mean zero and variance σ_a^2. The model (3.1) is stationary and invertible if all the roots of $\Phi(B)$ and $\Pi(B)$ lie outside the unit circle. This implies that the behaviour of the time series remains same over time and therefore it is traceable. If the series is integrated it can be transformed into stationary series by suitable transformation.

If the observed time series does not evolve over time in a linear manner, then it may be possible to develop a non-linear model conforming to the generating process which may result in improvement is the accuracy of the forecast. There are several such non-linear models of which some are described below.

Non-Linear Models

State Dependent Model (SDM)

A general non-linear model is suggested by Priestley (1980) which can be written as

$$Z_t + \sum_{i=1}^{p} \varnothing_i(w_{t-1})Z_{t-i} = \mu(w_{t-1}) + \epsilon_t + \sum_{j=1}^{q} \Pi_j(w_{t-1})\epsilon_{t-j} \quad \dots \qquad (3.2)$$

where $w_t = (\epsilon_{t-q+1}, \dots, \epsilon_t, Z_{t-p+1}, \dots Z_t)$ is the state vector.

As the model depends on this state vector, it is called the state dependent model (SDM) of order p and q. The parameters $\varnothing_i(x)(i=1, ..., p)$ $\Pi_j(x)$ $(j=1, ...q)$ and $\mu(x)$ depend on the state of the process at time t-1, and variance σ^2. Priestley has shown that this model is of general type from which a number of models can be obtained as special cases. If the parameters of this model are assumed to be independent of x, then the model reduces to

$$Z_t + \sum_{i=1}^{p} \varnothing_i Z_{t-i} = \mu + \epsilon_t + \sum_{j=1}^{q} \Pi_j \epsilon_{t-j} \quad (3.3)$$

which is an ARMA (p,q) model.

Bilinear model

If we assume that

$$\Pi_j(w_{t-j}) = \Pi_j + \sum_{v=1}^{\varnothing} C_{jv} Z_{t-v} \quad (j = i, ...q)$$

and take $\mu(x)$ and $\varnothing(x)$ as constants for all $\varnothing = 1, ...p$, then (3.2) becomes

$$Z_j + \sum_{i=1}^{p} \varnothing_i Z_{t-i} = \mu + \epsilon_t + \sum_{j=1}^{q} \Pi_j \epsilon_{t-j} + \sum_{1}^{r} \sum_{1}^{s} e_{jv} Z_{t-v} \epsilon_{t-j} \quad ... \quad (3.4)$$

which is a particular case of SDM called bilinear model.

(Self-Exciting) Threshold Autoregressive Model (SETAR)

This model due to Tong (1977, 1980) is determined by representing a generating process into a finite set of AR models with thresholds for the passage from one member of the set to the other. The passage determined by the past data value relative to the thresholds gives rise to self-exciting threshold autoregressive (SETAR) model.

For this model one assumes $\mu(x) = \varnothing_0^{(j)}$, $\Pi_j(x) = \theta$ and $\varnothing_i(w_{t-1}) = \varnothing_i^{(j)}$ in (3.2) when $Z_{t-d} \in R^{(j)}$ $(i = 1,...,p,\ j = 1,...,k)$ where d is a positive integer known as delay parameter and $R^{(j)}$'s are sub-sets of real line known as threshold regions. With these assumptions we get the following model

$$Z_t + \varnothing_0^{(j)} + \sum_{i=1}^{p} \varnothing_i^{(j)} Z_{j-i} = \in_i^{(j)}, \qquad \ldots \qquad (3.5)$$

$$\text{for } Z_{t-d} \in R^j, j=1,..k$$

where the white noise $\in_i^{(j)}$ is independent of $\in_i^{(j')}$, $j \neq j'$. Different threshold regions $R^{(j)}$ (j=1, ... k) gives different orders of the model (p_1, ... p_k), but we have considered only two threshold regions SETAR (2; p_1, p_2).

Random Coefficient Autoregressive (RCA) model

In this case, in (3.2) it is assumed that $\mu(x)$=constant, $\Pi_i(k) = 0$ and $\varnothing_i(w_{t-1}) = ß_i + b_i(t)$ which gives the following model

$$Z_t + \sum_{i=1}^{p} \{ ß_i + b_i(t) \} Z_{t-i} = \mu + \in_t \qquad \ldots \quad (3.6)$$

where $ß_i$'s are constants for i=1, ... p and ($b_1(t)$, ... $b_p(t)$)' is a zero mean i.i.d. vector process independent of $\in_t$.

ARCH Model

The Autoregressive Conditional Heteroscedastic (ARCH) model is due to Engle (1982). The model is an AR(p) with ARCH(q) disturbances for the dependent variable Z_t which can be written as

$$Z_t = X_t'ß + \in_t, \; t = 1,2,...,n. \qquad \ldots \quad (3.7)$$

where $\{\in_t\}$ are conditioned on information set available till the time t-1 with variance given by $h_t = \alpha_0 + \alpha_1 (\in_{t-1}^2) + ... + \alpha_q \in_{t-q}^2$, $\alpha o > O$ and $\alpha_i \geq \theta$ (i = 1, ...,q). It may be seen that the model has non-linearity based on conditional variance of $\{\in_t\}$.

There are several other non-linear models which can also be considered. We have however confined to these 5 major non-linear models and ARMA model for generation of forecasts and to examine their performance in terms of accuracy of forecasts for different lead periods.

4. Model Identification and Estimation

Identification of models

The identification of a model refers to selection of the number of lags of autoregression, moving average and other components that represent the generating process of a stationary time series. In case of ARMA models, the autocorrelation and partial autocorrelation functions provide a clue about the lags to be included in the model. In addition, one has to exercise judgment based on experience to select a model from the different alternatives that give more accurate forecast. A criteria which comes in handy in this process is Akaike's information criterion (AIC) defined as

$$AIC = \ln(\sigma^2) + 2(\text{no.of parameters})/n,$$

where σ^2 is an estimate of residual variance of the model and n is the length of the time series i.e., total number of observations. The first and second terms act as penalty for lack of good fit and overparameterization respectively. Therefore, it is necessary to select the lags that minimizes AIC.

The identification of parameters for the non-linear models are more difficult than explained above. It involves certain trial and error in addition to AIC, in absence of a satisfactory criteria on their choice (Luukkonen (1990)).

Model checking

After identification of the lags, the parameters are estimated by the methods appropriate for each model. In the next stage, the residuals are examined to find out if they are all white noise or some information still remain in them that can be built into the model. This is done by analysing the autocorrelations and partial autocorrelation functions of residuals. In case they all lie within two standard-error limits, then it is inferred that no useful information are still left out. If however the autocorrelations and/or partial autocorrelations for any lagged residual is high, the information is ploughed back into the model through inclusion of appropriate lag in the specification of the model. In the process, it is also seen that the model is not overparameterised, because parsimony is a basic desirable trait in the identification of a model.

Measurement of Forecast Error

Let us assume that the generating function for the observed time series can be represented as

$$X_n = f(X_1, ..., X_{n-1}, e_1, ..., e_n)$$

where X_i are the observed values and e_i's are the errors. We are interested in the forecast of X_n for h time points in the future. As we have information only upto the current time point n, the forecasts for the h lead periods will be conditional on this information set I_n. This can be represented by the conditional expectation

$$f_{n,h} = E(X_{n+h}/I_n)$$

where $f_{n,h}$ is the forecast of X_n for lead period h[1]. In practice, forecasts obtained in the first lead period is used to generate forecast for the 2nd lead period and so on. The h step ahead forecast error can be represented as

$$e(h) = X(n+h) - f(n,h)$$

In general the forecast errors will rise with the increase in lead period. If this forecasting exercise is repeated k number of times by adding one observation at a time, we can estimate the mean square percentage error for the lead period h as

$$me(h) = \frac{1}{k} \sum_{i=1}^{k} [(X(n-k-H+i+h) - f(n-k-H+2,h))/X(n-k-H+i+h))]^2 * 100$$

$$\text{for } h = 1,2,...,H.$$

We have estimated the square root of this measure of mean square error and use the root mean square percentage error (RMSPE) to evaluate the performance of different models.

5. Estimated Models and Forecast Performance

Estimated models

The estimates of parameters of models for each of the 11 series by the six methods are given in Table 5(a)-5(f). The estimates have been obtained by the method of estimation applicable for each of them. The estimates indicate the extent of influence of lagged values in the generation process of each of the series. The models where the lag operator L^{12} appear, the seasonal elements are important factors in the generation of the series. In general, the first lag and the twelfth lag are the most important components for explaining the evolution of different series. In monthly series, it is quite natural to expect the predominant influence of first and twelfth lag in explaining the evolution of a series.

1. In theory, one attaches a loss function for evaluation of different forecasting procedures (Granger and Newbold (1986)).

Evaluation of forecasting performance by different models

With a view to evaluating the performance of the forecast, we have generated out of sample forecasts for 12 lead periods by different models. For this, we have started with the data upto April'91; estimated the parameters of the identified model and generated forecasts for 12 months upto April'92. In the next step, we added data for May'91 and estimated the parameters afresh and then generated forecasts for 12 months from June'91 to May'92. This process has been continued by adding data for one month at each stage; estimating the parameters afresh and obtaining the forecasts for 12 months. In this way we got 12 forecasts for first lead period, 12 forecast for second lead period and so on. The root mean square percentage error based on these 12 forecasts for each lead periods are then worked out (Table 6(a)-6(k)). The performance of the forecasts in terms of errors (RMSPE) is discussed below :

The WPI (All Commodities) Series

The comparison of forecasts generated by different models used for forecasting wholesale price index for all commodities indicate the following errors:

Table 6(a) : RMSPE's For The WPI (All Commodities) Series

Model	RMSPE For Lead Period											
	1	2	3	4	5	6	7	8	9	10	11	12
BOX	0.77	1.37	1.76	2.09	2.11	2.11	2.22	2.25	2.23	2.30	2.43	2.58
BIL	0.75	1.35	1.73	2.00	1.98	1.94	2.03	2.07	2.09	2.22	2.41	2.59
SDM	0.91	1.53	1.95	2.21	2.09	1.92	1.88	1.82	1.89	2.08	2.35	2.63
RCA	0.85	1.52	1.97	2.27	2.16	2.04	2.01	1.93	1.96	2.09	2.33	2.66
ARCH	1.05	1.66	2.12	2.38	2.27	2.19	2.20	2.15	2.20	2.33	2.59	3.01
SETAR	1.58	1.13	1.03	1.34	1.33	1.14	1.35	1.36	1.40	1.46	1.47	1.60

It may be seen that the root mean square percentage error of the forecast is around 1 per cent for lead period of one month. The errors are gradually higher for longer lead periods. However, the SETAR model gives more accurate forecast than other models for longer lead periods. It may be said that the non-linearities caused by volatility in the series in the recent period are approximated more appropriately by SETAR model based on local linearisation assumption.

In the interpretation of forecast errors, it may also be noted that the period from 1990-91 to 1992-93, in which the forecasts are compared with actuals, witnessed wide fluctuations in prices. The annual average growth rates in WPI ranged from 4.43 per cent to 8.19 per cent during 1983-84 to 1989-90. This period was marked by high economic growth and the external sector of the economy did not yet come under severe strain. The war in the Gulf changed the whole picture, and the crisis started showing up in the Balance of Payments. The prices started moving up. The inflation crossed double digit at 10.26 per cent in 1990-91, which went up further to 13.75 per cent in 1991-92 before starting responding to various policy measures initiated as a part of stabilisation programme. The inflation came down to 10.05 per cent in 1992-93. On a point-to-point basis the inflation reached a peak of 17 per cent in August 1991 which deeped to 7 per cent in March, 1993. The sharp deceleration in prices in the second half of 1992-93 was a clear deviation from immediate past-trend and therefore the forecast errors were relatively high during this period. But for these unusual volatilities in WPI, the forecasts would have been closer to the actuals.

The Non-Administered Items Series

The administered items account for a weight of 19.7 per cent (See Appendix 1). The prices of these items change in jumps in accordance with the decision of the government. Consequently the prices of some of the non-administered items also rise almost immediately. However, the prices of non-administered items respond to various other factors. The forecast error of this group of items is given below :

Table 6(b) : RMSPE's For The Non-Administered Items Series

Model	RMSPE For Lead Period											
	1	2	3	4	5	6	7	8	9	10	11	12
BOX	0.75	1.28	1.61	1.90	1.93	2.01	2.22	2.36	2.52	2.82	3.18	3.57
BIL	0.82	1.39	1.76	2.09	2.13	2.19	2.34	2.40	2.46	2.69	2.95	3.24
SDM	0.92	1.54	1.97	2.28	2.22	2.11	2.10	2.12	2.33	2.74	3.23	3.76
RCA	0.89	1.66	2.23	2.62	2.60	2.54	2.60	2.51	2.47	2.49	2.61	2.91
ARCH	1.10	1.67	2.15	2.41	2.30	2.15	2.08	1.90	1.82	1.89	2.14	2.62
SETAR	2.33	2.16	2.09	2.00	1.70	1.34	1.09	0.88	0.72	0.85	1.13	1.61

It may be found that BOX, BIL and SDM models generate forecasts of non-administered items with relatively low error (RMSPE less than 2 per cent upto 3 months lead period). The forecasts for lead period above 3 months have least error when generated by SETAR model.

The Primary Articles Series

The series on primary articles is composed of food articles, non-food articles and minerals with an weight of 32.3 per cent. The forecast errors of primary articles for different lead periods are given below :

Table 6(c) : RMSPE's For The Primary Articles Series

Model	RMSPE For Lead Period											
	1	2	3	4	5	6	7	8	9	10	11	12
BOX	1.28	2.26	2.97	3.53	3.59	3.69	3.98	4.05	4.20	4.41	4.71	5.31
BIL	1.30	2.31	3.06	3.66	3.74	3.76	3.92	3.81	3.65	3.46	3.31	3.55
SDM	1.24	2.17	2.85	3.41	3.52	3.73	4.12	4.36	4.70	5.13	5.65	6.39
RCA	1.38	2.53	3.37	4.04	4.11	4.13	4.40	4.36	4.25	4.04	3.77	4.02
ARCH	2.08	2.89	3.77	4.21	4.30	4.30	4.46	4.32	4.16	3.97	3.91	4.34
SETAR	5.48	5.61	5.82	5.85	5.72	5.45	5.05	4.60	4.15	3.80	3.37	3.11

The forecasts have high errors (RMSPE is more than 2 per cent even for 2 months lead period). The output of food and non-food articles fluctuate widely depending on the incidence and spread of monsoon. If the monsoon does not shape well, the expectation also plays its role in pushing up the prices of these commodities. These factors can not be built into univariate time series models unless they occur at regular intervals. In view of this, the forecasts of this series obtained by employing time series models are found to be less accurate.

The Manufactured Products Series

The manufactured products is the largest group accounting for 57 per cent of the total weight. The changes in prices of this group is therefore the major source of inflation. The errors in the forecast of this series is given below :

Table 6(d) : RMSPE's For The Manufactured Products Series

Model	RMSPE For Lead Period											
	1	2	3	4	5	6	7	8	9	10	11	12
BOX	0.71	1.30	1.67	1.94	1.87	1.67	1.56	1.53	1.57	1.81	2.06	2.20
BIL	0.69	1.27	1.62	1.91	1.86	1.64	1.54	1.50	1.58	1.82	2.07	2.21
SDM	0.82	1.49	1.95	2.25	2.15	1.87	1.62	1.47	1.55	1.82	2.13	2.33
RCA	0.81	1.50	1.98	2.29	2.21	1.96	1.74	1.61	1.70	1.96	2.24	2.42
ARCH	0.92	1.56	2.06	2.39	2.60	2.87	3.11	3.31	3.46	3.57	3.68	3.83
SETAR	1.95	1.59	1.31	1.16	1.19	1.21	1.19	1.22	1.14	0.96	0.85	0.99

The models have performed well in capturing the dynamics of the series. The forecasts errors of this series for lead period even upto 12 months is about 2 per cent, except ARCH, which is high, and SETAR which is strikingly low at only 1 per cent. The forecasts generated by BOX, BIL, SDM and RCA are also good for lower lead periods. On the whole, SETAR model gives the best forecast for this main group of WPI.

The Essential Commodities Series

This group with weight of 36 per cent comprises of the items - cereals, vegetables, medicines, cotton textiles, soaps, etc. - which are very essential in day to day life of a common man. It may be seen from table 1 that the annual growths in prices for this group are higher than the same for "all commodities" in seven out of ten years. This indicates that the poorer section were the worst effected by fast rising price levels for this group.

Table 6(e) : RMSPE's For The Essential Commodities Series

Model	RMSPE For Lead Period											
	1	2	3	4	5	6	7	8	9	10	11	12
BOX	1.01	1.62	2.08	2.54	2.66	2.93	3.27	3.45	3.63	3.96	4.24	4.59
BIL	1.04	1.75	2.26	2.74	2.89	3.09	3.34	3.47	3.64	4.02	4.34	4.74
SDM	1.28	2.10	2.71	3.15	3.05	2.96	2.96	2.97	3.29	3.89	4.48	5.17
RCA	1.25	2.26	3.10	3.77	3.73	3.60	3.58	3.38	3.29	3.23	3.22	3.61
ARCH	1.84	2.66	3.48	3.89	3.84	3.64	3.57	3.36	3.38	3.49	3.71	4.17
SETAR	3.48	3.78	4.21	4.62	4.77	4.67	4.45	4.26	3.98	3.71	3.49	3.21

It is observed from the above table that all the models except ARCH and SETAR give good forecasts for lead period upto 6 months. RCA model continues to generate satisfactory forecasts even for 1 year lead period. It may therefore be said that the dynamics of the series is well captured by the properties of RCA model.

The Seasonal Items Series

Almost one third of the total weight in WPI basket comprises of seasonal items like food-grain, vegetables, sugar, khandsari & gur, edible oils, etc.. Prices of these commodities show season fluctuations depending on their availability in the market.

Table 6(f) : RMSPE's For The Seasonal Items Series

Model	RMSPE For Lead Period											
	1	2	3	4	5	6	7	8	9	10	11	12
BOX	1.37	2.43	3.10	3.62	3.51	3.51	3.69	3.64	3.73	3.99	4.36	5.02
BIL	1.39	2.45	3.15	3.67	3.59	3.51	3.57	3.34	3.19	3.18	3.33	3.84
SDM	1.41	2.52	3.34	4.01	4.00	3.89	4.04	3.85	3.73	3.66	3.71	4.46
RCA	1.42	2.53	3.36	4.05	4.04	3.93	4.08	3.88	3.73	3.61	3.61	4.34
ARCH	1.84	2.90	3.70	4.22	4.21	4.10	4.11	3.86	3.69	3.63	3.93	4.79
SETAR	6.25	6.38	6.45	6.49	6.25	5.78	5.34	4.81	4.20	3.50	2.98	2.75

Comparison of RMSPE's for different lead periods reveals that the BOX and BIL models are the best for lead periods upto 8 months. SDM, RCA and ARCH models also perform well in the generation of the forecasts. SETAR model has least forecast errors for 11-12 lead months.

The Major Items Series

Eighteen items in WPI basket with weight of 1 per cent or more account for a total weight of 31.8 per cent. These 18 major items have considerable influence on general price level. The forecast of this series by different models give the following errors :

Table 6(g) : RMSPE's For The Major Items Series

Model	RMSPE For Lead Period											
	1	2	3	4	5	6	7	8	9	10	11	12
BOX	0.88	1.53	1.80	1.89	1.90	2.08	2.36	2.37	2.31	2.31	2.41	2.65
BIL	0.91	1.64	2.11	2.40	2.62	2.95	3.37	3.57	3.70	3.77	3.83	4.07
SDM	0.87	1.50	1.73	1.78	1.77	1.94	2.20	2.18	2.11	2.15	2.38	2.67
RCA	0.88	1.55	1.84	1.94	1.96	2.15	2.45	2.48	2.43	2.43	2.55	2.79
ARCH	1.25	1.84	2.33	2.70	2.96	3.31	3.75	4.01	4.21	4.29	4.37	4.63
SETAR	3.57	2.90	2.37	1.64	1.34	1.24	1.17	1.11	1.15	1.27	1.21	1.18

SDM model performs most accurately for lead periods upto 3 months. The performance of SETAR model is the best from lead period of 4 months onwards.

The Food Articles Series

Despite bumper food-grains production in the last three consecutive fiscal years, the annual growth rates in prices of food articles have been very high. It reached a peak of 20.3 per cent in the year 1991-92. Moreover in seven out of ten years, the prices of these commodities accelerated at higher rate than general price level. The changes in prices of food articles show high fluctuation (table 1). A close look at the annual growth rates indicate that when the monsoon does not shape well, the speculative trading sentiment gets set into the price mechanism. This phenomenon can not be properly explained by univariate time series model. Inspite of this limitation, we tried to capture it's dynamic movement; to the extent possible, by univariate time series models.

Table 6(h) : RMSPE's For The Food Articles Series

Model	RMSPE For Lead Period											
	1	2	3	4	5	6	7	8	9	10	11	12
BOX	1.57	2.54	3.35	3.95	3.85	3.90	4.01	3.95	4.24	4.79	5.38	6.27
BIL	1.46	2.43	3.28	3.85	3.75	3.83	3.95	3.91	4.25	4.82	5.39	6.27
SDM	1.57	2.53	3.35	3.95	3.86	3.94	4.08	4.05	4.39	5.01	5.67	6.64
RCA	1.59	2.61	3.47	4.10	4.01	4.04	4.13	4.02	4.24	4.70	5.23	6.10
ARCH	2.35	3.41	4.41	4.92	4.94	4.81	4.80	4.53	4.52	4.59	4.79	5.41
SETAR	4.24	4.19	4.81	5.52	5.83	5.72	5.29	4.74	4.23	3.87	3.77	3.73

The comparison of forecast performance of different models given above indicate that the errors are high for this series. The behaviour of this series seems to be non-linear and bilinear model performs reasonably well for lead periods upto 9 months. Forecasts associated with higher lead periods are most accurate when these are generated by employing SETAR model.

The Non-Food Articles Series

All the agro-based industrial raw materials, viz., raw cotton, raw jute, oil seeds, etc., are included in this group. As these commodities are used as input to industrial sector, any shock in prices of this group is expected to have an impact on related industrial production.

Table 6(i) : RMSPE's For The Non-Food Articles Series

Model	RMSPE For Lead Period											
	1	2	3	4	5	6	7	8	9	10	11	12
BOX	1.81	2.84	3.50	4.03	4.27	4.30	4.22	3.96	3.50	3.11	2.68	2.60
BIL	1.81	2.85	3.48	4.00	4.24	4.29	4.20	3.93	3.46	3.07	2.62	2.51
SDM	2.18	3.57	4.59	5.46	5.87	5.88	5.82	5.64	5.19	4.78	4.81	4.74
RCA	2.17	3.56	4.58	5.45	5.87	5.90	5.88	5.89	5.76	5.64	5.94	6.00
ARCH	2.66	3.92	5.08	5.78	6.00	6.02	6.13	6.28	6.37	6.35	6.60	7.28
SETAR	1.98	3.67	4.61	5.40	5.93	6.00	5.79	5.06	4.38	4.28	4.61	4.87

The forecast errors indicate that the performance of BOX and BIL models are the best.

The Food Products Series

The price movement of this group covering all processed food items, is very complex. The forecast performance of different models is given below :

Table 6(j) : RMSPE's For The Food Products Series

Model	RMSPE For Lead Period											
	1	2	3	4	5	6	7	8	9	10	11	12
BOX	1.11	1.67	2.06	2.56	2.49	2.32	2.25	1.94	2.02	2.46	2.86	3.57
BIL	1.14	1.70	2.12	2.58	2.51	2.32	2.19	1.79	1.81	2.16	2.53	3.23
SDM	1.11	1.78	2.14	2.75	2.81	2.60	2.50	2.05	1.92	2.14	2.51	3.29
RCA	1.10	1.80	2.19	2.82	2.88	2.66	2.56	2.02	1.77	1.86	2.11	2.93
ARCH	1.47	2.49	3.17	3.77	3.94	3.78	3.64	3.17	2.68	2.14	1.87	2.62
SETAR	4.24	4.67	4.75	5.03	5.08	5.06	5.09	5.11	5.16	5.09	4.97	4.94

Though short-term dynamics of the series can be explained by BOX, BIL, SDM and RCA models, for forecasts above 10 months lead periods ARCH has performed well. For this series SETAR model has shown high forecast error.

The Textiles Series

Textile industry is one of the oldest and important sector of Indian economy. This industry accounts for a weight of 11.5 per cent. The change in prices of items under this group has been negative in 1985-86 and 1986-87 which is a rare phenomenon. However, this deep in prices was more than recouped in the next three years when the prices grew above those of all commodities.

Table 6(k) : RMSPE's For The Textiles Series

Model	RMSPE For Lead Period											
	1	2	3	4	5	6	7	8	9	10	11	12
BOX	0.80	1.58	2.14	2.42	2.36	2.25	2.23	2.40	2.69	2.89	2.85	2.58
BIL	0.77	1.53	2.12	2.41	2.32	2.17	2.14	2.32	2.63	2.85	2.84	2.59
SDM	0.80	1.61	2.20	2.50	2.46	2.36	2.36	2.54	2.85	3.07	3.06	2.81
RCA	0.81	1.61	2.19	2.48	2.44	2.34	2.34	2.52	2.82	3.04	3.00	2.74
ARCH	1.11	1.52	1.82	1.91	1.71	1.58	1.65	1.97	2.26	2.31	2.12	1.75
SETAR	0.89	1.52	2.05	2.61	2.95	2.88	2.85	3.01	3.86	5.08	5.94	6.64

The behaviour of this price index series is well captured by ARCH model for all most all the lead periods except for the first lead period when BOX is most suitable.

In sum, the RMSPE of forecasts of different series for various lead periods indicate that Box-Jenkins, Bilinear and State Dependent models perform well for lead periods upto 3-4 months; with average forecast error being around 2-3 per cent in majority of the cases. Forecasts generated by RCA and ARCH models had average error somewhat higher than these models, while SETAR had maximum error in the short-run. However, SETAR model performed very well for lead period ranging from 4 to 12 months. One year ahead forecast generated by SETAR had less average error than other models in case of 8 out of 11 series. It is observed that the choice of a model also depend on the peculiarity of a series. For example, ARCH and Bilinear models performed very well for generating forecast of 'Textiles' and 'Non-food Articles' series respectively. SETAR did not perform as well for forecasting of prices of 'Non-food Articles', 'Food Products' and 'Textiles'. Another interesting phenomenon is that in case of series like 'All Commodities', 'Non-Administered Items', 'Manufactured Products', 'Major Items', 'Food Products' and 'Textiles', most of the models generated reasonably accurate forecasts. In general, it can be said that the time series models tried in this exercise had been able to generate quite satisfactory forecasts of wholesale price index series at aggregate and disaggregate levels.

6. Conclusions

In this paper, we tested empirically the accuracy of forecasts of ARIMA model and five selected univariate non-linear time series models on data relating to Wholesale Price Index and its 'subgroups'. It has been observed that some of the non-linear models generate forecasts with satisfactory level of accuracy for lead periods upto 12 months. But it is difficult to say that any single method performs uniformly better than others in all cases. In general, SETAR model performs well for most of the series for lead periods above 3 months. Box-Jenkins, Bilinear and State Dependent models gave higher forecast accuracy for shorter lead periods upto 3-4 months. Bilinear model generates good forecasts even for higher lead periods.

The forecast performance also depends on the nature of volatility in each series. As the wholesale prices were fluctuating widely during 1991-93, the mean percentage forecast error of two per cent for 12 month lead period, as found for most of the series augur well on the accuracy of univariate non-linear models for forecasting these series. It may also be noted that as time series models approximate the generating process of a series based on the past data, the difference between the forecast and the actual can be thought of, at least in part, as a reflection of innovative initiatives taken through policy measures or otherwise to keep the price rises under check. The accuracy of the forecasts should be judged taking into account various shocks having their bearing in the post-sample lead period, which cannot be explained by the models based on previous observations in case such shocks are not experienced in the past or its dimensions become more complex than witnessed earlier.

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Table 4: Test of Non-Linearity(Contd.)

Series Name	F-Stat	d1	d2	Levels	Lags upto
1. All Commodities	3.408	3	122	0.020*	2
	3.231	6	118	0.006*	3
	2.071	10	113	0.032*	4
	0.916	66	50	0.634	11
2. Non-Administered Items	3.034	3	122	0.032*	2
	3.517	6	118	0.003*	3
	1.998	10	113	0.040*	4
3. Primary Articles	0.017	1	125	0.895	1
	0.761	3	122	0.518	2
	1.755	6	118	0.114	3
	1.646	10	113	0.103	4
4. Manufactured Products	3.546	6	118	0.003*	3
	2.103	10	113	0.030*	4
	1.473	45	73	0.070	9
	2.504	55	62	0.000*	10
	2.478	66	50	0.001*	11
5. Essential Commodities	0.876	10	113	0.558	4
	1.357	15	107	0.182	5
	1.681	21	100	0.046*	6
	1.566	55	62	0.044*	10
	1.755	66	50	0.020*	11
6. Seasonal Items	0.187	1	125	0.666	1
	1.322	3	122	0.270	2
7. Major Items	1.465	3	122	0.228	2
	1.888	6	118	0.088	3
	2.156	10	113	0.026*	4
	2.296	15	107	0.007*	5
8. Food Articles	0.216	1	125	0.643	1
	0.109	3	122	0.955	2
	0.590	6	118	0.738	3
	0.472	10	113	0.905	4
	1.262	21	100	0.219	6
	1.176	28	92	0.277	7
	1.148	36	83	0.299	8

* Significant at 5 per cent.

Table 4 : Test of Non-Linearity (Concld.)

	Series Name	F-Stat	d1	d2	Levels	Lags upto
9.	Non-food Articles	1.291	1	125	0.258	1
		1.177	3	122	0.321	2
		0.940	6	118	0.469	3
10.	Food Products	3.551	1	113	0.062	1
		4.135	3	110	0.008*	2
		2.089	6	106	0.061	3
		1.989	10	101	0.042*	4
		1.734	66	38	0.034*	11
11.	Textiles	5.112	1	125	0.025*	1
		2.139	3	122	0.099	2
		0.842	66	50	0.746	11

* Significant at 5 per cent.

Table 5(a) : Equations for Forecasting : Box-Jenkins Models

Variable	Model	AIC Value
1. All Commodities	$(1 + 0.10L^4 - 0.85L^{12})X(t) = (1 + 0.24L - 0.62L^{12})e(t)$ (0.04) (0.05) (0.07) (0.09)	-1567.68
2. Non-Administered Items	$(1 - 0.89L)X(t) = (1 + 0.15L + 0.11L^3 - 0.65L^4)e(t)$ (0.05) (0.06) (0.05) (0.08)	-1533.70
3. Primary Articles	$(1 - 0.33L - 0.31L^{12})X_t = e(t)$ (0.08) (0.08)	183.56
4. Manufactured Products	$(1 - 0.87L^{12})X(t) = (1 + 0.27L - 0.59L^{12})e(t)$ (0.05) (0.07) (0.08)	-1589.21
5. Essential Commodities	$(1 - 0.90L^{12})X(t) = (1 + 0.20L - 0.66L^{12})e(t)$ (0.05) (0.07) (0.08)	-1411.98
6. Seasonal Items	$(1 + 0.25L^6 - 0.31L^{12})X(t) = (1 + 0.32L)e(t)$ (0.08) (0.09) (0.08)	-1327.12
7. Major Items	$(1 - 0.26L - 0.31L^{12})X(t) = e(t)$ (0.08) (0.08)	-1471.28
8. Food Articles	$(1 - 0.32L - 0.32L^{12})X(t) = e(t)$ (0.08) (0.07)	-1279.01
9. Non-food Articles	$(1 - 0.95L + 0.13L^{12})X(t) = (1 + 0.17L - 0.84L^{12})e(t)$ (0.03) (0.02) (0.04) (0.04)	-1169.30
10. Food Products	$(1 - 0.33L^{11} - 0.29L^{12})X(t) = e(t)$ (0.08) (0.04)	-1313.71
11. Textiles	$(1 - 0.43L - 0.18L^{12})X(t) = e(t)$ (0.08) (0.08)	37.23

Note : Figures in brackets indicate standard errors of the relevant co-efficient.

Table 5(b) : Equations for Forecasting : Bilinear Models

	Variable	Model	AIC Value
1.	All Commodities	$(1 - 0.87L^{12}) X(t) = (1 + 0.24L - 0.60L^{12}) e(t)$ (0.06) (0.07) (0.06) $- 43.47L X(t) L^{12}(t)$ (23.75)	-1570.65
2.	Non-Administered Items	$(1 - 0.90L) X(t) = (1 + 0.20L - 0.63L^{12}) e(t)$ (0.05) (0.07) (0.10) $- 15.92L^{12} X(t) L^{12} e(t)$ (9.17)	-1533.53
3.	Primary Articles	$(1 - 0.36L - 0.39L^{12}) X(t) = e(t) - 0.06L^{12} X(t) L^{12} e(t)$ (0.08) (0.09) (0.03)	181.18
4.	Manufactured Products	$(1 - 0.85L^{12}) X(t) = (1 + 0.30L - 0.52L^{12}) e(t)$ (0.06) (0.07) (0.10) $+ 97.63L^{12} X(t) L e(t)$ (35.71)	-1594.61
5.	Essential Commodities	$(1 - 0.89L^{12}) X(t) = (1 + 0.24L - 0.66L^{12}) e(t)$ (0.05) (0.07) (0.08) $+ 16.59L^{7} X(t)^{L12} e(t)$ (10.56)	-1411.77
6.	Seasonal Items	$(1 + 0.16L^{6} - 0.36L^{12}) X(t) = (1 + 0.34L) e(t)$ (0.07) (0.08) (0.08) $- 22.08L^{12} X(t) L^{12} e(t)$ (7.82)	-1331.33
7.	Major Items	$(1 - 0.27L - 0.33L^{12}) X(t) = e(t) - 36.83L^{12} X(t) L^{12} e(t)$ (0.08) (0.08) (15.14)	-1473.16
8.	Food Articles	$(1 - 0.29L - 0.34L^{12}) X(t) = e(t) + 21.40L^{6} X(t) L^{2} e(t)$ (0.08) (0.07) (9.31)	-1281.41
9.	Non-food Articles	$(1 - 0.95L + 0.13L^{12}) X(t) = (1 + 0.18L - 0.82L^{12}) e(t)$ (0.03) (0.03) (0.04) (0.04) $+ 1.28L X(t) L e(t)$ (0.97)	-1167.09
10.	Food Products	$(1 - 0.34L^{11} - 0.29L^{12}) X(t) = e(t) + 13.42L X(t) L^{12} e(t)$ (0.08) (0.08) (11.18)	-1167.09
11.	Textiles	$(1 - 0.43L - 0.17L^{12}) X(t) = e(t) - 0.28L X(t) L^{12} e(t)$ (0.07) (0.07) (0.09) $+ 0.35L^{12} X(t) L e(t)$ (0.09)	31.70

Table 5(c) : Equations for Forecasting : State Dependent Models

	Variable	Model
1.	All Commodities	$X(t) = 0.002 + 0.38L^{12} X(t) + e(t)$
2.	Non-Administered Items	$X(t) = 0.002 + 0.43L^{12} X(t) + e(t)$
3.	Primary Articles	$X(t) = 0.36 - (0.32L + 0.36L^{12}) X(t) + e(t)$
4.	Manufactured Products	$X(t) = 0.001 + (0.23L + 0.38L^{12}) X(t) + e(t)$
5.	Essential Commodities	$X(t) = 0.002 + 0.44L X(t) + e(t)$
6.	Seasonal Items	$X(t) = 0.002 + 0.37L X(t) + e(t)$
7.	Major Items	$X(t) = 0.001 + (0.23L + 0.37L^{12}) X(t) + e(t)$
8.	Food Articles	$X(t) = 0.001 + (0.31L + 0.33L^{12}) X(t) + e(t)$
9.	Non-food Articles	$X(t) = 0.006 + (0.94L - 0.13L^{12}) X(t) + e(t)$
10.	Food Products	$X(t) = 0.002 + (0.17L + 0.32L^{12}) X(t) + e(t)$
11.	Textiles	$X(t) = 0.29 + (0.45L + 0.18L^{12}) X(t) + e(t)$

Table 5(d) : Equations for Forecasting : Random Coefficient Autoregressive Models

	Variable	Model
1.	All Commodities	$X(t) = (0.34L - 0.26L^{12}) X(t) + e(t)$
2.	Non-Administered Items	$X(t) = 0.40L X(t) + e(t)$
3.	Primary Articles	$X(t) = 0.44L X(t) + e(t)$
4.	Manufactured Products	$X(t) = (0.29L + 0.33L^{12}) X(t) + e(t)$
5.	Essential Commodities	$X(t) = 0.46L X(t) + e(t)$
6.	Seasonal Items	$X(t) = 0.39L X(t) + e(t)$
7.	Major Items	$X(t) = (0.26L + 0.30L^{12}) X(t) + e(t)$
8.	Food Articles	$X(t) = (0.33L + 0.28L^{12}) X(t) + e(t)$
9.	Non-food Articles	$X(t) = (0.94L - 0.14L^{12}) X(t) + e(t)$
10.	Food Products	$X(t) = (0.22L + 0.28L^{12}) X(t) + e(t)$
11.	Textiles	$X(t) = (0.44L + 0.18L^{12}) X(t) + e(t)$

Table 5(e) : Equations for Forecasting : SETAR Models (Contd.)

Variable		Model
1. All Commodities	X(t) =	$-0.0016 + (-0.3933\,L + 0.2057\,L^2 + 0.0945\,L^3 - 0.1659\,L^4 + 0.0363\,L^5 + 0.1829\,L^6 - 0.3868\,L^7 - 0.0828\,L^8 - 0.0746\,L^9 + 0.4651\,L^{10} + 0.1858\,L^{11})\,X(t) + e(t)$
		for $X(t-2) \leq -0.0035$
	=	$-0.001 + (0.5009\,L - 0.2509\,L^2 + 0.2669\,L^3 - 0.5306\,L^4 + 0.0927\,L^5 - 0.0980\,L^6 + 0.2066\,L^7 - 0.3318\,L^8 + 0.2524\,L^9)\,X(t) + e(t)$
		for $X(t-2) > 0.0018$
2. Non-Administered Items	X(t) =	$-0.0006 + (0.1517\,L + 0.3337\,L^2 + 0.6707\,L^3 - 0.1683\,L^4 - 0.4266\,L^5 - 0.0309\,L^6 + 0.0684\,L^7 - 0.1337\,L^8 - 0.1746\,L^9 + 0.2893\,L^{10} + 0.2383\,L^{11})\,X(t) + e(t)$
		for $X(t-5) \leq -0.0019$
	=	$-0.0003 + (0.2731\,L - 0.1864\,L^2 + 0.1707\,L^3 - 0.2843\,L^4 + 0.0955\,L^5 + 0.0560\,L^6 - 0.0484\,L^7 - 0.3055\,L^8 + 0.2906\,L^9 + 0.0163\,L^{10} + 0.2464\,L^{11} + 0.1671\,L^{12})\,X(t) + e(t)$
		for $X(t-5) > -0.0019$
3. Primary Articles	X(t) =	$-0.0044 + (0.3816\,L + 0.1979\,L^2 + 0.2514\,L^3 - 0.1602\,L^4 - 0.0180\,L^5 - 0.1689\,L^6 + 0.0509\,L^7 - 0.2337\,L^8 - 0.0101\,L^9 - 0.0385\,L^{10} + 0.2775\,L^{11})\,X(t) + e(t)$
		for $X(t-2) \leq 0.0036$
	=	$-0.0040 + 0.5218\,X(t-1) + e(t)$
		for $X(t-2) > 0.0036$
4. Manufactured Products	X(t) =	$0.0001 + (0.4436\,L + 0.2661\,L^2 + 0.3847\,L^3 - 0.5138\,L^4)\,X(t) + e(t)$
		for $X(t-5) \leq -0.0036$
	=	$-0.0000 + (0.3960\,L - 0.4035\,L^2 + 0.3642\,L^3 - 0.3754\,L^4 + 0.2563\,L^5 - 0.2487\,L^6 + 0.0838\,L^7 - 0.1529\,L^8 + 0.1595\,L^9 - 0.1092\,L^{10} - 0.0006\,L^{11} + 0.3311\,L^{12}) - X(t)\,e(t)$
		for $X(t-5) > -0.0036$

Table 5(e) : Equations for Forecasting : SETAR Models (Contd.)

Variable		Model
5. Essential Commodities	$X(t) =$	$-0.0023 + (0.1631\,L + 0.0469\,L^2 + 0.2216\,L^3 - 0.2209\,L^4 - 0.2561\,L^5)\,X(t) + e(t)$
		for $X(t-13) \leq 0.0029$
	$=$	$0.0038 + (0.7825\,L - 0.3665\,L^2)\,X(t) + e(t)$
		for $X(t-13) > 0.0029$
6. Seasonal Items	$X(t) =$	$-0.0042 + (0.2259\,L - 0.2362\,L^2 + 0.2737\,L^3)\,X(t) + e(t)$
		for $X(t-1) \leq -0.0098$
	$=$	$-0.0000 + (0.3372\,L + 0.1051\,L^2 + 0.0372\,L^3 - 0.2828\,L^4 - 0.1741\,L^5 + 0.1687\,L^6 + 0.0715\,L^7 - 0.3441\,L^8 + 0.0211\,L^9 + 0.1568\,L^{10} + 0.1954\,L^{11})\,X(t) + e(t)$
		for $X(t-1) > -0.0098$
7. Major Items	$X(t) =$	$-0.0035 + 0.21L\,X(t) + e(t)$
		for $X(t-12) \leq 0.0$
	$=$	$0.0019 + (0.3248L + 0.0585L^2 + 0.2324L^3 - 0.4629L^4)\,X(t) + e(t)$
		for $X(t-12) > 0.0$
8. Food Articles	$X(t) =$	$0.0109 + (0.4399\,L + 0.2680\,L^2 + 0.2292\,L^3 - 0.1932\,L^4 - 0.2076\,L^5 - 0.2633\,L^6 - 0.0609\,L^7 - 0.1297\,L^8 - 0.0902\,L^9 - 0.0626\,L^{10} + 0.0888\,L^{11} + 0.2065\,L^{12})\,X(t) + e(t)$
		for $X(t-2) \leq 0.0024$
	$=$	$-0.0044 + 0.4270\,X(t-1) + e(t)$
		for $X(t-2) > 0.0024$
9. Non-food Articles	$X(t) =$	$0.0328 + (0.5466\,L + 0.1635\,L^2 - 0.2041\,L^3 + 0.0680\,L^4 + 0.3082\,L^5 - 0.2060\,L^6 - 0.0344\,L^7 + 0.10445L^8 - 0.0265\,L^9 + 0.1726\,L^{10} + 0.0607\,L^{11} - 0.4289\,L^{12})\,X(t) + e(t)$
		for $X(t-9) \leq 0.0689$
	$=$	$0.0159 + (1.3392\,L - 0.5008\,L^2 + 0.3286\,L^3 - 0.1630\,L^4 - 0.0699\,L^5 - 0.0137\,L^6 + 0.3571\,L^7 - 0.4282\,L^8)\,X(t) + e(t)$
		for $X(t-9) > 0.0689$

Table 5(e) : Equations for Forecasting : SETAR Models (Concld.)

Variable		Model
10. Food Products	X(t) =	$0.0205 + 1.2083\,X(t-1) + e(t)$
		for $X(t-1) \le -0.0096$
	=	$-0.0023 + (0.3539\,L - 0.3266\,L^2 + 0.3695\,L^3 - 0.2557\,L^4 - 0.0183\,L^5 - 0.2248\,L^6 + 0.0278\,L^7 - 0.3054\,L^8 - 0.0137\,L^9 - 0.0061\,L^{10} + 0.3414\,L^{11})\,X(t) + e(t)$
		for $X(t-1) > -0.0096$
11. Textiles	X(t) =	$0.0045 + (0.3968\,L - 0.0462\,L^2 - 0.1715\,L^3 + 0.5809\,L^4 - 0.1841\,L^5 + 0.0977\,L^6 + 0.3150\,L^7 - 0.4553\,L^8 - 0.3820\,L^9 - 0.1192\,L^{10} - 0.1916\,L^{11} - 0.6625\,L^{12})\,X(t) + e(t)$
		for $X(t-4) \le -0.0059$
	=	$0.0006 + 0.5614\,X(t-1) + e(t)$
		for $X(t-4) > -0.0059$

Table 5(f) : Equations for Forecasting : ARCH Models

Variable	Model
1. All Commodities	$X(t) = 0.0006 + 0.15L\,X(t) + e(t)$
2. Non-Administered Items	$X(t) = 0.0005 + 0.32L\,X(t) + e(t)$
3. Primary Articles	$X(t) = 0.20 + 0.44L\,X(t) + e(t)$
4. Manufactured Products	$X(t) = 0.0003 + (0.17L + 0.60L^{12})\,X(t) + e(t)$
5. Essential Commodities	$X(t) = 0.45L\,X(t) + e(t)$
6. Seasonal Items	$X(t) = 0.0001 + 0.32L\,X(t) + e(t)$
7. Major Items	$X(t) = 0.0001 + (0.38L - 0.05L^{12})\,X(t) + e(t)$
8. Food Articles	$X(t) = 0.0003 + 0.40L\,X(t) + e(t)$
9. Non-food Articles	$X(t) = 0.0876 + (0.32L + 0.10L^{12})\,X(t) + e(t)$
10. Food Products	$X(t) = -0.0001 + 0.33L^{12}\,X(t) + e(t)$
11. Textiles	$X(t) = 0.23 + 0.70L\,X(t) + e(t)$

Appendix 1 : Constituents of Different Groups and their Weights in WPI (Contd.)

COMM_NAME	COMM_WT
1. ALL COMMODITIES	100.0000
2. Primary Articles	32.2950
3. Manufactured Products	57.0420
4. Essential Commodities	35.9620
(A) Cereals	6.8240
(B) Pulses	1.0930
(C) Vegetables	1.2910
(D) Fruits	2.7980
(E) Milk	1.9610
(F) Eggs,Fish & Meat	1.7830
(G) Condiments & Spices	0.9470
(H) Tea & Coffee	0.6890
(I) Grain Mills Products	1.5300
(J) Bakery Products	0.2420
(K) Sugar,Khandsari & gur	4.0590
(L) Salt	0.0350
(M) Edible Oils	2.4450
(N) Tea & coffee processing	0.2360
(O) Soft drink & carbonated water	0.0660
(P) Manu. of bidi,cig,tobacco & zarda	1.9250
(Q) Cotton textiles	6.0930
(R) Drugs & medicines	1.0650
(S) Soaps & detergents	0.8800
5. Seasonal Items	34.4030
(A) Food articles	17.3860
(B) Non-food articles	10.0810
(C) Sugar,Khandsari & gur	4.0590
(D) Edible Oils	2.4450
(E) Oil cakes	0.4320

Appendix 1 : Constituents of Different Groups and their Weights in WPI (Concld.)

COMM_NAME		COMM_WT
6.	Major Items	31.8420
(A)	Rice	3.6850
(B)	Wheat	2.2480
(C)	Milk	1.9610
(D)	Raw Cotton	1.3350
(E)	Groundnut seed	1.2960
(F)	Cotton seed	1.2540
(G)	Sugarcane	2.7060
(H)	Imported petroleum crude	3.0040
(I)	Indigenous petroleum crude	1.2700
(J)	High speed diesel oil	2.1540
(K)	Sugar	2.0130
(L)	Gur	1.7460
(M)	Bidi	1.0860
(N)	Poplin/shirting	1.1270
(O)	Dhotics,sarees & voils	1.1880
(P)	Blended mixed cloth	1.5730
(Q)	Cotton Hosiery	1.1860
(R)	Resawan &hewan timber planks railways sleepers & others	1.0100
7.	Administered Items	19.6970
(A)	Petroleum crude & natural gas	4.2740
(B)	Coal Mining	1.2560
(C)	Mineral oils	6.6660
(D)	Electricity	2.7410
(E)	Fertilizers	1.7480
(F)	Iron & steel	2.4410
(G)	Non-ferrous metals other than aluminium	0.5710
8.	Food articles	17.3860
9.	Non-food articles	10.0810
10.	Food products	10.1430
11.	Textiles	11.5450

Appendix 2 : Test For Stationarity

The test makes use of the "evolutionary spectra" of a series. It is known that the evolutionary spectra of a stationary series is uniform over time. Thus to apply this method one needs to estimate evolutionary spectra over a range of time points for different frequencies. Let h(t,w) be the evolutionary spectra of the series for frequency w at time point t. For a time series $\{X(t)\}$ the estimate of h(t,w) denoted by $h^*(t,w)$ may be obtained via the use of "double window" $\{g_u, z_v\}$ suggested by Priestley (1988) as follows

$$h^*(t,w) = \sum_v z_v \mid U_{t-v} \mid^2$$

where $U_t = \sum_u g_u X(t-u) \exp[-iw(t-u)]$,

$\{g_u\}$ and $\{z_v\}$ are suitably chosen windows.

It is shown (Priestley, 1988) that $h^*(t,w)$ is approximately unbiased estimate of h(t,w). Further

$$\text{Cov}\{ h^*(t_1,w_1), h^*(t_2,w_2)\} = 0$$

whenever (a) $| w_1 \pm w_2 |$ > bandwidth of square of the Fourier transformation of $\{g_u\}$

or (b) $| t_1 - t_2 |$ > bandwidth of $\{z_v\}$.

Formulation of The Test For Stationarity

Let us assume that evolutionary spectra is estimated over the interval (0,T). We choose a set of times $\{t_1,t_2, \ldots ,t_p\}$ and a set of frequencies $\{w_1,w_2, \ldots ,w_q\}$ which cover the range of times and frequencies of interest and satisfy the conditions (a) and (b) stated above.

Define $Y_{ij} = \log[h^*(t_i,w_j)]$.

and $h_{i,j} = \log[h(t_i,w_j)]$, i=1,2, ... ,p and j=1,2, ... ,q.

Then from Priestley (1988), $Y_{ij} = h_{ij} + e_{ij}$ where e_{ij} are independent and identically distributed as $N(0, \sigma^2)$ with $\sigma^2 = \text{Var}[\log_e\{h^*(t,w)\}]$. To test $\{X(t)\}$ for stationarity a two factor analysis of variance model is set up. Let S_T, S_F and S_{I+R} denotes the "between times sum of squares", "between frequencies sum of squares" and "interaction plus residual sum of squares" respectively.

To test the null hypothesis Ho : "{ X(t) } is stationary" the relevant statistics are S_{I+R}/σ^2 and S_I/σ^2 both of which follow Chi-square distribution with (p-1)(q-1) and (p-1) degrees of freedom respectively. The stationarity test starts with examining the statistics S_{I+R}/σ^2. If this is significant then it is concluded that {X(t)} is a non-stationary series and not uniformly modulated (a non-stationary time series {X(t)} is said to be uniformly modulated if we can represent X(t) as $X(t)=c(t)X^*(t)$ where c(t) is a deterministic function of time t and $X^*(t)$ is a stationary time series). Otherwise we conclude that the series is at least uniformly modulated and proceed for testing for stationarity. If both S_{I+R}/σ^2 and S_I/σ^2 are insignificant we conclude that the time series {X(t)} is stationary.

In practice one may use Bartlett's window for $\{g_u\}$ and Daniell window for $\{w_v\}$ (for details see Priestley, 1988). The discrete form of these windows are given as

$$g_u = \frac{1}{2\sqrt{(h\pi)}} \quad \text{if } |u| \le h$$

$$= 0 \quad \text{if } |u| > h$$

and $z_v = 1/k$ if $-k/2 \le v \le k/2$

$= 0$ otherwise

where h and k are suitably chosen positive integers. Use of these windows results in $\sigma^2 = (4h)/(3k)$. In our calculation we took h = 12 and k = 12 and thus $\sigma^2 = 4/3$.

Appendix 3 : Test for Linearity

A General Non-linearity Test

Let $\{Y(t)\}$ be a stationary time series. We can write $Y(t)$ in its general form, as

$$Y(t) = \mu + \sum_{i=-\infty}^{\infty} b_i e_{(t-i)} + \sum_{i>j=-\infty}^{\infty} b_{ij} e_{(t-i)} e_{(t-j)}$$

$$+ \sum_{i,j,k=-\infty}^{\infty} b_{ijk} e_{(t-i)} e_{(t-j)} e_{(t-k)} + \ldots ,$$

where μ = mean of $Y(t)$, $\{e(t)\}$ is a strictly stationary process of independent and identically distributed random variables. Obviously $Y(t)$ is nonlinear if any of the higher order coefficients, $\{b_{ij}\}$, $\{b_{ijk}\}$, ..., are non-zero. Following this argument, the test procedure as formulated by Tsay may be performed systematically as follows :

Step 1 : Fix a positive integer M. Regress $Y(t)$ on $\{1, Y_{(t-1)}, Y_{t-2)}, \ldots, Y_{(t-M)}\}$ by least square technique. Let $\{e^*(t)\}$ be the estimated residual series.

Step 2 : Define $U_t = (Y_{(t-1)}, \ldots, Y_{(t-M)})$
Z_t = *Transpose of vect* $(U_t' U_t)$
where U_t' = Transpose of U_t.

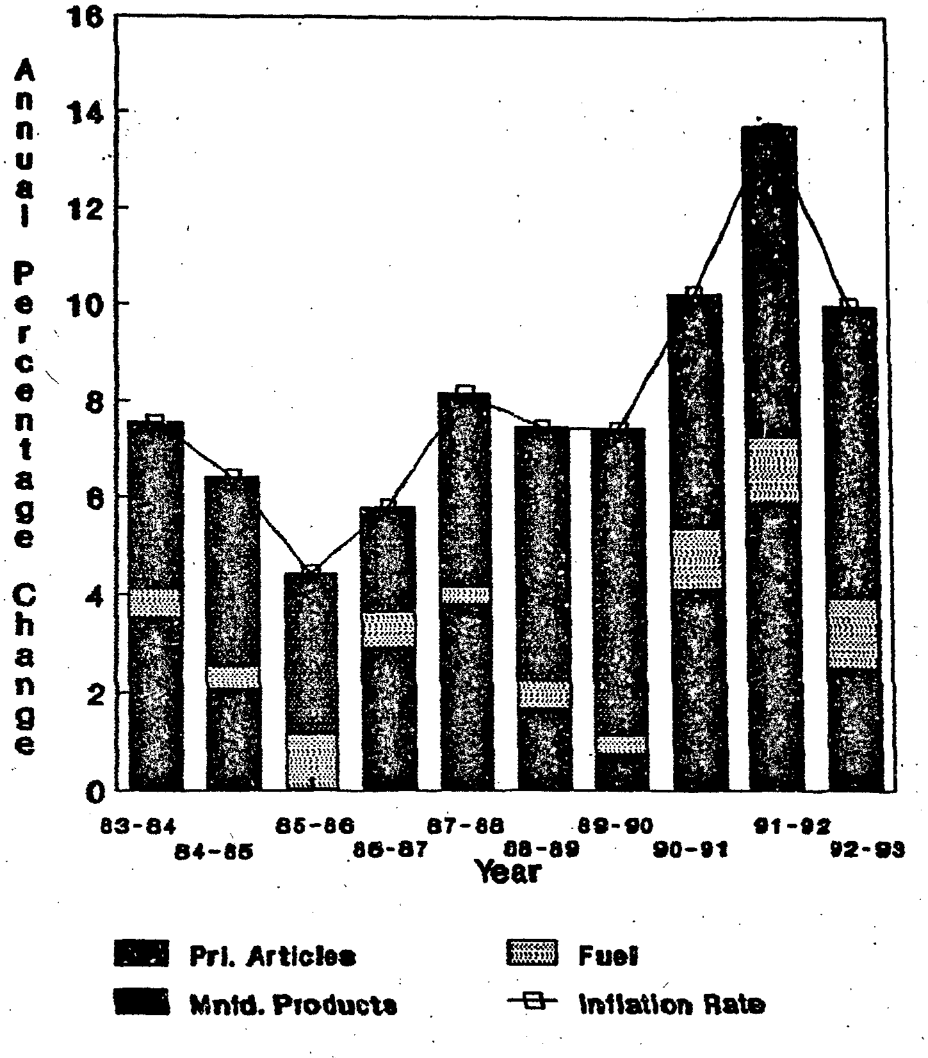
Now regress the vector Z_t on $\{1, Y_{(t-1)}, \ldots, Y_{(t-M)}\}$ using least square technique in multivariate framework. Let X_t be the residual vector.

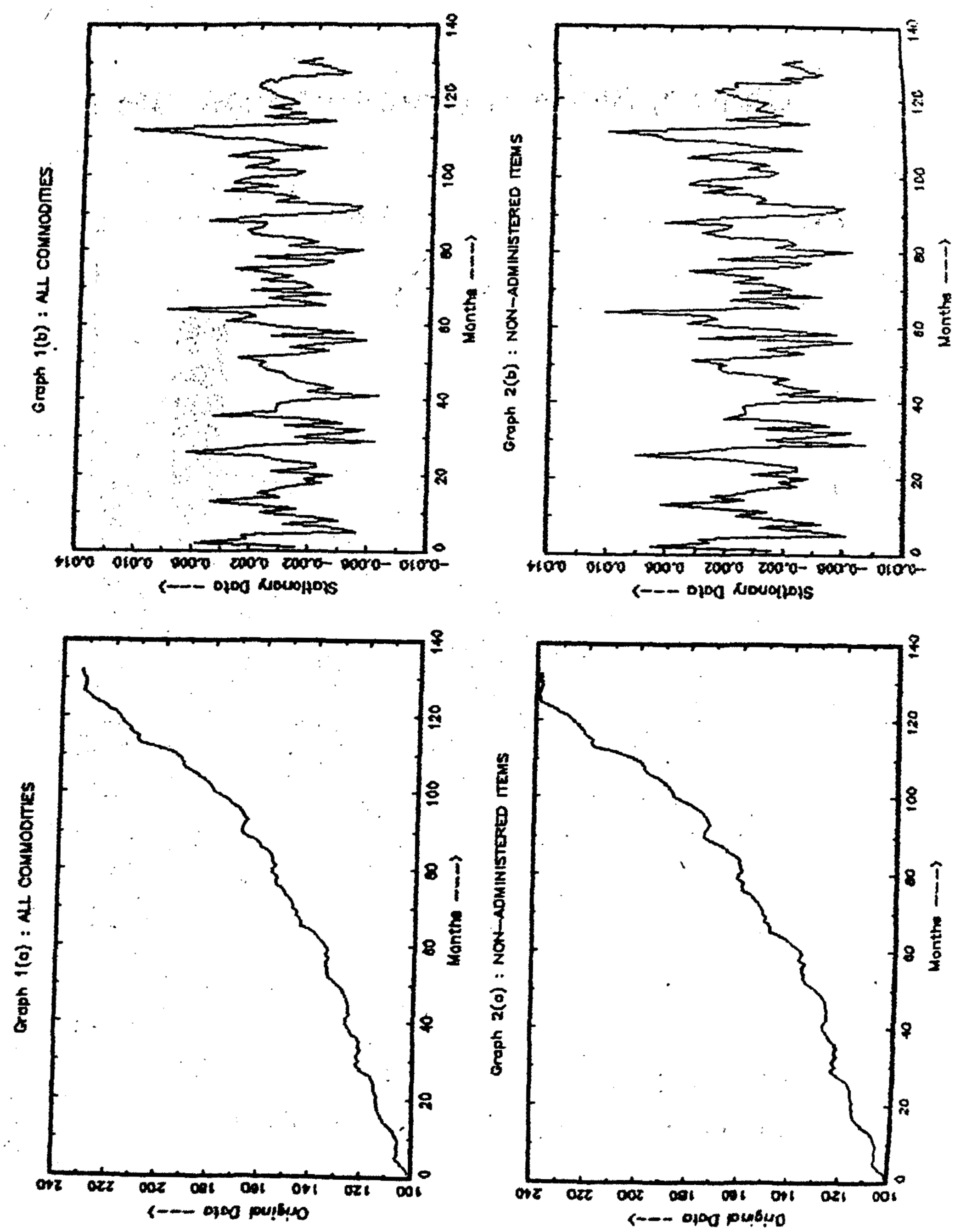
Step 3: Regress $e^*(t)$ on X_t and let F^* be the F ratio of the mean square of regression to the mean square error. i.e. fit
$e^*(t) = X_t \beta + \epsilon_t$, $t = M+1, \ldots, n$ ... (A3.1)
n being the sample size and define

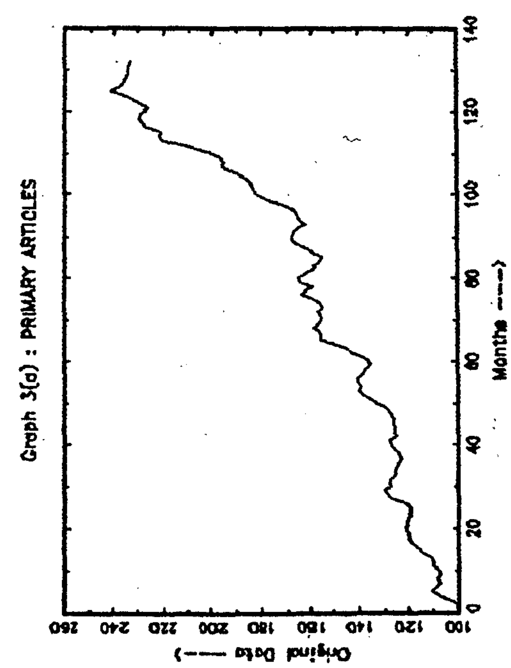
$$F = \frac{\{(\Sigma X_t e^*(t) (\Sigma X_t' X_t)^{-1} \Sigma X_t' e^*(t)\}/m}{\Sigma \epsilon_t^2 / (n-M-m-1)}$$

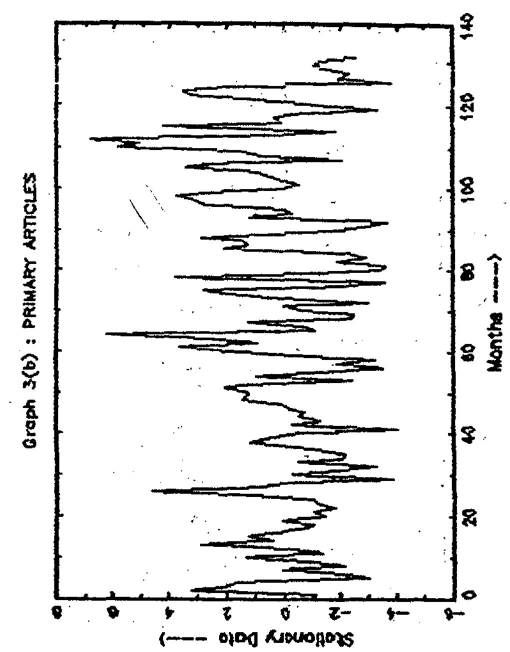
where $m = M(M+1)/2$ and summations are over t from M+1 to n and ϵ_t is the least squares residual for (A3.1). Under the null hypothesis of linearity F follows a F-distribution with (m, n-M-m-1) degrees of freedom.

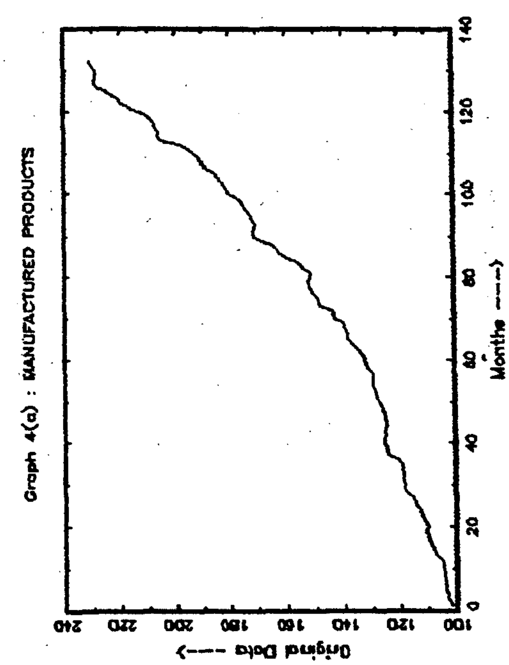
Chart 1: Share in overall inflation rate

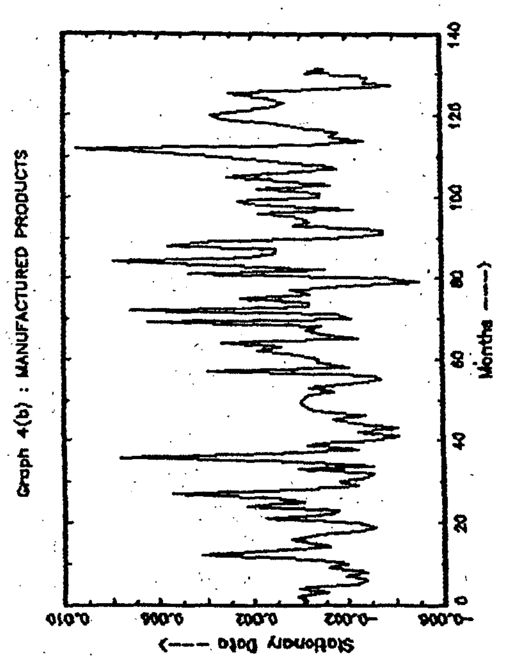


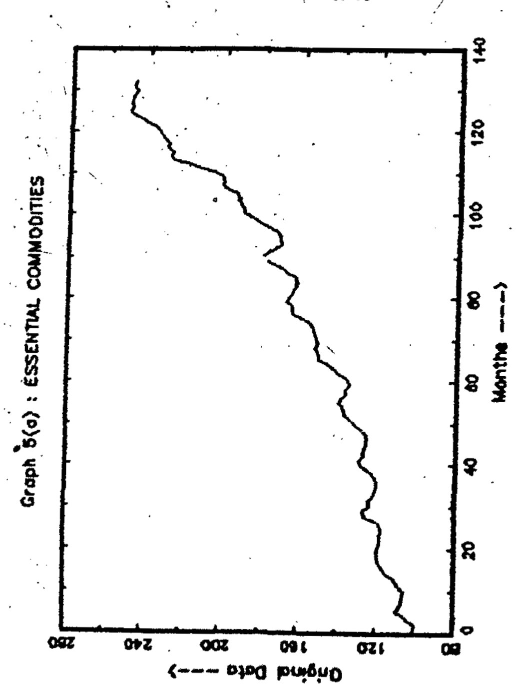

Graph 1(a) : ALL COMMODITIES
Graph 1(b) : ALL COMMODITIES
Graph 2(a) : NON-ADMINISTERED ITEMS
Graph 2(b) : NON-ADMINISTERED ITEMS
Months ---->
Original Data ---->
Stationary Data ---->
0 20 40 60 80 100 120 140
100 120 140 160 180 200 220 240
-0.010 -0.006 -0.002 0.002 0.006 0.010 0.014

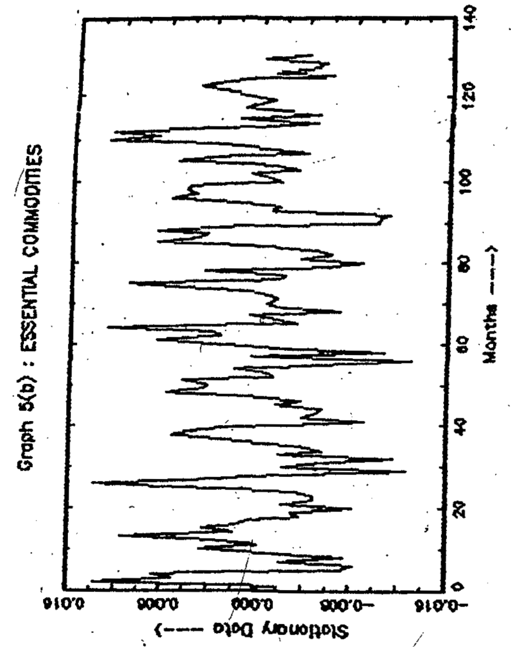

Graph 3(a) : PRIMARY ARTICLES
Original Data ---->
Months ---->

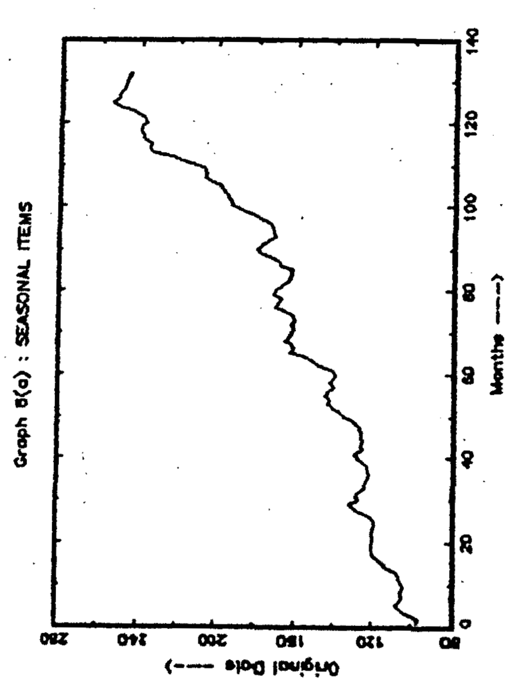

Graph 3(b) : PRIMARY ARTICLES
Stationary Data ---->
Months ---->

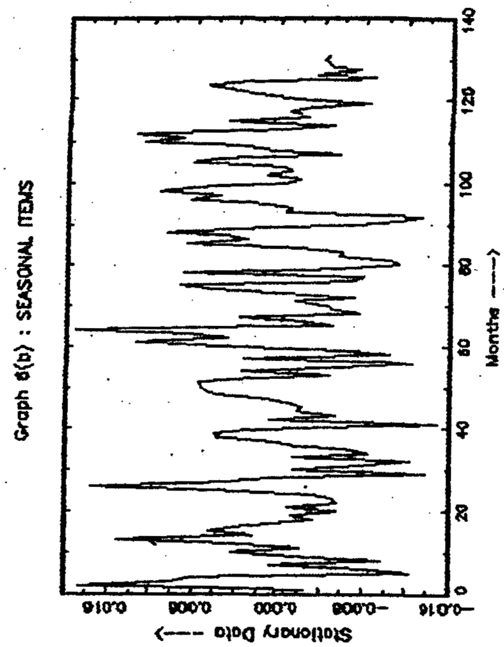

Graph 4(a) : MANUFACTURED PRODUCTS
Original Data ---->
Months ---->

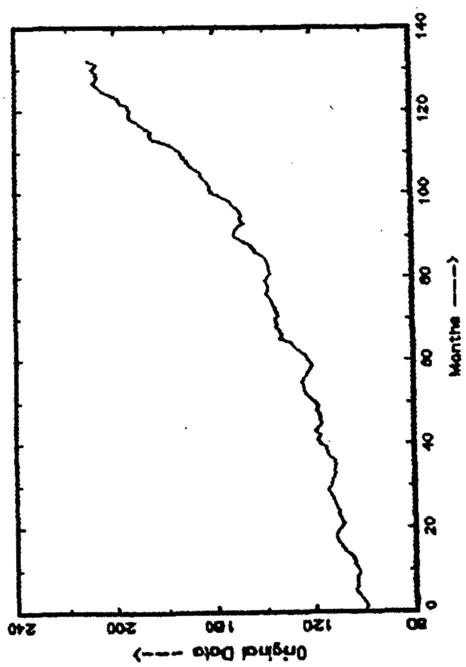

Graph 4(b) : MANUFACTURED PRODUCTS
Stationary Data ---->
Months ---->


Graph 5(a) : ESSENTIAL COMMODITIES
Original Data ---->
Months ---->

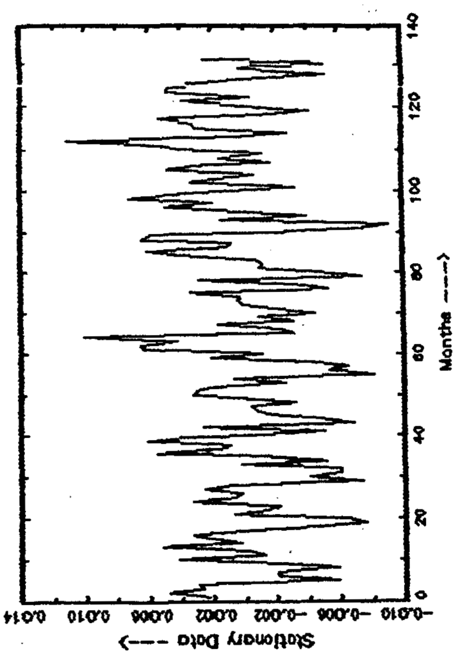

Graph 5(b) : ESSENTIAL COMMODITIES
Stationary Data ---->
Months ---->


Graph 6(a) : SEASONAL ITEMS
Original Data ---->
Months ---->

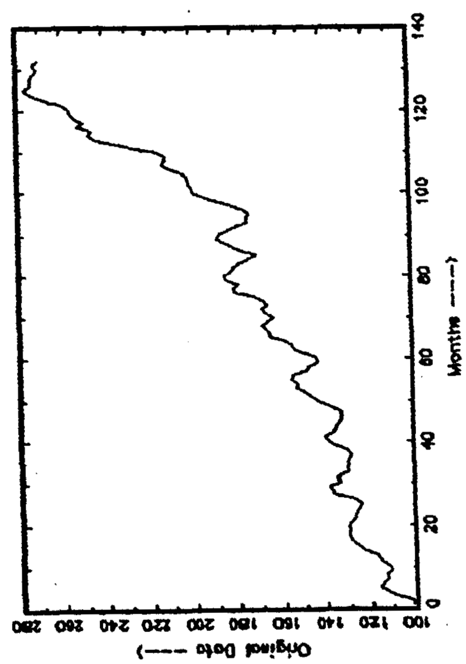

Graph 6(b) : SEASONAL ITEMS
Stationary Data ---->
Months ---->



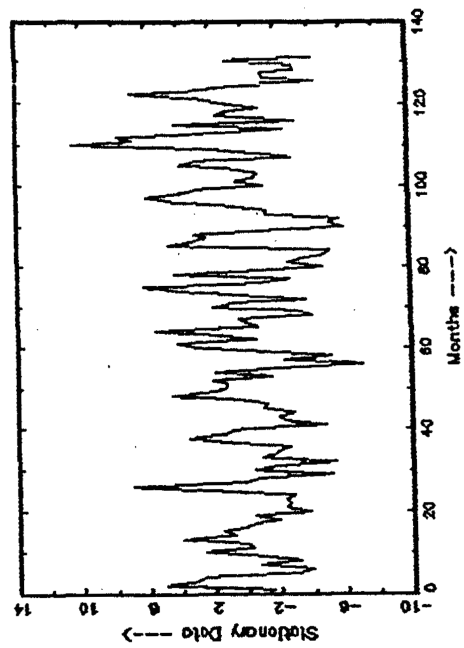
Graph 7(a) : MAJOR ITEMS



Graph 7(b) : MAJOR ITEMS



Graph 8(a) : FOOD ARTICLES



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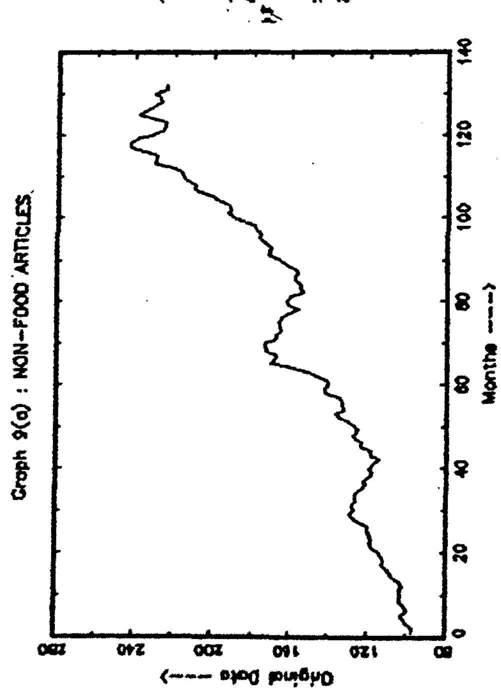
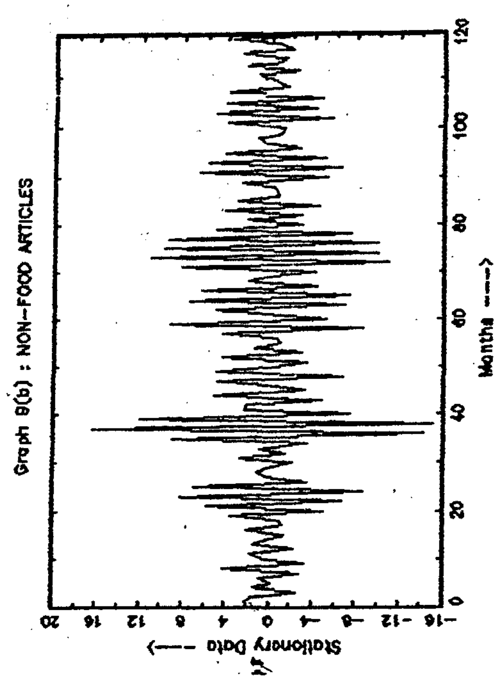
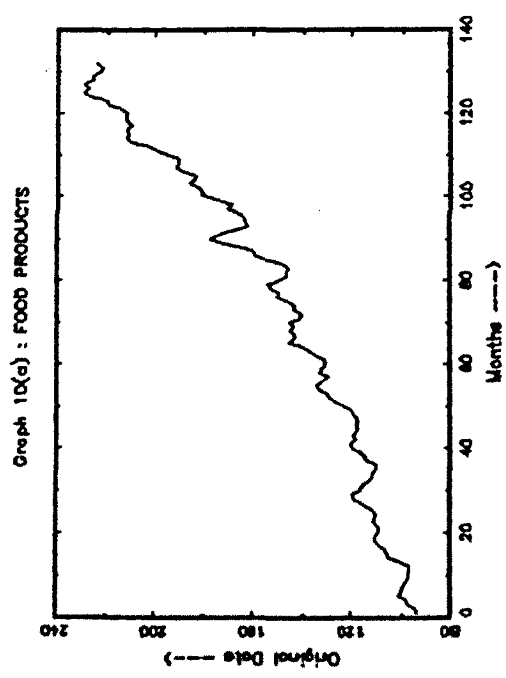
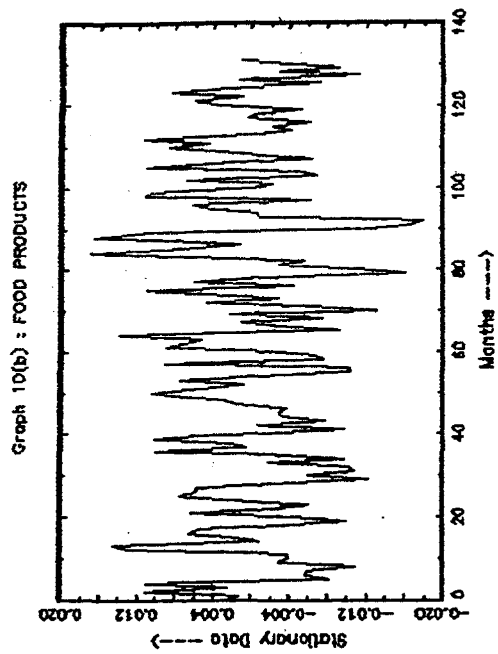

Graph 9(a) : NON-FOOD ARTICLES
Original Data ---->
Months ---->


Graph 9(b) : NON-FOOD ARTICLES
Stationary Data ---->
Months ---->


Graph 10(a) : FOOD PRODUCTS
Original Data ---->
Months ---->


Graph 10(b) : FOOD PRODUCTS
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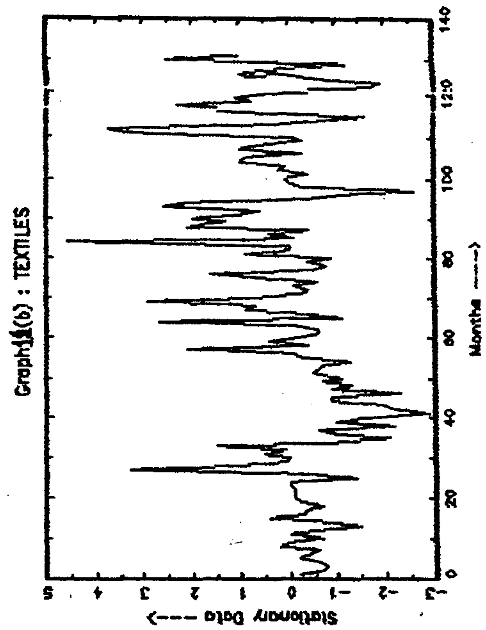
Months ---->


TEXTILES
Stationary Data
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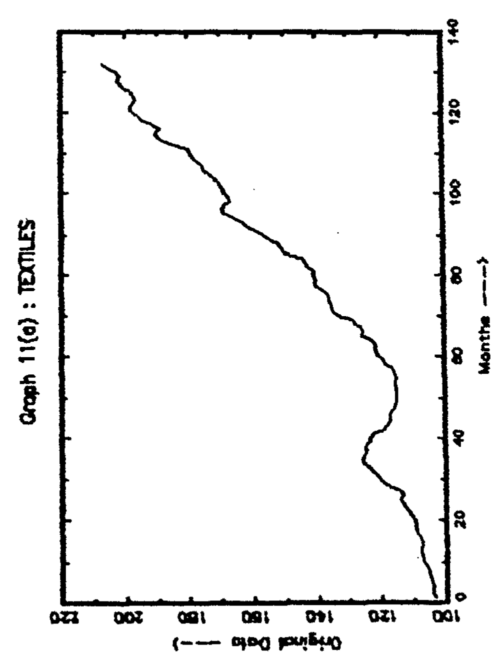
Graph 11(a) : TEXTILES
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Months

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An Analysis of Production Trends in Pulses

K.S. Ramachandra Rao*

The objectives of the paper are to review the production trends and other major aspects of pulse crops and estimate the acreage response function. The paper also attempts to explain the behaviour of output and yield of all pulse crops. India accounts for the largest share at one-fourth of the world's output of total pulses. But, the growth of output of pulses in India is erratic and grew at a fractional growth of 0.4 per cent per annum during the past three decades. The Eighties, however, witnessed an annual growth of 3.0 per cent in the output of all pulses. The paper finds that rainfall and relative prices - own prices relative to its competing crop - are the main factors influencing the acreage allocation to pulse crops. The yield elasticity of output is found to be high at 0.92 suggesting high yielding varieties of seeds of pulses can increase the production of pulses. Increasing the use of high yielding variety of seeds would, therefore, help improve the availability of pulses and go a long way to meet the high demand for pulses.

Introduction

Pulses constitute the main protein and nutrient part of Indian diet. The production of pulses witnessed an erratic growth during the past three decades. The output of pulses grew at a fractional rate of 0.40 per cent per annum (compound rate) during the past three decades as against the annual growth in population at 2.2 per cent. In absolute terms the output fluctuated within a range of 8 to 14 million tonnes and stood at 12.0 mn tonnes in 1991-92 but estimated to reach 14.7 mn tonnes in 1992-93[1]. The area under pulse crops, however, fluctuated in a narrow range between 22 and 24 million hectares. The yield rate varied between 377 kgs. per hectare and 617 kgs. per hectare; touching the peak yield in 1992-93. Coupled with the population growth, the per capita net availability of pulses, therefore, became almost half from 69 grams per day in 1960-61 to 39.7 grams in 1990-91 as against a

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minimum requirement of 104 grams per day per capita as estimated by Sukhatme (1965) and lower than the minimum level of 45 grams prescribed by the Indian Council of Medical Research (1969).

Considerable efforts were made to increase the productivity of important cereals (like wheat and rice) through use of high yielding variety of seeds and additional irrigation facilities. The Department of Agriculture and Co-operation, Government of India[2], admittedly reported that "pulses production did not keep pace with the advancement in the technology and breakthrough in the production of foodgrains covered by Green Revolution". They added that "as a result thereof, in many areas, pulses have been relegated to the status of comparatively unimportant crops, confined to marginal and unirrigated conditions". Thus, the green revolution in cereals along with higher relative prices and relative yield of the crops would have influenced the farmers in diverting more area to those crops than to pulses. Efforts similar to green revolution, if implemented, would considerably help to boost the output of pulses.

To fill the gap between demand and supply of pulses and to improve the production of pulses, the Government of India gave special thrust during the Sixth Five Year Plan. They have since been making efforts through the National Pulses Development Project (NPDP) and Special Foodgrains Production Programme (SFPP)-Pulses. The Government of India laid emphasis on timely sowing, use of improved seeds, fertilizers and pesticides, irrigation, etc., for improvement in the production of pulses. It is interesting to examine whether any of these factors, besides relative prices, have any impact on farmers' response in allocating more area to pulse crops and increase the yield so as to improve the output levels of pulses.

The objective of the paper is, thus, to estimate the acreage response function for all pulse crops. Attempt is also made to explain the behaviour of output and yield of pulses. However, before estimating the functions, trends in various aspects of pulses have been reviewed based on the data for the period 1960-61 to 1990-91. The response functions are, however, estimated for more recent period, 1976-77 to 1991-92, so that latest trends are captured by the equations. Forecasts of output of pulses are also generated from supply and demand points of view.

The rest of the paper is organised in four sections. Section 2 presents the data sources. Section 3 discusses the production and price trends of pulses along with certain other aspects of these crops. Specifications of the model estimated in the paper are given in Section 4. The empirical results are discussed in Section 5 along with a few broad conclusions.

Section 2

Data Sources

Data on area, production and yield of all pulse crops, and certain other aspects of pulse crops have been obtained from the publications on **Area and Production of Principal Crops, Indian Agriculture in Brief, Bulletin on Food Statistics, Agricultural Situation in India** published by the Ministry of Agriculture, Government of India. Rainfall data are published by the India Meteorological Department. Statistics on fertilizer consumption are obtained from **Fertilizer Statistics** published by the Fertilizer Association of India. However, consumption of fertilizers by pulse crops are not readily available. These data have been estimated based on the study of NCAER on 'Fertilizer Demand' for 1977-78 in the absence of any other relevant information. It is estimated that the pulse crops account for about 13 per cent of total consumption of fertilizers by all crops and this share is assumed for the study period. Index numbers of wholesale prices of pulses and wheat are available upto 1981-82 with base 1970-71=100 and thereafter, with base 1981-82 = 100. In order to have a comparative series for the study period, the new price series has been converted into 1970-71 base with appropriate conversion factors. Statistics on output of pulses of different countries are obtained from **Production Year Book** published by the Food and Agriculture Organisation of the United Nations.

Section 3

Trends in Certain Aspects of Pulse Crops

India's Share in World Production

India is one of the major countries producing pulses which accounted for the largest share of 27 per cent of the world output of pulses in 1970 and continued to hold its rank although its share has declined to about one-fifth of the world output in 1990 (Table 1). The erstwhile USSR and China followed with second and third ranks accounting for 16.6 per cent and 11.0 per cent, respectively, in 1990. It is interesting to note that China and the former USSR had high yield of 1,475 kgs. per hectare and 1,683 kgs. per hectare, respectively, with only 6.4 per cent and 8.5 per cent of total cropped area of 68.8 mn hectares in 1990 compared with India's share of 33.9 per cent in gross cropped area with a yield of only 553 kgs. per hectare. USA recorded the largest yield of 1,693 kgs. per hectare though it accounted for only 2.8 per cent of the world output of pulses. Mexico and Brazil together accounted for about 6.4 per cent of the world output in 1990.

Geographical Factors

Pulse crops are also known as soil building crops. Many pulses are grown on dry lands and also as mixed crops with cereals. Little moisture will help the crops to give a better yield. When two crops are sown, pulses are sown as second crop in both *kharif* and *rabi* seasons. Important *kharif* pulses are red gram (tur), horse gram, black gram (urad), green gram (moong) and cluster bean. *Rabi* pulses are Bengal gram (Chana), lentil (masur), wal (Indian pea), field pea and lakh. Among these pulses, Bengal gram has the largest share in total output of all pulses.

Cropping Pattern

Although India accounted for the largest share in world output of pulses, production of pulses in India is not encouraging when compared to that of total cereals and other crops. Pulse crops accounted for only 14.6 per cent of the gross cropped area in 1990-91 compared with 61.1 per cent shared by cereals and millets (Table 2). However, in absolute terms, the area under pulse crops hovered around 22-24 mn hectares during the period under review and stood at 24.66 mn hectares in 1990-91. In spite of Government's emphasis to improve the production of pulses through special programmes, like National Pulses Development Project and Special Foodgrain Production Programme, the area under pulses did not increase significantly.

Production Patterns and Trends

The output of cereals registered more than two-fold rise from 69.3 mn tonnes in 1960-61 to 155.1 mn tonnes in 1991-92, resulting in an increase in their share from 84.5 per cent to 92.8 per cent of total foodgrains production during the same period. On the other hand, the share of output of all pulses declined from 15.5 per cent to 7.2 per cent during the same period (Table 3). Among the pulses' crops, Gram accounted for the largest share of 48.8 per cent in 1960-61 which declined to 34.2 per cent in 1990-91. Other pulses, thus, registered an increase both in terms of magnitude and share in all pulses.

It is observed that the growth in production of pulses is very erratic and varied in the range from 8.3 mn tonnes in 1966-67 to 14.3 mn tonnes in 1990-91 (Table 4). The total output of all pulses decreased during 1960s, although through fluctuations, by 0.73 per cent per annum[3] from 12.7 mn tonnes in 1960-61. The decline in growth rate continued in 1970s at a rate of 1.07 per cent per annum and the output level stood at 10.6 mn tonnes in 1980-81. The growth in pulses' production touched a positive rate of 3.04 per cent annually during 1980s and was estimated to reach a peak level of 14.3 mn tonnes in 1990-91. It is further observed that the variability, as measured through the coefficient of variation, is the largest at 11.5 per cent in output during 1970-71 to 1990-91 as against 9.5 per cent and 4.2 per cent, respectively, in yield and area. It may be mentioned in this connection that steps were initiated to raise the output of pulse crops through government schemes and this could have resulted in a positive growth in 1980s[4]. However, these steps do not seem to be adequate enough to keep pace with the increasing demand.

Among various pulse crops, Bengal gram accounted for about one-third of total output of pulses. It is produced largely in Uttar Pradesh, Madhya Pradesh, Rajasthan and Haryana which had accounted for 80 to 85 per cent of total production of Bengal gram.

Kharif and Rabi Crops

As mentioned earlier, the pulse crops are grown in both *kharif* and *rabi* seasons. The output in *rabi* season formed about 70 per cent of total output of all pulses with about 59 per cent of total cropped area of all pulses during 1966-67 to 1969-70 (Table 5). Over the period of three decades, the *kharif* pulses outpaced the *rabi* pulses in terms of growth in both output and gross cropped area; the share of *kharif* output had increased from 30 per cent of total pulses output in the second half of Sixties to 39.6 per cent during 1986-87 to 1990-91 while that of area increased from 41.1 per cent to 47.8 per cent during the same period. On the other hand, the share of *rabi* pulses had declined in respect of both area and output (58.7 per cent to 52.8 per cent and 69.6 per cent to 60.4 per cent, respectively). In absolute terms, the *kharif* season's area and output stood at 11.4 mn hectares and 5.4 mn tonnes, respectively, in 1990-91 while the corresponding levels for *rabi* pulses were 13.3 mn hectares and 8.9 mn tonnes. Thus, it appeared that output of *kharif* pulses, *viz.*, red gram, green gram, black gram and horse gram, gained some importance over *rabi* pulses other than Bengal gram.

Irrigated Area under Pulses

The gross irrigated area under all crops increased steadily during the past three decades from 28.0 mn hectares in 1960-61 to 54.0 mn hectares in 1985-86 (Table 6). Cereal crops accounted for about 72.1 per cent of gross irrigated area of all crops whereas pulse crops shared only about 6.8 per cent in 1960-61 which decreased to about 3.9 per cent in 1985-86. In absolute terms, irrigated area under pulses hovered around 2.0 to 2.1 mn hectares. Although large quantity of pulse crops is grown under unirrigated conditions, irrigation also facilitates to boost the production levels to a certain extent, particularly in the case of loam soils. As such, increased irrigation facility to a certain extent may raise the output of pulses.

Spatial Distribution

The state-wise distribution of area sown under pulses and the corresponding production pattern for bench mark years are presented in Table 7. Uttar Pradesh had the largest share of 30.2 per cent in 1960-61 in the all-India output of pulses. The share, however, decreased to 22.3 per cent in 1980-81 and further to 19.6 per cent in 1990-91. The erstwhile state of Punjab and Madhya Pradesh followed with their respective shares at 16.6 per cent and 15.0 per cent in 1960-61. Madhya Pradesh outpaced U.P. and Punjab in the production of pulses with its share increasing to 20.6 per cent in 1990-91, thus, relegating U.P. to second position. Rajasthan also improved its share from 9.4 per cent in 1960-61 to 12.2 per cent in 1990-91. Although Punjab was the second largest state producing pulses (16.6 per cent) in 1960-61, the output of Punjab together with Haryana accounted for only 9.5 per cent in 1970-71 which further decreased to 4.6 per cent in 1990-91. This would possibly be due to the fact that the green revolution in wheat and rice production must have influenced the farmers to shift away from pulse crops. The share of Bihar decreased from 8.5 per cent in 1960-61 to 6.5 per cent in 1990-91. Andhra Pradesh, Karnataka and Orissa, on the other hand, improved their shares during the period under review.

Trends in Prices of Pulses

Data on wholesale price indices of pulses, wheat and all commodities along with annual variations in the indices for the years from 1960-61 to 1991-92, are presented in Table 8. The rise in prices of all pulses was multifold during the past three decades and in particular, rose by 185 per cent during the Eighties alone. Annual change in prices behaved erratically similar to output and varied between -32.0 per cent in 1968-69 to 48.3 per cent in 1964-65. Prices of pulses rose steeply in the years succeeding drought year(s), such as 1964-65 (48.3 per cent) 1967-68 (45.8 per cent), 1977-78 (47.7 per cent), 1980-81 (32.4 per cent) and 1988-89 (30.2 per cent). The rise in prices of wheat, a competing crop, was large in 1974-75 (69.2 per cent), 1964-65 (30.4 per cent) and 1967-68 (20.2 per cent). It is observed that the price level of the competing crop and its annual growth are much lower than those of pulses.

For the purpose of analysis, the total period under review has been divided into three sub-periods, each covering a decade. The annual growth rates (compound) during the Sixties, the Seventies, and the Eighties in the prices of pulses, wheat and all commodities are given in Table 9.

It is seen from the table that the rise in prices of pulses was maximum at 12.45 per cent per annum during the Seventies while the rise was more or less the same around 9 per cent in the Sixties and the Eighties. The long term growth rate in prices was 10.17 per cent as against 6.7 per cent in prices of wheat and 7.7 per cent in the general price level. It can also be seen that the output of pulses decelerated in the first two decades but registered a positive rate of 3.04 per cent per annum during the Eighties. The fluctuating level of output and the increasing demand for pulses must have resulted in higher growth in their prices.

Table 9 : Growth Rates in Wholesale Price Indices of Pulses, Wheat, and All Commodities

Period	All Pulses	Wheat	All Commodities
1960-61 to 1970-71	9.04 (-0.73)	7.82 (8.02)	6.14
1971-72 to 1980-81	12.45 (-1.07)	5.83 (4.31)	9.91
1981-82 to 1990-91	9.08 (3.04)	6.46 (4.26)	7.16
1960-61 to 1990-91	10.17 (0.40)	6.70 (5.52)	7.73

Notes : 1. Growth rates are at compound rate.
2. Figures in brackets relate to growth rates in respective output in the corresponding periods.

Monthly data on wholesale prices of all pulses were also examined for the seasonality and stability patterns in the series. For this purpose, the series was considered for two sub-periods, *viz.*, 1971-72 to 1981-82 and 1982-83 to 1991-92. The seasonal factors are presented in Table 10. It was observed that the seasonal factor was at peak in November in Period 1 which had shifted to

October in Period 2. Based on the average range (AR) of the seasonal factors and the coefficient of variation (CV) of the range, it was observed that the series is moderately seasonal and moderately stable in both the periods as seen from Table 10.[5] It may also be noted that the seasonality was more in period 1 than in period 2. But the seasonality was less stable in period 2 than that in period 1. This indicates that the prices were more volatile in period 2, perhaps, due to increasing demand and poor growth in output levels.

Table 10: Average Seasonal Factors in WPI of All Pulses

Month	1971-72 to 1981-82 (period 1)	1982-83 to 1991-92 (period 2)
April	95.25	97.01
May	95.43	97.05
June	96.21	98.35
July	98.44	100.28
August	100.24	101.98
September	102.58	101.66
October	103.39	103.31
November	105.15	103.05
December	102.76	101.07
January	102.70	99.99
February	100.12	99.37
March	97.75	96.88
Average Range (AR)	9.93	7.04
Coefficient of Variation (CV)	11.2 per cent	13.6 per cent

The sharp increase in prices is an incentive to the farmers to allocate more area for pulse crops although relative price of pulses over a competing crop, *viz.*, wheat, may be better indicator to the farmers. Besides, the relative yield may also play an important role. But, it is observed that the yield of wheat is almost four times than that of pulses (2,274 kgs. per hectare compared with 576 kgs. per hectare in 1990-91). The yield, relative to that of wheat, may not, therefore, play an effective role in farmers' decisions. The farmers' response to various factors in allocating the acreage to pulse crops is examined in the next two sections.

Section 4

Specifications

The output of an agricultural crop depends substantially on the total area allocated to that crop by the farmers besides other agricultural inputs. The farmers' willingness or response to allocate certain area to a particular crop depends on various factors, such as prevailing and expected prices of the commodity and those of a competing commodity, the yield of the commodity and that of competing one, and the area allocated to the crop in the previous year. In addition, the extent of rainfall and its spatial distribution and the irrigation facility are also expected to influence the farmers' decisions in allocating the area under a certain crop. The farmers' response to acreage under pulses is, thus, explained through the relative price of pulses over that of wheat, relative yield of pulses to that of wheat, extent and distribution of rainfall in the year, and the area allocated in the previous year[6]. It is assumed that partial adjustment model operates in explaining the area under pulses[7]. The model is formulated as given below:

$$AP^*_t = a_0 + a_1 RF_t + a_2 RY_t + a_3 RP_t + e_t \quad \ldots \quad (1)$$

$$\text{and } (AP_t - AP_{t-1}) = \lambda (AP^*_t - AP_{t-1}) \quad \ldots \quad \ldots \quad (2)$$

where, λ is the coefficient of adjustment and lies between 0 and 1; AP* is the desired acreage under pulse crops; AP, RF, RY, RP represent area under pulse crop, rainfall, relative yield and relative price of pulses to wheat, and e_t is the error term.

Equation (2) postulates that actual change in acreage in any given period t is a fraction of the desired increase in the acreage for that period. The reduced form of the model is written as:

$$AP_t = b_0 + b_1 RF_t + b_2 RY_t + b_3 RP_t + (1-\lambda) AP_{t-1} + u_t \quad \ldots \quad (3)$$

In addition, the paper attempts to expalin the behaviour of output and yield of pulses. Output of pulses is explained by major agricultural inputs, such as, area under the crop, rainfall (average rainfall), fertilizer consumption, yield per hectare (as a proxy for high yielding variety of seeds), and irrigation facilities. A dummy variable for drought years was also included to explain the variations in output of pulses. The yield of pulses was explained through fertilizer consumption per hectare, rainfall and dummy for drought years.

Section 5

Empirical Results

The functional relationships were estimated for the period 1976-77 to 1991-92. Alternative formulations were estimated and those were selected which satisfied certain statistical criteria, such as, coefficient of multiple determination (adjusted R^2), t-statistic, Durbin-Watson Statistic (DW; also h-statistic) and standard error of the estimate. The appropriateness of the sign of the coefficient was also considered in selecting an equation.

The area under pulse (AP) crops, as stated earlier, was explained by rainfall in the year, previous year's relative prices of pulses to those of wheat and area under pulse crops in the previous year. Alternatively, prices of the pulses prevailing in the previous year were also considered to explain the variation in acreage under pulse crops. The coefficient of the rainfall is expected to be positive indicating that good monsoon would induce farmers to allocate more acreage under the crop. The prices of pulses (PP) prevailing in the previous year would also induce farmers to allocate large area under pulses with an expectation of higher prices for pulses. Because wheat is a competing crop for pulses, prices of pulses relating to those of wheat (RP) can also influence the farmers' decision with regard to acreage allocation. As such, it was also included as an explanatory variable in acreage response function.

The yield of pulses (YP) and irrigated area under pulses did not give satisfactory results. It is observed that the yield of pulses relative to that of wheat, however, did not have any impact on farmers' decision mainly because of the wide difference between the two yields. The variable, "prices of pulses in previous year" is not a significant factor although it has expected positive sign. The estimated equation is given below.[8]

$$1.\ AP = \underset{(2.525)}{14162.84} + \underset{(3.443)}{5.4946}\,RFP + \underset{(1.851)}{729.7033}\,RP_{-1} + \underset{(0.475)}{0.0957}\,AP_{-1}$$

$$\bar{R}^2 = 0.422;\ DW = 2.213;\ SEE = 630.89;\ Mean = 23146$$

The coefficients of rainfall and the relative prices are significant and have expected positive sign. The coefficient of the lagged dependent variable is found to have expected positive sign but not significant and its inclusion improved the explanatory power of the equation although low around 42 per cent. Residuals are relatively free from serial correlation. Both short and long-run elasticities of relative prices to those of wheat (one period lag) are found to be very small (Table A) indicating that farmers' response to prices is comparatively poor although the estimated coefficient is found to be significant. The actuals and estimated values are given in Graph 1.

It is observed from the acreage response function that the explanatory power of the equation is only about 42 per cent. Perhaps, the negligible growth in the area under the crop, (0.15 per cent during 1960-91 and 0.03 per cent during 1975-91) might have resulted low explanatory power. This relationship may need further examination at disaggregated level, say at State level which produce pulses, and this may throw some more light in the area. The paper further attempts to explain, in the following paragraphs, the behaviour of output of pulses and the yield of pulses.

Output Equations

The output of pulses was explained by rainfall, fertilizer consumption, yield, area under pulses and proportion of area under irrigation facilities. The average rainfall (average of current year and previous year) explained better than the rainfall during the year. The irrigation facilities, represented by proportion of area under irrigation to area under all pulse crops, did not show any significant impact, perhaps because the crop is mostly grown under dry land farming.The explanatory power of the equation with rainfall, fertilizer consumption and yield was higher than that with the area under pulses. The selected equation is given below:

2. OP = -2047.158 + 2.9689 AVRF + 0.6721 FCP + 20.4060 YP
(-1.079) (2.003) (1.678) (6.084)

- 651.3097 DM
(-2.379)

$\bar{R}^2$ = 0.945; DW = 2.448; SEE = 318.17; Mean = 12014; CV = 2.65

The coefficient of average rainfall and yield rate are significant and fertilizer consumption is significant at lower confidence level. Inclusion of dummy in the equation improved the explanatory power of the equation and lowered the forecasting error. The actual and estimated values of output of pulses are plotted in Graph 2.

Table A : Elasticities of Acreage and Output of Pulses

With respect to	Elasticity of Acreage		Output
	Short-run	Long-run	
1. Rainfall	0.213	0.236	0.129
2. Average rainfall	—	—	0.423
3. Relative prices (one period lag)	0.024	0.026	—
4. Yield	—	—	0.917
5. Fertilizer Consumption	—	—	0.037

It may be seen from Table A that yield elasticity of output is as high as 0.92 indicating that a 10 per cent increase in yield will rise the output by 9.2 per cent. This suggests that the high yielding varieties of seeds, if employed, would push up the production of pulses. The rainfall elasticity of output is however, low at 0.21 while the total effect is around 0.24.[9]

Yield Equations

The yield of pulses was explained by an autoregressive structure and the exogenous variables, *viz.*, the rainfall in the year and the consumption of fertilizer per hectare. These two variables are expected to have positive relationship with yield. A dummy variable for drought conditions, when included improved the fit. The forecasts obtained from the equations are adjusted for autoregressive structure in the residuals. The estimated equation is given below :

$$3.\quad YP = \underset{(4.056)}{288.4450} + \underset{(2.113)}{0.1212}\,REP + \underset{(3.716)}{2635.326}\,FA - \underset{(-2.851)}{50.0053}\,DM$$

$$\text{and}\quad U_t = \underset{(1.777)}{0.4585}\,U_{t-1} + E_t$$

where U_t is the residual series obtained from YP equation.

$\bar{R}^2 = 0.785$; DW = 1.131; SEE = 22.93; Mean = 517.5

The coefficients of all the explanatory variables are significant; and they explained about 79 per cent of the variations in yield. The dummy when included improved the explanatory power of the equation. The actuals and estimated values are depicted in Graph 3.

Forecasts of Output of Pulses

Based on the above equations for yield and output, assumed from the view point of supply of output, a forecast of output of pulses is derived for 1993-94. This forecast is compared with the estimate of output derived from demand side.

For the purpose of forecasting of output of pulses from supply side, the rainfall during 1993-94 is assumed to be normal based on the available indicators. The acreage for pulse crop is estimated at 23.440 mn. hectares based on Equation 1. The fertilizer consumption by pulse crops is estimated at 1.784 million tonnes based on the equation given in the Annexure. If the high yielding variety of seeds with a yield of about 614 kgs. per hectare is deployed in 1993-94, derived from equation (3), the output of pulses is forecasted to be around 14.712 million tonnes during 1993-94. It may be seen from Table B that the forecast error is less than 3 per cent for output in the last three years which is in the range of -1.4 per cent to 2.8 per cent.

Table B : Performance of Forecasts

Year	Yield (Kgs.per hectare)			Output (mn.tonnes)		
	Actuals	Forecasts@	% Error	Actuals	Forecasts@	% Error
1990-91	578	605.1	4.69	14.265	13.882	-2.68
1991-92	534	541.2	1.34	12.050	12.394	2.85
1992-93	617	593.3	3.85	14.700	14.492	-1.42

@ Derived as dynamic forecasts.

The demand for pulses for 1993-94 is estimated from the minimum daily requirement of pulses (45 gms. per capita per day) prescribed earlier by the Indian Council of Medical Research and the mid-year population for 1993-94 projected to grow at a rate of 2 per cent over 1992-93 population. The demand for pulses is, thus, estimated to be 14.63 mn. tonnes in 1993-94.

The net availability of pulses for consumption is observed to form, on an average, about 90 per cent of the production in the year. Thus, it is estimated that 13.24 mn. tonnes would be available for consumption as against the estimated demand of 14.63 mn. tonnes, in 1993-94 giving rise to a gap of 1.39 mn. tonnes, between demand for and supply of pulses.

Conclusions

Rainfall and relative prices, own prices relative to its competing crop, are found to be significant factors influencing the acreage allocation to pulse crops. The partial adjustment do not, however, appear to be operating in the acreage allocation to pulse crops. The estimated acreage response equations have low explanatory power and may, need to examine further at disaggregated level.

The yield elasticity of output is found to be high at 0.92 suggesting that high yielding variety of seeds of pulses can increase the prospects of pulses' output. Attempts, to improvise high yielding variety of seeds may increase the availability of pulses and meet the demand requirement. The gap between demand for and supply of pulses may further rise unless adequate steps are taken to improve the production of pulse crops. A further research at disaggregated level may throw some further details on the topic.

Notes

1. Reserve Bank of India (1993), Annual Report, 1992-93.
2. Department of Agriculture and Co-operation, Government of India, 1983.
3. At compound growth rate.
4. As stated earlier, the Government of India had introduced certain schemes to accelerate the production of pulses. It is of interest to probe whether there are any new technologies which would sustain and accelerate the production of pulses. This, however, is outside the scope of the paper. It is for the researchers to further investigate in this direction.
5. According to RBI (1991), seasonality is said to be less, moderately and highly seasonal if the average range is a) less than or equal to 5 per cent, b) between 5 and 15 per cent and c) between 15 and 25 per cent, respectively. Seasonality is highly stable, moderately stable, unstable and highly unstable if the CV is, respectively, a) less than or equal to 5 per cent, b) between 5 and 15 per cent, c) between 15 and 25 per cent and d) 25 per cent and above.
6. Chopra and Kusum (1975) observed in their study, based on area shifts in different crops in pulses producing States, that wheat is the most competing crop in the States which account for the major share in output of pulses. Besides, *Rabi* pulses account for the largest share in total pulses output and wheat is a *Rabi* crop. Moreover, pulses and

wheat have the same marketing season, *viz.*, April to March. In view of this, wheat is considered, in the paper, as a competing crop.

7. The partial adjustment model is assumed by Chopra and Kusum to estimate the acreage response function for major States producing pulses. Ray (1981) assumed the adjustment model to estimate the response function for foodgrains, non-foodgrains and three other major crops.

8. Figures in brackets below the coefficients, in all equations represent t-statistic value.

9. Ray (1981); The total effect of rainfall on output is the sum of direct and indirect effects. It is obtained as the sum of i) the elasticity of output with respect to rainfall and ii) the product of elasticity of output with respect to acreage and the elasticity of acreage with respect to rainfall.

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Annexure

A. List of Variables used in the Equations

AP : Area under all Pulse crops (in million hectares);

AVRF : Average rainfall of current and previous years [(RFP(T)+ RFP(T-1))/2]

FA : Fertilizer consumption by pulse crops, per hectare;

FCP : Fertilizer consumption of Pulse crops (in thousand tonnes);

OP : Output of all pulse crops (in million tonnes);

PP : Wholesale price index of all pulses (1970-71 = 100);

PW : Wholesale price index of wheat (1970-71 = 100);

RP : Relative price of pulses to prices of wheat (PP/PW);

RFP : Weighted all-India rainfall (in millimetres);

T : Time Trend;

YP : Yield of pulse crops (in Kgs. per hectare);

B. Estimated Equation for Total Fertilizer Consumption:

$$FCP_t = \underset{(-0.637)}{-45.4722} + \underset{(1.674)}{0.4277}\, FCP_{t-1} + \underset{(2.278)}{45.8253}\, T$$

$\bar{R}^2 = 0.971$; D.W. = 1.862; SEE = 65.458; Mean = 1021.5.

Time period : 1976-77 to 1991-92.

Table 1: Area, Production & Yield of Total Pulses - By Major Producing Countries

Area (A) : In thousand hectares.
Production (P) : In thousand tonnes.
Yield(Y) : Kgs. per hectare.

Country	1970	1975	1980	1985	1990
1	2	3	4	5	6
1. Brazil					
Area	3654	4331	4777	5458	4805
	(5.6)	(6.2)	(7.6)	(8.2)	(7.0)
Production	2285	2358	2005	2594	2270
	(5.1)	(5.3)	(5.0)	(5.1)	(3.8)
Yield	625	544	420	475	472
2. China					
Area	8573	10960	5462	4419	4417
	(13.1)	(15.8)	(8.7)	(6.7)	(6.4)
Production	8016	11175	6752	5831	6515
	(17.9)	(25.0)	(16.7)	(11.1)	(11.0)
Yield	935	1020	1236	1319	1475
3. India					
Area	23958	23157	22910	24224	23316
	(36.7)	(33.4)	(36.6)	(36.5)	(33.9)
Production	12086	10941	9167	12576	12902
	(27.0)	(24.4)	(22.7)	(24.5)	(21.9)
Yield	541	472	400	519	553
4. Mexico					
Area	2005	2130	2061	1974	2299
	(3.1)	(3.1)	(3.3)	(3.0)	(3.3)
Production	1121	1271	1294	1138	1520
	(2.5)	(2.8)	(3.2)	(2.2)	(2.6)
Yield	559	597	628	576	661
5. U.S.A.					
Area	745	759	902	719	960
	(1.1)	(1.1)	(1.4)	(1.1)	(1.4)
Production	1022	1017	1488	1174	1625
	(2.3)	(2.3)	(3.7)	(2.3)	(2.8)
Yield	1371	1340	1649	1634	1693
6. U.S.S.R. *					
Area	5070	5670	4715	6523	5823
	(7.8)	(8.2)	(7.5)	(7.8)	(8.5)
Production	7629	5321	6362	9523	9800
	(17.0)	(11.9)	(15.7)	(14.6)	(16.6)
Yield	1505	938	1349	1460	1683
World					
Area	65342	69394	62679	66344	68762
	(100.0)	(100.0)	(100.0)	(100.0)	(100.0)
Production	44790	44793	40429	51366	58973
	(100.0)	(100.0)	(100.0)	(100.0)	(100.0)
Yield	685	645	645	774	858

Notes : 1 Figures in brackets are percentages to total Area/Production
2 Data relates to calendar years
* Erstwhile U.S.S.R

Source : Food and Agriculture Organisation, United Nations, *Production Year Book*, Different Issues.

Table 2 : Cropping Pattern

(Area in thousand hectares)

Item	1960-61	1965-66	1970-71	1975-76	1980-81	1985-86	1990-91
TOTAL CEREALS & MILLETS	92018 (60.2)	92385 (59.5)	101782 (61.4)	103727 (60.5)	104210 (65.8)	103605 (65.1)	103173 (61.1)
TOTAL OIL SEEDS @	13770 (9.0)	16232 (10.5)	16640 (10.0)	16920 (9.9)	17603 (11.1)	19020 (11.9)	24148 (14.3)
TOTAL PULSES	23563 (15.4)	22718 (14.6)	22534 (14.0)	24454 (14.5)	22457 (13.3)	24418 (15.3)	24662 (14.6)
OF WHICH, GRAM	9276 (6.1)	8015 (5.2)	7839 (4.7)	8320 (4.9)	6584 (3.9)	7805 (4.9)	7521 (4.5)
GROSS CROPPED AREA +	152772 (100.0)	155276 (100.0)	165791 (100.0)	170990 (100.0)	158442 (100.0)	159263 (100.0)	168719 (100.0)

Notes : 1. Gross cropped area includes also the area under sugarcane, condiments and spices, fruits & vegetables, cotton, jute and a few other crops.

2. Figures in brackets are percentages to gross cropped area.

@ : Includes groundnut, rapeseed & mustard, sesame, linseed, castorseed, nigerseed, safflower, sunflower and soyabeen.

\+ : Represents gross sown area including area sown more than once.

Table 3 : Production Pattern of Foodgrains

(Unit : Million tonnes)

Item	1960-61	1965-66	1970-71	1975-76	1980-81	1985-86	1990-91	1991-92 P
1. Total Cereals	69.3	62.4	96.6	108.0	119.0	137.1	162.1	155.1
	(84.5)	*(86.2)*	*(89.1)*	*(89.2)*	*(91.8)*	*(91.1)*	*(91.9)*	*(92.8)*
of which								
a) Rice	34.6	30.6	42.2	48.7	53.6	63.8	74.3	73.7
	(42.2)	(42.3)	(38.9)	(40.3)	(41.4)	(42.4)	(42.1)	(44.1)
b) Wheat	11.0	10.4	23.8	28.8	36.3	47.1	55.1	55.1
	(13.4)	(14.4)	(22.0)	(23.8)	(28.0)	(31.3)	(31.2)	(33.0)
2. Total Pulses	12.7	9.9	11.8	13.0	10.6	13.4	14.3	12.0
	(15.5)	(13.7)	(10.9)	(10.8)	(8 2)	(8.9)	(8.1)	(7.2)
of which								
a) Gram	6.2	4.2	5.2	5.9	4.3	5.8	5.4	4.1
	(7.6)	(5.8)	(4.8)	(4.9)	(3.3)	(3.9)	(3.1)	(2.5)
b) Other Pulses	6.5	5.7	6.6	7.2	6.3	7.6	8.9	7.9
	(7.9)	(7.9)	(6.1)	(5.9)	(4.9)	(5.0)	(5.0)	(4.7)
3. Total Foodgrains	82.0	72.3	108.4	121.0	129.6	150.4	176.4	167.1
	(100)	(100)	(100)	(100)	(100)	(100)	(100)	(100)

Note : Figures in brackets are percentages to total foodgrains.
P: Provisional

Table :4 Growth rates in the Production of Pulses

(million tonnes)

Year	Total pulses	
	Production	% Change
1960-61	12.7	—
1961-62	11.8	-7.09
1962-63	11.4	-3.39
1963-64	10.1	-11.40
1964-65	12.4	22.77
1965-66	9.9	-20.16
1966-67	8.3	-16.16
1967-68	12.1	45.78
1968-69	10.4	-14.05
1969-70	11.7	12.50
1970-71	11.8	0.85
1971-72	11.1	-5.93
1972-73	9.9	-10.81
1973-74	10.0	1.01
1974-75	10.4	4.00
1975-76	13.0	25.00
1976-77	11.4	-12.31
1977-78	12.0	5.26
1978-79	12.2	1.67
1979-80	8.6	-29.51
1980-81	10.6	23.26
1981-82	11.5	8.49
1982-83	11.9	3.48
1983-84	12.9	8.40
1984-85	12.0	-6.98
1985-86	13.4	11.67
1986-87	11.7	-12.69
1987-88	11.0	-5.98
1988-89	13.8	25.45
1989-90	12.8	-7.25
1990-91	14.3	11.72
1991-92 P	12.0	-16.08
Compound rate of growth (per annum)		
1961-62 to 1970-71		-0.73
1971-72 to 1980-81		-1.07
1981-82 to 1990-91		3.04
1961-62 to 1990-91		0.40

P: Provisional

Table 5 : Area and Production of Total Pulses by Kharif & Rabi Seasons

Area : In million hectares
Production : In million tonnes
Yield : Kgs. per hectare

Year	Kharif Pulses			Rabi Pulses			Total Pulses		
	Area	Production	Yield	Area	Production	Yield	Area	Production	Yield
1966-67	8.8 (39.7)	2.5 (29.4)	280	13.3 (60.3)	5.9 (70.6)	442	22.1	8.3	377
1967-68	9.3 (41.3)	3.5 (28.7)	371	13.3 (58.7)	8.6 (71.3)	649	22.6	12.1	534
1968-69	9.0 (42.2)	3.3 (31.5)	366	12.3 (57.8)	7.1 (68.5)	580	21.3	10.4	490
1969-70	9.1 (41.3)	3.5 (29.8)	383	12.9 (58.7)	8.2 (70.2)	635	22.0	11.7	531
1970-71	9.5 (42.0)	3.9 (32.8)	410	13.1 (58.0)	7.9 (67.2)	607	22.5	11.8	524
1971-72	8.9 (40.3)	3.3 (30.0)	374	13.2 (59.7)	7.6 (70.0)	586	22.2	11.1	501
1972-73	8.8 (42.1)	3.2 (32.0)	361	12.1 (57.9)	6.7 (68.0)	556	20.9	9.9	474
1973-74	10.1 (43.0)	3.6 (36.2)	359	13.3 (57.0)	6.4 (63.8)	479	23.4	10.0	427
1974-75	9.8 (44.6)	3.7 (35.6)	377	12.2 (55.4)	6.7 (64.4)	548	22.0	10.4	455
1975-76	10.6 (43.3)	4.4 (34.0)	418	13.9 (56.7)	8.6 (66.0)	621	24.5	13.0	533
1976-77	10.1 (43.8)	3.9 (34.3)	387	12.9 (56.2)	7.5 (65.7)	578	23.0	11.4	494
1977-78	10.1 (43.0)	4.2 (35.5)	420	13.4 (57.0)	7.7 (64.5)	577	23.5	12.0	510
1978-79	10.2 (43.0)	4.0 (32.8)	389	13.5 (57.0)	8.2 (67.6)	610	23.7	12.2	515
1979-80	10.2 (45.7)	3.3 (39.0)	329	12.1 (54.3)	5.2 (61.0)	432	22.2	8.6	385
1980-81	10.4 (46.4)	3.8 (35.4)	361	12.0 (53.6)	6.9 (64.6)	571	22.5	10.6	473

Contd..

Table 5 : Area and Production of Total Pulses by Kharif & Rabi Seasons (Concld.)

Area : In million hectares
Production : In million tonnes
Yield : Kgs. per hectare

Year	Kharif Pulses			Rabi Pulses			Total Pulses		
	Area	Production	Yield	Area	Production	Yield	Area	Production	Yield
1981-82	10.4 (43.8)	4.3 (37.6)	415	13.4 (56.2)	7.2 (62.4)	536	23.8	11.5	483
1982-83	10.3 (44.9)	4.1 (34.8)	402	12.6 (55.1)	7.7 (65.2)	615	22.8	11.9	519
1983-84	11.0 (46.8)	5.2 (41.2)	476	12.5 (53.2)	7.4 (58.8)	597	23.4	12.7	548
1984-85	10.5 (46.3)	4.8 (40.0)	453	12.2 (53.7)	7.2 (60.0)	589	22.7	12.0	526
1985-86	11.0 (45.1)	4.5 (33.8)	412	13.4 (54.9)	8.8 (66.2)	658	24.4	13.3	547
1986-87	10.7 (46.1)	4.2 (35.9)	392	12.4 (53.9)	7.5 (64.1)	604	23.2	11.7	506
1987-88	10.0 (47.2)	4.4 (40.0)	435	11.2 (52.8)	6.6 (60.0)	587	21.2	11.0	515
1988-89	11.1 (48.0)	5.6 (40.6)	504	12.0 (52.0)	8.2 (59.4)	686	23.1	13.8	598
1989-90	11.5 (49.1)	5.5 (43.0)	480	11.9 (51.9)	7.3 (57.0)	616	23.4	12.8	549
1990-91	11.4 (46.2)	5.4 (37.8)	474	13.3 (53.3)	8.9 (62.2)	669	24.7	14.3	579
1991-92 P	11.4 (50.4)	4.4 (36.7)	386	11.2 (49.6)	7.6 (63.3)	679	22.6	12.0	534

Note : Figures in brackets are percentages to total area/production.
P : Provisional

Table 6 : Gross Irrigated Area - By Selected Crops

(million hectares)

Year	Total Cereals	Pulse Crops		Gross Irrigated Area
		Total	Gram	
1960-61	20.2	1.9	1.1	28.0
	(72.1)	(6.8)	(4.0)	(100)
1965-66	21.9	2.1	1.3	30.9
	(70.9) ...	(6.9)	(4.2)	(100)
1970-71	28.1	2.0	1.2	38.2
	(73.5)	(5.3)	(3.2)	(100)
1975-76	32.1	2.0	1.4	43.4
	(74.1)	(4.5)	(3.2)	(100)
1980-81	35.6	2.0	1.4	49.6
	(71.8)	(4.1)	(2.7)	(100)
1985-86	38.5	2.1	..	54.0
	(71.3)	(3.9)		(100)

Notes : 1. Gross irrigated area includes the area in respect of sugarcane, condiments and spices, fruits and vegetables, cotton and other crops.

2. Figures in brackets are percentages to gross irrigated area.

Table 7 : State-wise Distribution of Area and Production of Total Pulses

Area : In thousand hectares
Production : In thousand tonnes

State	1960-61		1970-71		1980-81		1985-86		1990-91 (P)	
	Area *	Production	Area	Production	Area	Production	Area	Production	Area	Production
1	2	3	4	5	6	7	8	9	10	11
Andhra Pradesh	3117	255	1451	450	1431	419	1350	629	1636	717
	(5.4)	(2.0)	(6.4)	(3.8)	(6.3)	(3.8)	(5.5)	(4.7)	(6.7)	(5.1)
Assam	185	26	85	32	122	47	141	66	138	49
	(0.3)	(0.2)	(0.8)	(0.3)	(0.5)	(0.4)	(0.6)	(0.5)	(0.6)	(0.3)
Bihar	5623	1061	1645	987	1391	747	1233	887	1187	917
	(9.8)	(8.5)	(7.3)	(8.3)	(6.1)	(6.7)	(5.1)	(6.6)	(4.9)	(6.5)
Gujarat	1097	138	423	165	554	266	756	338	932	627
	(1.9)	(1.1)	(1.9)	(1.4)	(2.5)	(2.4)	(3.1)	(2.5)	(3.8)	(4.5)
Haryana	—	—	1141	813	785	704	833	678	732	536
	(—)	(—)	(5.1)	(6.9)	(3.5)	(6.3)	(3.4)	(5.1)	(3.0)	(3.8)
Himachal Pradesh	66	8	71	32	69	24	43	13	43	14
	(0.1)	(0.1)	(0.3)	(0.3)	(0.3)	(0.2)	(0.2)	(0.1)	(0.2)	(0.1)
Jammu & Kashmir	9	2	47	30	54	36	44	29	39	24
	(—)	(—)	(0.2)	(0.3)	(0.2)	(0.3)	(0.2)	(0.2)	(0.2)	(0.2)
Karnataka	2855	297	1131	404	1280	627	1584	489	1483	550
	(4.2)	(2.4)	(5.0)	(3.4)	(5.7)	(5.6)	(6.5)	(3.7)	(6.1)	(3.9)
Kerala	109	16	39	14	35	16	36	26	25	19
	(0.2)	(0.1)	(0.2)	(0.1)	(0.2)	(0.2)	(0.1)	(0.2)	(0.1)	(0.1)
Madhya Pradesh	9315	1870	4246	1992	4921	2146	5142	2610	4798	2902
	(16.2)	(15.0)	(18.8)	(16.9)	(21.7)	(19.2)	(21.1)	(19.5)	(19.7)	(20.6)
Maharashtra	5804	1035	2491	776	2804	831	2860	1164	3257	1444
	(10.1)	(8.3)	(11.1)	(6.6)	(12.4)	(7.4)	(11.7)	(8.7)	(13.4)	(10.3)
Orissa	1260	251	845	467	1789	972	1815	1031	2033	1062
	(2.2)	(2.0)	(3.8)	(3.9)	(7.9)	(8.7)	(7.4)	(7.7)	(8.3)	(7.6)
Punjab @	6531	2064	414	309	349	245	225	204	146	108
	(11.3)	(16.6)	(1.8)	(2.6)	(1.5)	(2.2)	(0.9)	(1.5)	(0.6)	(0.8)
Rajasthan	7376	1169	3616	1777	3048	1154	3891	1767	3685	1722
	(12.8)	(9.4)	(16.1)	(15.0)	(13.5)	(10.3)	(16.0)	(13.2)	(15.1)	(12.2)
Tamil Nadu	1052	102	482	116	570	184	832	322	868	351
	(1.8)	(0.8)	(2.1)	(1.0)	(2.5)	(1.7)	(3.4)	(2.4)	(3.6)	(2.5)
Uttar Pradesh	11280	3767	3725	3069	2880	2491	3159	2312	3009	2758
	(19.6)	(30.2)	(16.5)	(26.0)	(12.7)	(22.3)	(13.0)	(17.3)	(12.3)	(19.6)
West Bengal	1913	385	665	375	524	239	422	264	373	219
	(3.3)	(3.1)	(2.9)	(3.2)	(2.3)	(2.1)	(1.7)	(2.0)	(1.5)	(1.6)
All India	57667	12467	22534	11817	22634	11165	24366	13361	24384	14064
	(100.0)	(100.0)	(100.0)	(100.0)	(100.0)	(100.0)	(100.0)	(100.0)	(100.0)	(100.0)

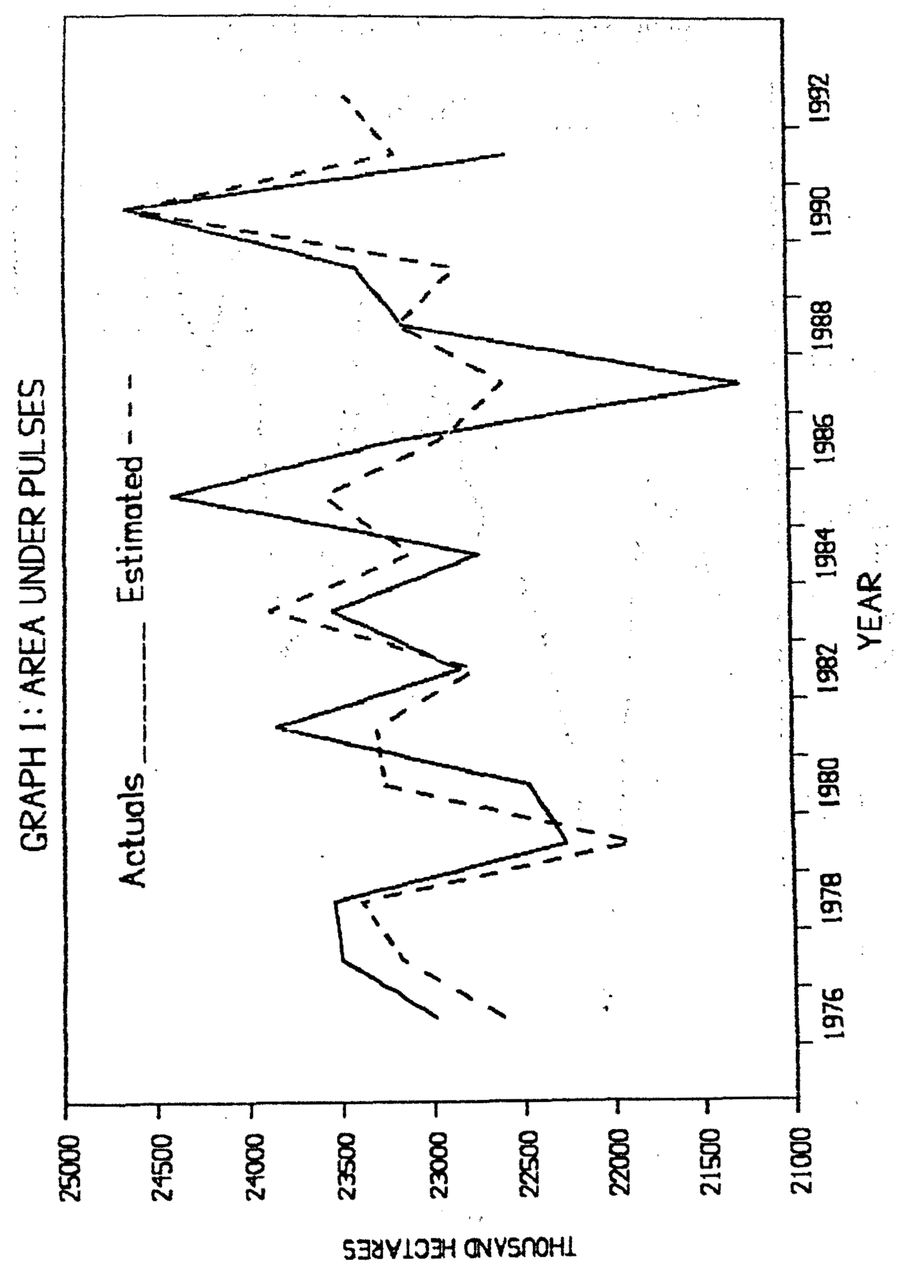
Notes: 1. Figures in brackets are percentages to All-India data.
2. Total of all States does not add to all-India as the latter includes also data for other States, producing pulses, viz., Goa, Manipur, Meghalaya, Nagaland, Sikkim and Tripura.
* : In thousand acres.
@ : Combined State of Punjab and Haryana for 1960-61.
P : Provisional

Table 8: Price Trends in Pulses and Wheat

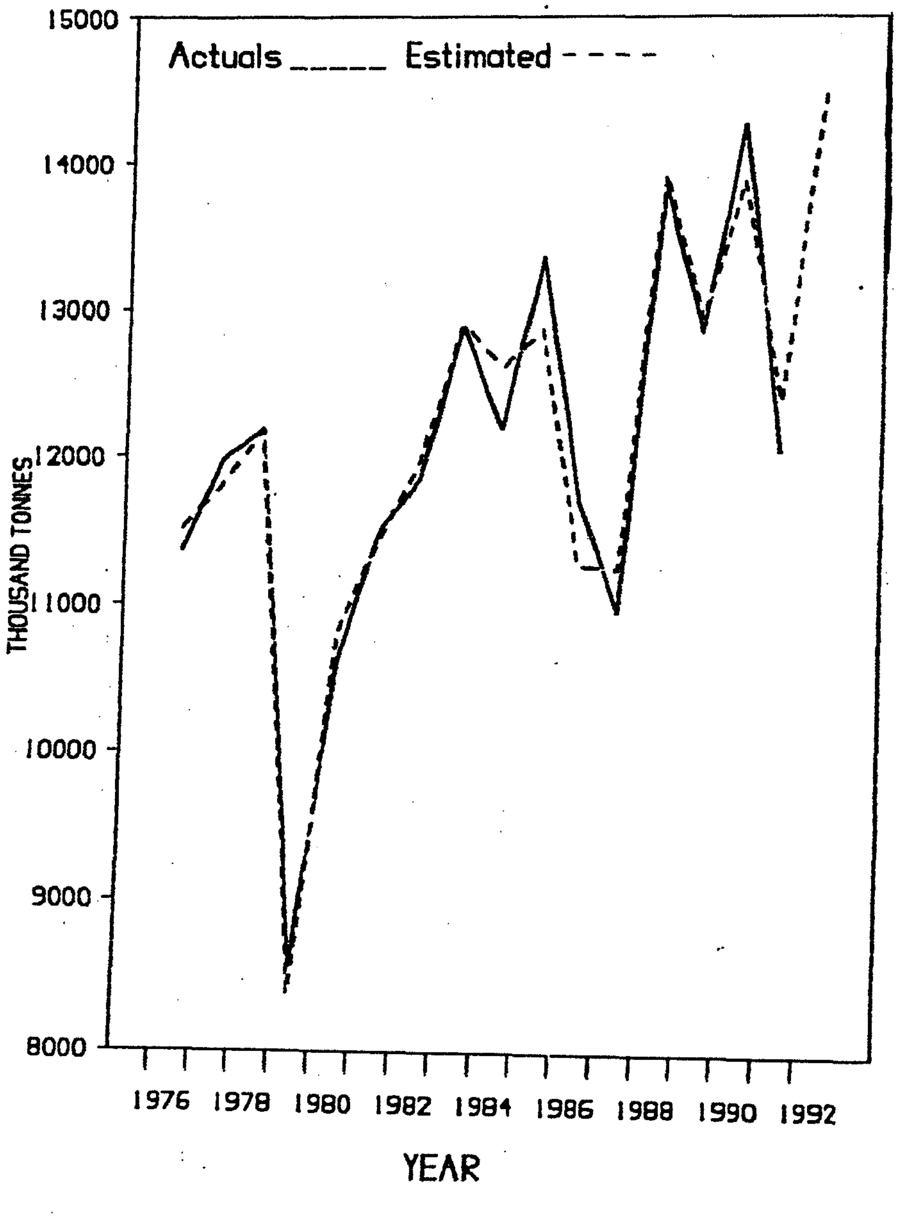
(1970-71=100)

Year	Wholesale Price Indices of					
	Pulses		Wheat		All commodities	
	Index	% change	Index	% change	Index	% change
1960-61	42.1		47.1		55.1	
1961-62	41.7	-1.0	47.9	1.7	55.2	0.2
1962-63	48.7	16.8	47.2	-1.5	57.3	3.8
1963-64	54.0	10.9	50.7	7.4	60.9	6.3
1964-65	80.1	48.3	66.1	30.4	67.5	10.8
1965-66	79.6	-0.6	71.5	8.2	72.7	7.7
1966-67	93.6	17.6	85.2	19.2	82.8	13.9
1967-68	136.5	45.8	102.4	20.2	92.4	11.6
1968-69	92.8	-32.0	97.9	-4.4	91.3	-1.2
1969-70	99.6	7.3	103.0	5.2	94.8	3.8
1970-71	100.0	0.4	100.0	-2.9	100.0	5.5
1971-72	110.7	10.7	99.5	-0.5	105.6	5.6
1972-73	137.9	24.6	106.5	7.0	116.2	10.0
1973-74	176.9	28.3	108.2	1.6	139.7	20.2
1974-75	215.7	21.9	183.1	69.2	174.9	25.2
1975-76	181.6	-15.8	159.6	-12.8	173.0	-1.1
1976-77	145.7	-19.8	152.0	-4.8	176.6	2.1
1977-78	215.2	47.7	156.5	3.0	185.8	5.2
1978-79	247.1	14.8	153.8	-1.7	185.8	0.0
1979-80	244.2	-1.2	160.7	4.5	217.6	17.1
1980-81	323.2	32.4	176.2	9.6	257.3	18.2
1981-82	338.7	4.8	191.6	8.7	281.3	9.3
1982-83	319.1	-5.8	213.1	11.2	295.1	4.9
1983-84	372.6	16.8	217.7	2.2	317.6	7.6
1984-85	443.0	18.9	212.3	-2.5	337.8	6.4
1985-86	467.4	5.5	228.0	7.4	352.8	4.4
1986-87	434.6	-7.0	243.5	6.8	373.3	5.8
1987-88	519.6	19.6	257.7	5.8	403.9	8.2
1988-89	676.4	30.2	295.4	14.6	450.6	11.6
1989-90	696.7	3.0	284.1	-3.8	466.1	3.4
1990-91	770.5	10.6	329.6	16.0	513.9	10.3
1991-92	841.7	9.2	390.3	18.4	584.3	13.7

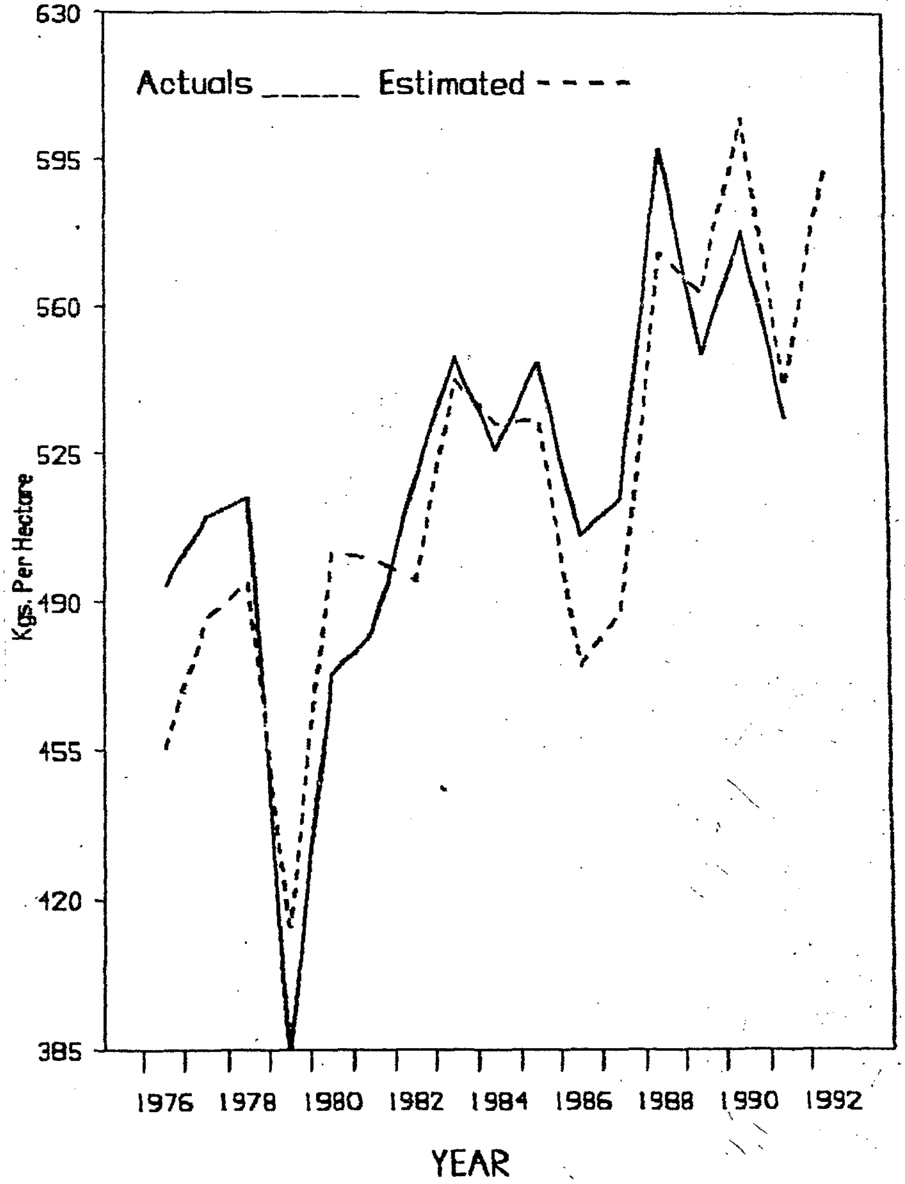
Note : Data for the period from 1982-83 onwards have been converted into old base, 1970-71 = 100


GRAPH I : AREA UNDER PULSES
Actuals
Estimated
YEAR
1976
1978
1980
1982
1984
1986
1988
1990
1992
THOUSAND HECTARES
25000
24500
24000
23500
23000
22500
22000
21500
21000

GRAPH 2: PRODUCTION OF PULSES



GRAPH 3: YIELD OF PULSES



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BOOK REVIEWS

Development and Change: Essays in Honour of K.N. Raj, Edited by Pranab Bardhan, Mrinal Datta-Chaudhuri and T.N.Krishnan, Oxford University Press, Bombay, 1993, Pp. xi + 359, Price Rs.350

Professor K.N.Raj has played a leadership role in initiating research on many economic problems. He played a crucial role in launching the strategy of planned development of India. His belief was that development demands an atmosphere of change where institutions undergo rapid transformation to accommodate the demands of development. It is thus quite apt to have a volume on Development and change in honour of K.N. Raj. It is much more heartening to note that some of the contributors are relatively young. Professor Raj had always encouraged young scholars and had been a great source of inspiration to them. No brief review can capture the detail and richness of the contents of this volume. However, an attempt has been made to highlight the essence of the volume through this review. Eighteen papers incorporated in this volume provide a comprehensive insight into various issues in development theory, comparative development experience and also issues in Indian Development. Raj's works reflect these interests and attempted to discuss issues of policy bearing nature. The volume is divided into three parts. Part I having six papers deals with issues in development theory. The first paper is that of Professor Amartya Sen, "Life Expectancy and Inequality : Some Conceptual Issues". Life expectancy is treated as a good criterion for judging economic advancement - a criterion that has some advantages over national income or GNP per head as a measure of economic development.However, the use of life expectancy as a systematic criterion of progress still requires scrutiny and assessment. Professor Sen concentrates only on one specific issue, to wit, the need for distributional concern in using life expectancy information. The picture is not quite similar to that of income distribution for various reasons, in particular (1) the instrumental role of incomes as opposed to the intrinsic importance of life expectancies, and (2) the relevance of biological differences between women and men in terms of survival potentials. There are good grounds for taking note of both aggregative and distributive considerations in judging life expectancies to consider the systematic biological differences between the genders, and to take into account the value of equal treatment and non-discrimination in basic facilities for living. Neither the maximization of average life expectancy irrespective of distribution, nor the no-nonsense pursuit of equality of life expectancies, is an acceptable rule to follow for public action. The *prima facie* argument for equality in life expectancies among the different groups has to be qualified by the bearing of other normative considerations. These considerations may or may not go in the same direction as equality of life expectancies. While administrative bodies have always been aware of the profound market inequities that cause famine or endemic hunger, this knowledge needs to be classified systematically and communicated to a far wider audience.

Professor Debraj Ray's paper, "Labour Markets, Adaptive Mechanisms and Nutritional Status", is a contribution to literature that seeks to study the interplay between the degree of 'casualness' of labour markets, and the nutritional status of the employed population in these markets. The basal metabolic rate (BMR) is essentially the energy required (under fasting conditions) to maintain body temperature. *Ceteris paribus* a history of low intake leads to lower bodymass and consequently a low BMR. Professor Ray has focussed the implications of such adaptive mechanisms for market behaviour. In economies where labour is in surplus and wages are low, it is a simple but basic truth that the labour market and its functioning are key to an understanding of the nutritional status.

Growth rates of different economies have been found to diverge significantly over long periods of time. Institutions have a strong inertia and can, therefore, condition growth prospects over long periods of time. Professor Ashoka Mody explains the evolution of institutions (non-market interactions) and their influence on the productive use of resources through his paper, "Making Institutional Choices". Institutions are best thought of as mechanisms that allocate resources through administrative methods rather than through price signals. Since institutions are a response to uncertainty and other informational failures, they must be capable of evolving as circumstances change. Change must reflect local or grass-roots knowledge and conditions to allow the most efficient use of information as well as to prevent extreme and volatile actions. Decentralized institutional structures, according to Professor Mody, are therefore, desirable. Decentralization in rules and standards making, in the architecture of specific organizations, and in the links between organizations (leading to net work formation) are therefore recommended. It may be added that in the phase of economic reforms, the choice of institutions is a very important issue. Economic reform by definition implies a smaller role of the government but a higher quality of governance. Rules and norms of behaviour need widespread acceptance.

Keynesian economics provided perhaps the strongest intellectual justification for the politics of coalition and consent. The unrelenting distributive conflict between capital and labour visualized by Marx could be transformed, at least in recessionary conditions, into a situation of class cooperation, so long as demand management could help to increase the level of output sufficiently. The increased size of the cake would control conflict over its distribution. Professor Amit Bhaduri stressed the changes occurring in contemporary capitalism in his paper, "The Economics and Politics of Social Democracy". The economic success of Japan and South Korea, could, to some extent, be interpreted in terms of the conservative version of co-operative capitalism. The conservative version of class cooperation, according to Professor Bhaduri, has its 'natural' appeal in the capitalist system because the capitalists have the authority to run the system, if necessary by offering material concessions for eliciting consent from the workers. In the final analysis, the appeal of profit and export-led economic expansion lies in the social authority structure.

Professor Mihir Rakshit thinks that shortage of foreign exchange would not be a binding constraint on domestic production if the elasticity of export demand is greater than unity and the government follows an appropriate trade and exchange rate policy. The market mechanism by itself (without any active government intervention) does not ensure the fulfillment of these objectives. Rakshit's paper, "Trade and Exchange Rate Policy with a Binding Foreign Exchange Constraint", explores the economic logic behind the formulation of an appropriate trade policy in the context of major forces perceived to operate in the domestic and international spheres. The focus of the paper is on the behaviour of the economy and policy options in the short and the medium run when the structure of the production sector does not undergo a significant change. When long-run considerations are brought into the picture, the optimum package of policies must include some new instruments for controlling the volume and the pattern of domestic investment.

There is oil under the ground in a certain region. Agents can either drill deep and take out a lot of oil in each period (the hawk strategy) or use another technology and take out a smaller amount of oil (the dove strategy). If everyone plays the dove, the game can continue endlessly because the oil regenerates itself at a certain rate, but if too many rounds of the hawk are played the game terminates in finite time. Similarly, problems of pollution where an individual can either use a technology which is environment-friendly or a more individually profitable strategy which damages the environment, can be thought of as a commons game. This also shows the close link between the problems of the commons and issues of sustainable development. Professor Kaushik Basu and Professor Ajit Mishra present a model - the commons game - in their paper, "Sustainable Development and the Commons Problem: A simple Approach". The commons game highlights the essential theoretical idea that has emerged from the large, interdisciplinary literature on sustainability, ecology and environment, viz., the basic problem of development may not be which among many endless paths to choose? but how to ensure that we do not choose a path which will come to an end quickly? It is emphasized that what is optimal for a model may not be the prescription for the world as well because reality is different from the model.

Professor Raj was a member of the United Nations Committee on Development Planning since its inception in the mid-sixties upto the mid-eighties. His interest in comparative analysis of developing economies are well evident. The contributions in the second part of the volume provide such a comparative development experience. Five papers are included in this part to cover experiences of China, Egypt, India and some other countries on both macro and micro issues.

Professor Azizur Rahman Khan deals with an issue on income growth and the distribution of income in his paper, "Determinants of Household Income in Rural China", while Professor Carl Riskin's paper, "Poverty In China's Countryside: Legacy and Change", highlights the importance of the combination of *inherited conditions and reform policies for rural poverty in 1988.* The poverty line is designed to encompass a minimum basket of goods and services needed to maintain 'simple reproduction' (the ability to live and work): food, clothing, housing, health care, tools, education etc. Following the State Statistical Bureau definition of poverty, some 13 per cent of rural households (or 13.8 per cent of individuals) fell below the poverty line in 1988. Besides, two-thirds of the rural poor live outside of officially - designated poverty areas, implying that anti-poverty policies confining themselves to such areas will miss the majority of the poor.

Professor Shigeru Ishikawa focusses on some issues of structural adjustment programme on IMF-WORLD BANK lines, applied to three major dirigiste countries, China, Egypt and India in his paper, "Structural Adjustment in China, Egypt and India". The findings of the study seem to suggest the wisdom of 'gradualism' in proceeding with the S A programme of the IMF-WB type. However, gradualism is after all a passive approach. A more positive approach seems to fit in with the World Bank concept of a 'market friendly' State intervention. Professor Edmar L. Bacha and Professor Dionisio D. Carneiro in their paper, " Stabilisation Programmes in Developing Countries: old Truths and New Elements", emphasised that effective and sustainable policy changes have better chances to succeed in implementing growthoriented stabilization with the help of foreign lending. Professor Gita Sen in her paper on "Paths to Fertility Decline: A Cross-Country Analysis" mentioned that focussing on female autonomy (as proxied by the female age at marriage) takes us beyond the current recognition of the importance of female education in reducing birth rates.

The third part of the volume consisting of seven papers provide some thoughtful discussions on issues in Indian Development. Professor A. Vaidyanathan in his paper, "Agrarian Reform and Agricultural Development : Some Neglected Dimensions", observes that the very limited serious discussion of reform in agrarian institutions dealing with management of joint production resources is a serious lacuna. There is certainly much room to secure informed user participation.

Professor N. Krishnaji's paper, "Widening Distances: State Domestic Product Variations, 1961-81", presents a statistical analysis of the trends in inter-state disparities in state domestic product per capita. Policies promoting agricultural growth have led to improvements in productivities and incomes not only in agriculture but also in other sectors. Such improvements were associated with perceptible changes in employment patterns, favouring in particular activities in the tertiary sector. However, this type of transformation has taken place only in the few regions of the country that have benefited from State support and public investment. Since we have not wholly abandoned planning, it is not too late to correct the imbalances. The choice is between the necessary policy changes and further political chaos. Professor T. N. Srinivasan in his paper, "Demand Deficiency and Indian Industrial Development", advocates that credibility of commitment to reforms has to be established. To be fair, four decades of dirigism cannot be easily replaced by a market friendly economic management in a year. As long as basic transport, communication and energy industries are in the public sector, adequate public investment in those industries, their efficient operation and appropriate pricing of their outputs have to be ensured if the incentives sought to be created by the reforms are to result in more rapid growth of output and exports. Once full exchange rate convertibility for the current account is achieved in the near term horizon, there would be no need for budgetary support for exports.

Professor Sudipto Mundle and Professor Hiranya Mukhopadhyay in their paper, "Stabilization and the Control of Government Expenditure in India", argue that the effectiveness of macroeconomic policies in India is impaired by precisely a mismatch between assumption and reality. In the presence of certain special features of the Indian economy, which derive from its highly regulated character, conventional policies can lead to quite unconventional results. Macroeconomic policies, particularly fiscal policies must be designed taking into account these specificities if the policies are to be made more effective. The argument is presented with the help of some simulation experiments relating to India's current stabilization programme and consequently the choice of basic fiscal strategies is also informed. The relevant simulations show that, even in the short run, compression of capital expenditure impairs growth whereas revenue expenditure compression promotes growth. These contrasts would be more pronounced in a longer-term perspective, which also takes into account the supply side effects of restricted capital expenditure.

Professor Ashok Rudra in his paper, "The Second Five Year Plan Strategy: A Reappraisal", argued that there was no case for total rejection of the Second Plan Strategy. The place it allocated to the private sector, the role it gave to regulation by the State, the emphasis it laid on heavy industries, the importance it attached to employment creation through labour intensive techniques, the stress it laid on lessening inequality - all these remain valid. The strategy, however, requires to be modified in respect of the method of planning, the method of delivery of welfare services and, most importantly, in the construction and management of the public sector.

Professor Gopalakrishna Kumar presented an extensive discussion on problem of under-nutrition in his paper, "Quality of Life and Nutritional Status: A reconsideration of some puzzles from Kerala". The experience of Kerala suggests that nutritional problems as revealed by caloric intake levels well below a specified norm may persist even though assessments of nutritional status based on anthropometric scores show a gradual amelioration.

The last paper of the volume is of Professor Pranab Bardhan, entitled "The 'Intermediate Regime': Any Sign of Graduation?" He advocates that Kalecki's analysis of intermediate regimes deserves closer examination. The intermediate regime is supposed to hover somewhere between full-scale capitalist development under the leadership of big business and socialist development serving the interests of poor workers and peasants. It is mentioned that the economic performance of this intermediate regime in India has not been spectacular. In an open pluralist policy with slow but growing assertiveness of some of the subordinate groups the liberal policy changes announced from above cannot acquire durable political legitimacy until and unless some serious attempts are made by the elite in striking downward alliances with some of these groups in the form of trying to work out some minimal social security safety net and extensive public works programmes, financed by more progressive taxation of income and expenditure and of urban property values, and by devolving real power and accountability to some representative local community institutions. Professor Bardhan concludes with the remarks that the question of political legitimacy is not being given enough attention either by the political leadership or by the international lending agencies which give financial support for adjustment.

Though the volume is commendable for its technical brilliance, the real problems of development facing poor countries cannot be viewed only from the technical angle. Development should entail provision of employment and price stability. There is no study of inflation, and employment implications of industrialisation, two themes on which Professor Raj showed considerable interest.

In appraising the development scene it is recognised that the international community's effort remains predomiminantly disappointing. The cause of development has lost momentum and should be moved towards the centre of the global agenda. This is not to be construed as an appeal for more aid.There is a need for some comprehensive work on trade, environment and sustainable development. The International Development Strategy must aim at up-holding and safeguarding an open,non discriminatory and equitable multilateral trading system on the one hand, and acting for protection of the environment and promotion of sustainable development on the other. The prime objective of the International Development Strategy should be to raise the whole population above the minimum: a minimum level of living consistent with human dignity.

Nevertheless, the editors of the volume should be congratulated for offering us such an excellent fare. For academic economists there are in the volume some interesting approaches to empirical work, abundant references to recent papers and a valuable insight into the current thinking of some of the distinguished economists who have contributed to the volume.

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Agricultural Trade Liberalization and India, by **Shankar Subramanian, Development Centre of the Organization for Economic Co-operation and Development, France, 1993, Pp.116, Price not given**

Among the several issues that liberalization entails, the role of trade liberalization and its relationship to macro economic and agricultural sector reforms is of critical importance. Recent studies on liberalization of agricultural trade by the OECD countries and its significance for developing countries by Maunder and Vald'es (1989), Goldin and Knudsen (1990) and others suggest that liberalization of agricultural trade by OECD countries will result in higher world agricultural prices. But what exactly are the implications of such a future increase in agricultural prices for growth, sectoral performance, welfare and distribution in developing countries? The book under review attempts to answer these questions with respect to India. This book is one in a series of case studies commissioned by the OECD Development Centre on 'Developing Country Agriculture and International Economic Trends'.

The author uses three sets of scenarios to answer the above question. The first set considers different scenarios for trade liberalization in India with or without higher world agricultural prices. The second set considers domestic policy issues, such as increase in crop yields and increase in fertilizer subsidy. And the third set is concerned with food subsidy policy. The outcomes of these scenarios have been simulated using a computable general equilibrium model of the Indian economy.

The book has four chapters. The first chapter provides an overview of India's recent agricultural performance, the role of the state intervention and current issues in agricultural policy based on the studies of Dantwala (1986), Rao *et.al.* (1988), George (1988), Sarma and Gandhi (1990), Gulati and Sharma (1990) and Subbarao (1991). The author highlights the issues of growth, crop imbalances, regional differences, skewed input use etc. This chapter also provides insights into the government intervention in agricultural marketing and the weakness of the public distribution system.

The second chapter deals with social accounting matrix and the model used in the study. The matrix is at producer prices and has 17 activities, 17 commodities and seven household classes. The model used in the study combines Binswanger-Quizon's (1989) multi-market approach to modeling agricultural supply and input demands, with the traditional computable general equilibrium production approach for the other sectors. The model has 17 commodity sectors and uses an econometrically estimated supply model for agriculture. Two main features of the model are, the trade quotas imposed in some sectors and the partial wages adjustment in the medium period to food prices which are determined by market-clearing forces over time. The base year of the model is 1983-84.

The third chapter provides different scenarios for policy reforms. The major themes emerging from these scenarios highlight the linkages between agricultural and industrial sectors, price transmission and its impact on income distribution and the ineffectiveness of subsidy. Empirical results of the study reveal that restrictions and tariffs on agricultural trade represented only a small burden on agriculture whereas the industrial protection had acted as a tax on agriculture. In such a situation, impact of industrial liberalization on agriculture would be much larger than agricultural liberalization itself. The technical change scenario reveals that without trade liberalization, productivity gains in the sector will lead to adverse terms of trade for agriculture. However, with trade liberalization, the movement of terms of trade against agriculture can be moderated. Thus, trade acts as a means of moderating the transfer of productivity gains to other sectors.

The scenarios on price transmission show that trade liberalization will lead to higher price transmission elasticities for all unprocessed agricultural commodities except coarse cereals. Though it will improve farm incentives for medium and large farmers, it does little for the urban and rural poor, thereby leading to a major policy dilemma. As growth-enhancing efficiency gains of liberalization percolate to the lower level only in the long-run, the author takes the view that sustainable liberalization would require aid to the poor until such time that growth picks up and provides sufficient incomes to the poor. The author also considers the extension of trade liberalization to processed agricultural commodities as having a large adverse impact on agriculture since these are highly protected compared to unprocessed commodities. The author, therefore, cautions against extending trade liberalization to commodities such as edible oils, sugar and processed food because the decrease in derived demand from these sectors (due to lack of competitiveness) may outweigh the positive influence of liberalization on cereal prices. Given the low per capita availability of some of these commodities, trade liberalization should not be extended to the above commodities.

On the role of the fertilizer subsidy, the author finds that it is largely a subsidy to the fertilizer sector, not to agriculture as such. The misdirection of subsidy does little to enhance farm output or income. Though the literature on this subject supports this finding, the recent experience shows that even with the withdrawal of some amount of fertilizer subsidy, there has been a fall and distortion in fertilizer consumption. The net benefit of food subsidy depends on how the subsidy is financed. If it is financed by raising indirect taxes, the distortion cost of higher taxes outweighs the gains from subsidy, even for the recipients of the subsidy and if it is financed by raising direct taxes, the net benefits are strongly positive for recipients.

One of the most significant contributions of the study is that it provides an empirical proof for the argument that there would be substantial differences between the medium-run and long-run outcomes of trade liberalization. In the medium-run rural and urban poor would be affected mainly due to higher prices of rice and wheat. Liberalization induced growth may take time to trickle down to the lower class. The author, therefore, calls for a safety net to the rural and urban poor in the initial years of liberalization. Another contribution of the study is that it highlights the impact of general equilibrium effects on the agriculture sector and the role of trade policy in affecting the terms of trade between agriculture and non-agriculture.

The study should be commended for employing a sophisticated mathematical model, notwithstanding the concerns that one may have on some of the premises of the model. The model's main assumption that world agricultural prices will increase as a result of the trade liberalization by the OECD countries could well turn out to be unrealistic, going by the fact that the decline in the prices of many agricultural commodities, especially in the prices that affect the export earnings of developing countries, in recent years had been caused by the substantial increase in world supplies of these commodities. There is also an important piece of evidence acting against the assumption of the study. In a recent paper, Bleaney and Greenaway ("Long-run Trends in Relative Prices of Primary Commodities and the Terms of Trade of Developing Countries", *Oxford Economic Papers*, July, 1993) found that there was a statistically significant long-run downward trend in the relative price of primary products at the rate of 0.8 per cent per annum. If this were true, trade liberalization by the OECD countries alone may not help matters. The fall in the agricultural prices was due to debt induced macro-economic adjustment and trade policy reforms and the consequent decline in real exchange rates in primary producing countries, resulting in higher profitability of cultivation. It led to increased supply response which depressed the prices. Other reasons are the slowdown of growth in industrial countries and the effect of technological change, which reduced the demand for primary commodities. Since these factors are unlikely to reverse in the nineties, a bounce back in agricultural prices could well be improbable. Another assumption of the model is that in the long run wages are determined by market clearing forces. This again is of doubtful validity, as it is well-known that agricultural wages are highly rigid compared to wages in other sectors. Further, the simulation exercise assumes complete labour mobility within agriculture and industry which again may not be in the realm of realistic possibilities. Another limitation of the study is the selection of 1983-84 as the base year of the model. The results would have been different if the author had taken a more recent year as the base year. The overall tone of the study is loaded in favour of liberalizing the export of commodities to benefit from the expected increase in international prices. However, there is considerable literature that shows that only a few commodities like tobacco, cotton, tea and rice have a comparative advantage in the international market. Hence, it is possible to consider freeing trade in these commodities rather than liberalizing the entire sector.

Notwithstanding these concerns, the study is an excellent academic contribution and provides very helpful insights into the likely impact of trade liberalization on the agricultural sector and the economy in general. The book, in the view of this reviewer, will stimulate readers to reflect further and to do more policy-driven research on the subject.

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