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BOOK REVIEWS

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Random Coefficient Autoregressive Model: A Performance Appraisal with Indian Economic Time Series

T.P. Madhusoodanan*

In this article, we have developed Random Coefficient Autoregressive (RCA) models for thirteen Indian economic time series. The forecast performance of these models are compared with those of Box-Jenkins, Bilinear and State Dependent models. Our analysis indicates that RCA models fares extremely well for short-term forecasts, particularly upto lead period three, while the performance of Bilinear model is the best for long-term forecasts.

1. Introduction

Generating reliable forecasts is one of the most important objectives of time series analysis. There are a large number of techniques available in the time series parlance for this purpose. It is well known that there exists no technique which is consistently suitable for all the series or for all the time periods. So one needs to check the suitability of each of the available techniques for a series and select the one which by and large performs best.

In this context, Ray (1988) analysed the forecast performance of three models viz., Box-Jenkins, Bilinear and Threshold Autoregressive models, using ten Indian economic time series. He concluded that the forecast performance of Bilinear model is the best followed by Box-Jenkins model. Ray and Jadhav (1990) evaluated the performance of Random Coefficient Autoregressive models using the same set of series with that of the above three models.

In the present exercise, we shall study one non linear model namely Random Coefficient Autoregressive (RCA) model which was extensively studied by Nicholls and Quinn (1982). Our aim is to assess the suitability of RCA model in predicting Indian economic time series and to compare its performance vis-a-vis other three models, viz., (i) Box-Jenkins (Box and Jenkins (1976)) (ii) Bilinear (Granger and Andersen (1978), Subba

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Rao (1981)) and (iii) State Dependent Model (SDM) (Priestley (1980)). For the present exercise, we have used monthly data on thirteen Indian economic time series, regularly published in RBI Bulletin. The data coverage of all the series except Consumer Price Index for Industrial workers (CPI) is from April 1982 to March 1992 and for CPI, it is from April 1983 to March 1992. Following Nicholls and Quinn (1982), we have developed RCA models for these economic time series. Section 2 gives the details of the methodology for estimation of parameters and test of randomness. The forecast performance of these models vis-a-vis Box-Jenkins, Bilinear and State Dependent Model are given in Section 3. Concluding remarks appear in Section 4. The transformations taken to make the series stationary are given in the Annexure. The computer program developed using "GAUSS" package is available in Appendix.

2. Description of the Model

A stationary time series { X (t), t=0, ±1, ±2, ... } is said to follow a random coefficient autoregressive model of order p if X (t) can be represented as

$$X(t) = \sum_{i=1}^{p} (\beta_i + b_i(t))\, X(t-i) + e(t) \qquad (1)$$

where (i)$\beta = (\beta_1, \beta_2, ..., \beta_p)'$ is a px1 constant vector,

(ii) $b(t) = (b_1(t), b_2(t), ..., b_p(t))'$ is a sequence of independent and identically distributed (i.i.d) random variables with mean zero and $E(b(t)b'(t)) = \Sigma$,

(iii) (e (t), t=o, ±1, ±2, ...) is a sequence of i.i.d random variables with mean zero and variance σ^2,

(iv) b (t) is independent of e(t) for all t.

2.1 Estimation of Parameters

Given that a stationary time series {X (t)} satisfies equation (1), we need to estimate the parameters β using the past value of X(t). Since the RCA models are nonlinear in nature, any maximum likelihood estimation procedure will be iterative. Iteration will have to start from an initial estimate and it may happen that the iteration will end up with a local maximum of the likelihood function because of the nonlinearity. So it is very important to find out an initial estimate which is very close to the global maximum of the likelihood function. A least square estimation procedure is used to get strongly consistent estimates, under certain conditions, of the parameters. These least square estimates will be used to commence the iterative procedure which optimizes the likelihood criterion, so as to ensure that the optimum reached via the iterative procedure is global.

2.2 The least square estimation procedure

Given a sample {X (1), ...X(N)} from a time series {X (t)} which is stationary and satisfies (1), we will have to estimate the parameters β and Σ. Since the matrix Σ is symmetric, we need to estimate only τ = vech (Σ). The first step is to estimate the parameters β_i, i=1, ...,p.

From (1),

$$X(t) = \sum_{i=1}^{p} \beta_i X(t-i) + \sum_{i=1}^{p} b_i(t) X(t-i) + e(t)$$

or

$$X(t) = \beta' Y(t-1) + u(t) \qquad (2)$$

where $\beta = [\beta_1, ..., \beta_p]$, $u(t) = b(t) Y(t-1) + e(t)$ and $Y(t-1) = [X(t-p), ..., X(t-1)]$. Let F_t be the σ-field generated by {(e (t-1), b (t-1), (e (t-2), b (t-2)) ...}, then we have,

$$E(u_t/F_t) = \sigma^2 + z'(t)\, \tau \qquad (3)$$

where τ = vech (Σ) and $z(t) = K_p$ {vech [Y (t-1) Y' (t-1)]};

K_p is a {p (p+1) X p^2} matrix such that vec [Y (t-1) Y' (t-1)] = K_p' {vech {Y (t-1) Y' (t-1)}. Given the sample {X (1), ..., X (N)}, we obtain the least square estimates β^* of β from (2) by minimizing

$\sum_{i=1}^{N} u^2(t)$ with respect to β. The second step in the estimation procedure begins by using (2) to form the residuals

$$u^*(t) = X(t) - \beta^{*\prime} Y(t-1), \quad t=1, ..., N.$$

Let $\eta(t) = u^2(t) - \sigma^2 - z'(t)\tau$, in view of (3), then the estimation of τ^* and σ^{2*} respectively are estimated by minimising $\Sigma\, \eta^2(t)$ with respect to τ and σ^2, that is, by regressing $u^{2*}(t)$ on 1 and $z(t)$.

2.3 The Maximum Liklihood Method

From the structure of (1), we have, $E[X(t)/Y(t-1)] = \beta \bullet Y(t-1)$ and
$Var\{X(t)/Y(t-1)\} = \tau' z(t) + \sigma^2$.

The likelihood function of the sample $\{X(1), ..., X(N)\}$ conditional on the values $\{X(o), ..., X(1-p)\}$ is defined as

$$L_N(\beta, \tau, \sigma^2) = (2\pi)^{-N/2} \prod_{t=1}^{N} \left\{ (\sigma^2 + \tau' z(t))^{-1/2} + \exp\left(-\frac{1}{2} \frac{(X(t)-\beta' Y(t-1))^2}{\sigma^2 + \tau' z(t)} \right) \right\}$$

It is convenient to consider the minimization of the following function, instead of the maximization of $L_N(\beta, \tau, \sigma^2)$.

$$l_N(\beta, \tau, \sigma^2) = N^{-1} \sum_{t=1}^{N} \ln(\sigma^2 + \tau' z(t)) + N^{-1} \sum_{t=1}^{N} \frac{(X(t)-\beta' Y(t-1))^2}{\sigma^2 + \tau' z(t)}$$

This function is nonlinear in σ^2 and τ, and there is no closed form expression for the estimates β_N^*, τ_N^* and $\sigma^2{}_N^*$ of β, τ and σ^2, which minimize l_N. By letting $r = \tau/\sigma^2$, we may equivalently minimize a function of r alone, by concentrating out the parameters β and σ^2.

Thus we have,

$$l_N(\beta, r, \sigma^2) = \ln \sigma^2 + N^{-1} \sum_{t=1}^{N} \ln (1 + r' z(t))$$

$$+ \sigma^2 N^{-1} \sum_{t=1}^{N} \frac{(X(t)-\beta Y(t-1))^2}{1 + r' z(t)}$$

From this we will get,

$$\beta = \beta_N(r) = \left[N^{-1} \sum_{t=1}^{N} \frac{(Y(t-1) Y'(t-1))}{1 + r' z(t)} \right]^{-1} x$$

$$N^{-1} \sum_{t=1}^{N} \frac{(X(t) Y(t-1))}{1 + r' z(t)}$$

$$\sigma = \sigma_N(r) = N^{-1} \sum_{t=1}^{N} \frac{(X(t) - \beta_N'(r) Y(t-1))^2}{1 + r' z(t)}$$

Thus the maximum likelihood estimation β_N^*, τ_N^* and $\sigma^2{}_N^*$ may be obtained by calculating r_N^*, where r_N^* minimizes the function

$$l_N(r) = \ln \{\sigma_N^2(r)\} + N^{-1} \sum_{t=1}^{N} \ln (1 + r' z(t))$$

2.4 Test of Randomness

Now we will discuss briefly the test of randomness of the regression coefficients as suggested by Nicholls and Quinn (1982). Once we obtain the maximum likelihood estimates of β, σ^2 and τ, we need to check the randomness of the regression coefficients. A score test is used to test the null hypothesis of $\Sigma = o$ or alternatively $\tau = o$. For this purpose, we define the following:

(i) $\bar{Z} = \frac{1}{N} \sum_{t=p+1}^{N} Z(t)$

(ii) $e(t) = X(t-1) - \beta'^* Y(t-1)$

(iii) $G = \frac{1}{N} \sum_{t=p+1}^{N} e^2(t)z(t) - \sigma^2 \bar{z}$

(iv) $W = \frac{1}{N} \sum_{t=p+1}^{N} (z(t) - \bar{z})' (z(t) - \bar{z})$,

(v) $V = \frac{1}{N} \sum_{t=p+1}^{N} [(e^2(t)/\sigma^2) - 1]^2$

Then the test statistic,

$T = N (V \sigma^{2*})^{-1} G W^{-1} G$

is shown to follow a χ^2 distribution with p (p+1)/2 degrees of freedom.

The complete procedure of model identification, estimation of parameters and testing of randomness of regression coefficients is given by Nicholls and Quinn (1982). Following them we have identified and developed suitable RCA models for thirteen Indian economic times series.

2.5 Fitted Models

The models fitted on different series are given in Table 1 along with the maximum likelihood estimates of the variance and vech (Σ). In Table 2, we give the T - values for testing the randomness of the coefficients.

Table 1: Random Coefficient Autoregressive Models Along with the Maximum Likelihood Estimates of Parameters

Series	Model Description	σ^2	Vech (Σ)
1. Aggregate Deposits	X (t) = -0.0488X (t-1) -0.8341X (t-12) + e (t)	0.00000430	0.0343 0.1871 0.2982
2. Non-food Credit	X (t) = -0.3257X (t-1) -0.1943X (t-2) + e (t)	0.00009441	0.8488 0.5603 0.1060
3 Money Stock (M_3)	X (t) = -0.1410X (t-1) + e (t)	0.00000768	0.0756

Contd..

Series	Model Description	σ^2	Vech (Σ)
4. Money Supply (M_1)	X (t) = -0.2450X (t-1) + e (t)	0.00003468	0.1079
5. Currency with the Public	X (t) = -0.5116X (t-12) + e (t)	0.00003453	0.0000
6. Demand Deposits	X (t) = -0.3082X (t-12) + e (t)	0.00007978	0.5143
7. Time Deposits	X (t) = -0.8737X (t-1) + e (t)	0.00000703	0.0311
8. Bank Credit to Commercial Sector	X (t) = -0.1794X (t-1) + e (t)	0.00001649	0.0000
9. Net Bank Credit to Government	X (t) = -0.4710X (t-12) + e (t)	0.00015819	0.0000
10. Reserve Money	X (t) = -0.3527X (t-1) +0.3898X (t-12) + e (t)	0.00019240	0.1662 -0.0549 0.0000
11. Wholesale Price Index (WPI)	X (t) = -0.2312X (t-1) -0.6981X (t-12) + e (t)	0.56679213	0.0128 -0.2357 0.2628
12. Consumer Price Index for Ind. Workers (CPI)	X (t) = -0.2269X (t-1) -0.5963X (t-12) + e (t)	1.04710267	0.0117 -0.0322 0.1296
13. Index of Industrial Production (IIP)	X (t) = -0.3273X (t-1) + e (t)	0.00020423	0.0310

Concluded.

Table 2 : T - Values for Testing the Randomness of the Coefficients

Series	T	d.f.	Series	T	d.f.	Series	T	d.f.
1	2.6579	3	2	45.7393*	3	3	1.1802	1
4	2.9282	1	5	1.0484	1	6	45.7613*	1
7	1.4089	1	8	0.0169	1	9	0.4268	1
10	17.5266*	3	11	10.7924*	3	12	0.5523	3
13	0.1855	1						

* means significant at 5% level

The test for randomness indicates that only in four cases, Non-food Credit, Demand Deposits, Reserve Money and Wholesale Price Index, the coefficients show randomness.

3. Forecast Performance

Since generating reliable forecasts is one of the most important objectives of time series analysis, we would like to examine how good are the forecasts generated by the RCA models vis-a-vis other three models namely Box-Jenkins, Bilinear and State Dependenet models. For this purpose, we have selected a suitable criterion namely, mean square percentage error (MSPE) to evaluate the forecast performance of the models. On the basis of MSPE's of the four models, we shall try to assess the forecast performance of RCA model vis-a-vis other three models. We compared 12 one step ahead forecasts with the acutals for the year 1991-92. According to the MSPE, we have ranked different models for best fit. Obviously, this rank will indicate the performance of a model within a given series. We tabulate the MSPE's of different models in Table 3.

Table 3: Performance of Different Models
(Based on one step ahead forecast)

Series	Mean Square Percentage Error			
	Box	Bilinear	SDM	RCA
1. Aggregate Deposits	0.71	0.70	0.53	0.43*
2. Non-food Credit	6.08	4.72	4.87	3.97*
3. Money Stock (M_3)	0.42	0.58	0.44	0.46
4. Money Supply (M_1)	2.63	2.37	2.89	3.39
5. Currency with the Public	1.57	1.31	1.82	2.02
6. Demand Deposits	9.04	10.10	9.74	9.36
7. Time Deposits	0.26	0.38	0.28	0.46
8. Bank Credit to Commercial Sector	0.74	0.72	0.76	0.75
9. Net Bank Credit to Government	1.76	1.39	1.93	2.00
10. Reserve Money	10.71	10.67	14.62	12.98
11. Wholesale Price Index (WPI)	0.65	0.56	0.53	0.66
12. Consumer Price Index for Ind. Workers (CPI)	0.57	0.53	0.56	0.49*
13. Index of Industrial Production (IIP)	16.79	5.42	16.05	11.13

* indicates that the performance of RCA is the best.

From Table 3, it can be seen that for three series, viz., Aggregate Deposits, Non-food Credit and Consumer Price Index for Industrial Workers, RCA model gives better results than the other three models.

We have also evaluated the overall forecast performance of the four models by combining the series-wise results. Here we count the number of times one model outperforms the other three models for all lead period and for all series. For this purpose, we have taken two sets of forecasts, in addition to the one-step ahead forecasts, viz., three-step ahead and 12-step ahead forecasts. The combined results of these are shown in Table 4 (a) to 4 (c).

Table 4: Number of Times One Model Outperforms the Other Three Models

(a) Based on one-step ahead forecast errors

	Model	Number	Rank
1.	Box-Jenkins	36	3
2.	Bilinear	36	3
3.	State Dependent Model	40	2
4.	Random Coefficient Autoregressive	45	1

(b) Based on 3-step ahead forecast errors

	Model	Number	Rank
1.	Box-Jenkins	106	3
2.	Bilinear	119	2
3.	State Dependent Model	100	4
4.	Random Coefficient Autoregressive	143	1

(c) Based on 12-step ahead forecast errors

1.	Box-Jenkins	502	2
2.	Bilinear	732	1
3.	State Dependent Model	323	3
4.	Random Coefficient Autoregressive	315	4

If we combine the results of all the series as given in Tables 4(a) to 4(c), it is clear that RCA models are far superior for short-term forecasts. Upto three-step ahead forecasts, RCA models fares extremely well compared to all other three models. But for long-term forecasts, the performance of RCA is the worst, while Bilinear turns out to be the best. Bilinear fares only next to RCA in case of forecasts upto three-step ahead.

4. Conclusions

In this exercise, we have identified and developed RCA models for thirteen Indian economic time series, following Nicholls and Quinn (1982). The forecast performance of these models vis-a-vis Box-Jenkins, Bilinear and State Dependent models are evaluated using the criterion of MSPE. RCA models are shown to fare extremely well in case of only three series namely, 'Aggregate Deposits', Non-food Credit, and 'Consumer Price Indices for Industrial Workers'. But, in five of the remaining ten series, the performance of RCA is the worst. But when we consider the results of all the series and count the number of times one model outperforms the other three models, it was found that in general, the performance of RCA model was very good for short-term forecasting upto three lead period. For long-term forecasting, Bilinear model outperforms all the other three models. Thus we may conclude that in any serious short-term forecasting exercise Random Coefficient Autoregressive Model would be preferred as an alternative to the other available time series techniques.

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Annexure

Series	Transformation
1. Aggregate Deposits of All Scheduled Commercial Banks	(1-L) log AD
2. Non-food Credit of All Scheduled Commercial Banks	(1-L) log NFC
3. Money Stock (M_3)	(1-L) (1-L^{12}) log M3
4. Money Supply (M_1)	(1-L) (1-L^{12}) log M1
5. Currency with the Public	(1-L) (1-L^{12}) log CP
6. Demand Deposits	(1-L) (1-L^{12}) log DD
7. Time Deposits	(1-L^{12}) log TD
8. Bank Credit to Commercial Sector	(1-L) (1-L^{12}) log BCCS
9. Net Bank Credit to Government	(1-L) (1-L^{12}) log NBCG
10. Reserve Money	(1-L) log RM
11. Wholesale Price Index (WPI)	(1-L) (1-L^{12}) log WPI
12. Consumer Price Index for Industrial Workers (CPI)	(1-L) (1-L^{12}) log CPI
13. Index of Industrial Production (IIP)	(1-L) (1-L^{12}) log IIP

L indicates the lag operator.

APPENDIX - PROGRAM LISTING

```
/* THIS PROGRAM IS FOR FORECASTING TIME SERIES USING
   RANDOM COEFFICIENT AUTOREGRESSIVE MODEL. */

/* THIS PROCEDURE GENERATES THE DIFFERENCED SERIES
   */

PROC (1) = DIF (K, X);
  LOCAL L,M,Y1,Y2,Z;
  N=ROWS (X); M=COLS (X);
  Y1=X [K+1:N,.];
  Y2=X [1:N-K,.];
  Z=Y1-Y2;
  RETP (Z);
ENDP;

/* THIS PROCEDURE CALCULATES THE AUTOCORRELATION */

PROC (1) = CORR (M, X, Y);
  LOCAL R, N, K, X1, X2, S3, S4, M1, M2, S12;
  R=ZEROS (M, 1);
  N=ROWS (X);
  K=1,
  DO WHILE K LE M;
    X1=X [1:N-K, 1];
    X2=X [K+1:N, 1];
    S3=STDC (X1);
    S4=STDC (X1);
    M1=MEANC (X1);
    M2=MEANC (X2);
    S12=SUMC (X1.* X2);
    R [K, 1] = (S12/ (N-K)-M1 *M2)/ (S3*S4);
  ENDO;
  RETP (R);
ENDP;

/* THIS PROCEDURE TRANSFORMS THE ORIGINAL SERIES */

PROC (2) = TRANS (LCD, ID, IS, IDM, X);
   LOCAL M;
   IF LCD NE 0;
   X = LOG (X);
   ENDIF;
```

```
    IF ID NE 0;
    X = DIF (ID, X);
    ENDIF;
    IF IS NE 0;
    X = DIF (IS, X);
    ENDIF;
    IF IDM NE 0;
    M = MEANC (X);
    X = X - M;
    ELSE;
    M = 0;
    ENDIF
    RETP (M,X);
ENDP;

/* THIS PROCEDURE TRANSFORMS BACK THE FORECASTS */

PROC (1) = RETRANS (LG, ID, IS, IDM, M, X, F);
    LOCAL N, Y, L, I;     N = ROWS (X);
    F = F+M;
    IF LG NE 0;
      X = LOG (X);
    ENDIF;
    Y = X:F;     L = ROWS (Y);
    IF (ID NE 0) AND (IS NE 0);
      I = 1;
      DO WHILE I LE ROWS (F);
        Y [N+I, 1] = Y [N+I, 1] + Y [N+I-1, 1] + Y [N+I-IS, 1]
             - Y [N+I-IS-1, 1];
        I = I+1;
      ENDO;
      ELSEIF (ID NE 0) AND (IS EQ 0);
      I = 1;
      DO WHILE I LE ROWS (F);
        Y [N+I, 1] = Y [N+I, 1] + Y [N+I-IS, 1];
        I = I+1;
      ENDO;
      ELSEIF (ID EQ 0) AND (IS NE 0);
        I = 1;
        DO WHILE I LE ROWS (F);
          Y [N+I, 1] = Y [N+I, 1] + Y [N+I-IS, 1];
          I = I+1;
        ENDO;
     ENDIF;
```

```
    F = Y [N+1:L, 1];
    IF LG NE 0;
      F = 10^ (F);
    ENDIF;
    RETP (F);
ENDP;

/* THIS PROCEDURE IS USED TO FIND THE FORECAST OF TRAN-
SFORMED SERIES */

PROC (1) = FORECAST (X, BETA, NS, NAR, ARL);
    LOCAL AR, CA, Z, I, N, K;
    IF NAR NE 0;
      AR = ARL [1:NAR,.];
      CA = BETA [1:NAR,.];
    ENDIF;
    Z = ZEROS (NS, 1);
    I = 1;
    DO WHILE I LE NS;
      N = ROWS (X);
      K = 1;
      DO WHILE K LE NAR;
      Z [I, 1] = Z [I, 1] + CA [K, 1]* X[N-AR [K, 1] + 1, 1];
      K = K+1;
    ENDO;
    X = X : Z [I, 1];
    I = I+1;
    ENDO;
    RETP (Z);
ENDP;

                    /* MAIN PROGRAM */

CLS;
LOCATE 9, 15; " INPUT FILE NAME : ";;IFN = CONS; PRINT;
LOCATE 11, 15, "OUTPUT FILE NAME : ";; OFN = CONS; PRINT;
CLS;
LOAD DATA [ ] = ^IFN;
OUTPUT FILE = ^OFN ON RESET;
I = INDEXCAT (DATA, 999999);
SNAME = DATA [I+1]; I = I+1;
N = DATA [I+1]; I = I+1;
NAR = DATA [I+1]; I = I+1;
```

```
ARL = DATA [I+1:I+NAR]; I = I+NAR;
ACC = DATA [I+1]; I = I+1;
NF = DATA [I+1]; I=I+1;
NT = DATA [I+1]; I=I+1;
IT = DATA [I+1]; I=I+1;
ID = DATA [I+1]; I=I+1;
IS = DATA [I+1]; I=I+1;
IDM = DATA [I+1]; I=I+1;
ACT = DATA [I+1:ROWS (DATA)];
IF NT NE 0;
    NU = N-(NF+NT-1);
    FF = ZEROS (NT, NF);
    ELSE;
    NU = N;
ENDIF;
II = 1;
IF (NT EQ 1) OR (NT EQ 0);
    GOTO M1;
ENDIF;
DO WHILE II LE NT;

M1:  Y = ACT [1:NU];
    {M, X} = TRANS (IT, ID, IS, IDM, Y);
    XT = X [MAXC (ARL) + 1:ROWS (X)];
    YT1 = ZEROS (ROWS (XT), NAR);
    I=1;
DO WHILE I LE NAR;
      YT1 [.,I] = X [MAXC (ARL)-ARL[I]+1:ROWS (X)-ARL[I]];
    ENDO;
    B1 = XT/YT1;
    LSBETA = B1;
    ZT = ZEROS (ROWS (YT1), NAR* (NAR+1)/2);
    I = 1;

  J = 1;
  DO WHILE I LE NAR;
    K = I;
    DO WHILE K LE NAR;
      ZT [.,J] = YT1 [.,I] .* YT1 [.,K];
      K = K+1;
      J = J+1;
    ENDO;
    I = I+1;
  ENDO;
```

```
ZT1 = ONES (ROWS (ZT), 1) ~ZT;
UT = XT - YT1 * B1;
UT2 = UT ^ 2;
B2 = UT2/ZT1;
ITER = 0;
SIG2 = B2 [1,.];
LSSIG = SIG2;
ROW = ROWS (B2);
GAMMAF = B2 [2:ROW,.];
G = XPND (GAMMAF);
G = G/2;
HH = DIAG (G);
JJ = 1;
DO WHILE JJ LE ROWS (HH);
  IF HH [JJ] LT 0;
    HH [JJ] = 0;
  ENDIF;
  JJ = JJ + 1;
ENDO;
G = DIAGRV (G, HH*2);
GAMMAF = VECH (G);
LSQGAMMA = GAMMAF;
L1: UT = XT - YT1 *B1;
UT2 = UT ^ 2;
B2 = UT2/ZT1;
ITER = ITER + 1;
IF ITER GT 10';
  GOTO L2;
ENDIF;
SIG2 = B2 [1,.];
ROW = ROWS (B2);
GAMMAF = B2 [2:ROW,.];
G = XPND (GAMMAF);
G = G/2;
HH = DIAG (G); JJ = 1;
DO WHILE JJ LE ROWS (HH);
  IF HH [JJ] LT 0;
    HH [JJ] = 0;
  ENDIF;
  JJ = JJ = 1;
ENDO;
G = DIAGRV (G, HH*2);
GAMMAF = VECH (G);
R = GAMMAF /SIG2;
I = 1;
```

```
J = 1;
DO WHILE I LE NAR;
  K = I;
  DO WHILE K LE NAR;
    ZT [.,J] = YT1 [.,I] .* YT1 [.,K];
    K = K+1;
    J = J+1;
  ENDO;
I = I+1;
ENDO;
ZT1 = ONES (ROWS (ZT), 1) ~ZT;
UT = XT - YT1 * B1;
UT2 = UT ^ 2;
B2 = UT2/ZT1;
ITER = 0;
SIG2 = B2 [1,.];
LSSIG = SIG2;
ROW = ROWS (B2);
GAMMAR = B2 [2:ROW,.];
G = XPND (GAMMAF);
G = G/2;
HH = DIAG (G);
JJ = 1;
DO WHILE JJ LE ROWS (HH);
  IF HH [JJ] LT 0;
    HH [JJ] = 0;
  ENDIF;
  JJ = JJ + 1;
ENDO;
G = DIAGRV (G, HH*2);
GAMMAF = VECH (G);
LSQGAMMA = GAMMAF;
L1: UT = XT - YT1 *B1;
UT2 = UT ^ 2;
B2 = UT2/ZT1;
ITER = ITER + 1;
IF ITER GT 10;
  GOTO L2;
ENDIF;
SIG2 = B2 [1,.];
ROW=ROWS (B2);
GAMMAF = B2 [2:ROW,.];
G = XPND (GAMMAF);
G = G/2;
```

```
HH = DIAG (G); JJ = 1;
DO WHILE JJ LE ROWS (HH);
  IF HH [JJ] LT 0;
    HH [JJ] = 0;
  ENDIF;
  JJ = JJ + 1;
ENDO;
G = DIAGRV (G, HH*2);
GAMMAF = VECH (G);
R = GAMMAF /SIG2;
I = 1;

BETAN2 = I + ZT * R;
J = 1;
BETAN = ZEROS (1, NAR);
DO WHILE J LE ROWS (YT1);
  BETAN = BETAN + (ZT [T,.] * YT[J,.])/BETAN2[J,.];
  J = J + 1;
ENDO;
I = 1;
BETAD = ZEROS (NAR, NAR);
DO WHILE I LE ROWS (YT1);
  BETAD = BETAD + (YT1[I,.]' *YT1[I,.])/BETAN2[I,.];
  I = I + 1;
ENDO;
BETA = INV (BETAD) * BETAN';
SIGMAN = (XT - YT1 * BETA) ^ 2;
SIGMA2 = (SUMC (SIGMAN./BETAN2))/ROWS (XT);
IF ABSA (BETA - B1) > ACC;
  B1 = BETA;
  GOTO L1;
ENDIF;
L2: EROR = SQRT (SIGMAN);
ECORR = CORR (25, EROR, EROR);
GAMMAFF = SIGMA2 * R;
AIC = ROWS (XT)*LOG (SIGMA2) + 2*NAR;
AD = ROWS (ZT)/ROWS (X);
IF NAR = 1;
  WN = ZEROS (NAR* (NAR+1)/2,NAR*(NAR+1)/2);
  WN = STDC (ZT)^2 * AD;
  ELSE;
  I = 1;
  DO WHILE I LE ROWS (ZT);
```

```
      WN = WN + (ZT[I,.]-MEANC (ZT[I.,]'))'* (ZT[I.,]
      -MEANC (ZT[I.,]'));
      I = I + 1;
    ENDO;
    WN = WN/ROWS (X);
  ENDIF;
  GN = MEANC (SIGMAN .* ZT) *AD - SIGMA2*MEANC (ZT);
  VN = MEANC ((SIGMAN/SIGMA2)-1) ^ 2) * AD;
  TN = INV (VN*(SIGMA2) ^2) * ROWS (ZT)*GN'
  *INVSWP (WN)*GN;

IF II EQ 1;
"    ";;" RANDOM COEFFICIENT AUTOREGRESSIVE MODEL";
   PRINT;PRINT;
FORMAT /RD 6, 0;
"SERIES NAME                        : ";;$SNAME;
"NO. OF OBSERVATIONS                : ";;N;
FORMAT /RD 8, 4;
"MEAN                               : ";;M;
"LEAST SQUARE BETA                  : ";;LSBETA';
"LEAST SQUARE SIGMASQ               : ";;LSSIG;
"LEAST SQUARE GAMMA                 : ;;LSQGAMMA';
"MAXIMUM LIKELIHOOD BETA            : ";;BETA
"MAXIMUM LIKELIHOOD GAMMA           : ";;GAMMAFF';
"MAXIMUM LIKELIHOOD SIGMASQ         : ";;SIGMA;
FORMAT /RD 3, 0;
"NO. OF AR TERMS                    : ";;NAR;
FORMAT /RD 7, 0;
:LAGS OF AR TERMS                   : ";;ARL';
FORMAT /RD 8, 4;
"CORRESPONDING COEFFS.              : ";;BETA'; FORMAT/RD 3,0;
"IT, ID, ITS, IDM,                  : ";;IT ID IS IDM;
"NS, NT, ACCUR                      : ";;NF NT;;
FORMAT /RD 8,6;ACC; PRINT;
ENDIF;
"AIC                                : ";;AIC;
"TEST FOR RANDOMNESS - T            : ";;TN;

"          NO. OF OBS.:";;FORMAT 3,0,ROWS (X); PRINT;
    CF = FORECAST (X, BETA, NF, NAR, ARL);
    F = RETRANS (IT, ID, IS, IDM, M, Y, CF);
    OUTWIDTH 132;
    PRINT;
```

```
  IF NT EQ 0;
    " AUTOCORRELATIONS OF ERROR SERIES :";
    FORMAT /RD 5, 2,
    ECORR';
    PRINT;
  ENDIF;
    FORMAT /RD 9, 2;
    FORECAST :';;F';
  IF NT NE 0;
    ACT1 =ACT[NU+1:NU+NF, 1];
    " ACTUALS :";;ACT1';
    FF[II,.]=(((F'-ACT1')./ACT1')*100) ^2;
    " SQ.P.ER :";;FF[II,.];PRINT;
  ENDIF;
    NU = NU+1;
    II = II+1;
  ENDO;
    IF NT NE 0;
    MSPE = MEANC (FF);
    "M.S.P.E. : ";;MSPE';
    ENDIF;
END;
```

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CAPACITY UTILISATION IN INDIAN INDUSTRIES

D. Ajit*

The importance of capacity utilisation in the industrial sector in a capital-scarce economy like India lies in the fact that it reflects the use of scarce resources as well as the state of demand. The analysis of capacity utilisation data for 20-year period indicates a declining trend in capacity utilisation in industrial sector in India during 1970 through 1990, although during the 1980s there has been some *albeit* modest improvement in the capacity utilisation.

One of the widely used measures to judge the performance of industrial sector,both actual and potential, is capacity utilisation. It is also one of those variables over which there is no agreement with regard to either the concept or its measurement.[1]

The importance of capacity utilisation in the industrial sector in a capital-scarce economy like India lies in the fact that it reflects the use of scarce resources as well as the state of demand. Persistent low rate of capacity utilisation would, for instance, reflect wastage of resources in that the potential has been created without considerations of the level of prevailing effective demand and of the possibility of technology becoming obsolete before realising the full utilisation. In order to understand the dynamics of investment decisions that impinge on growth, it is necessary to investigate into the actual capacity utilisation and the policy ramifications arising out of it. Such an approach has to be necessarily empirical, but as no empirical inquiry can be meaningful without a sound analytical framework, one needs to examine the conceptual issues as well.

This paper attempts to study the trends in utilisation of industrial capacity during the period 1970 to 1990, 86 industries accounting for a weight of about one-fourth of weight in the index number of industrial production (Base 1980-81=100) have been picked up for the purpose.

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An attempt is also made at the outset to develop an analytical framework for subsequent empirical investigation.

Concepts and Indicators

In the theoretical literature one comes across various concepts of capacity, viz., licensed capacity, installed capacity, productive capacity, maximum or optimum capacity. At times, capacity utilisation is used synonymously with capital utilisation, even though capital has a distinct connotation and is rarely regarded as equivalent to productive capacity. Theoretically, capacity output could be defined as the minimum point on the average cost curve of the unit in a competitive market. But given the fact that most of the firms produce multiple products and the problem in locating a sharply defined minimum point in the average cost curve, the empirical determination of this version of capacity output becomes a difficult proposition. Some of the commonly used indicators of capacity utilisation are (i) Wharton Index of Capacity Utilisation (ii) RBI Index of Potential Utilisation (iii) Minimum Capital-Output Ratio Measure and (iv) Consumption of Electricity. The use of any statistical measure, however, depends upon the concept of capacity utilisation used.

(a) Wharton Index

Lawrence Klein (1960, 1966,1967) developed a meaningful concept of capacity based on "peak output". This has since come to be known as the Wharton Index of capacity utilisation. The "peak output" approach to the measurement of capacity is based mainly on capacity output between the peaks. Hence the approach is also called "Trend through peaks method". The construction of Wharton Index involves marking off cyclical peaks of industrial output and fitting linear segments between successive peaks. In fact the 'peak-output approach' has been used in India by ICICI to estimate capacity utilisation rates for various industries based on data on financial performance of companies. Ray and Kangasabapathy (1992) have used a simple variant of Wharton technique - the ratio of actual and trend values obtained by means of a linear equation - to estimate capacity utilisation in their study of industrial inflation in India.

There are, however, a number of limitations and criticisms of the Wharton index. First, it has been argued by Samuel Paul (1974) that peaks which are identified may not truly reflect capacity output of the industry. In economies like India which are characterised by supply constraints, especially energy factor and other rigidities, the peaks which are identified may in fact be lower than the true peaks and consequently the mean capacity tends to get under-estimated and the utilisation over-estimated. Thus, in the Indian context, industrial output for March is always higher than other months. Sometimes due to problems of lags in reporting of data, the peak output transcends to succeeding months also. Secondly, the "peaks approach" presupposes that capacity expansion takes place in a smooth and gradual manner which may not be true always. Thirdly, there is also a problem of aggregation when industries are aggregated. Peaks of one industry may not coincide with the peaks of other industry. Finally, the "peaks approach" presupposes a uniform rate of net investment between peaks for a given marginal capital-output ratio thus going against the standard acceleration principle of investment.

(b) RBI Index

The RBI index[2] of potential utilisation is a modified version of the Wharton Index. The main difference between the RBI Index and Wharton Index of capacity utilisation is the period for allocating the peaks. The RBI Index utilises mainly monthly output data to allocate peaks while the Wharton Index uses the quarterly series.

(c) Minimum Capital-Output Ratio

The National Conference Board of the U.S. estimates capacity on the basis of capital-output ratios. Under this method, on the basis of the lowest capital-output ratio, a bench mark year is selected and capital-output ratio is considered as capacity output. The capacity utilisation rate is estimated as the ratio of actual output as a proportion of the estimate of capacity, i.e.,

$$U = A/\hat{C} \times 100$$

Where

A = Real output

$\hat{C}$ = Estimate of capacity

Where

$$\hat{C} = C/(C/A) \text{ Minimum}$$

C = Real Fixed Capital

However, this concept is beset with the problem of measurement of capital.[3]

(d) Electricity Consumption

The electricity consumption as an indicator of capital usage is based on the work of Foss (1963) which was later developed by Jorgenson and Grilliches (1967).[4] Electricity consumption, like output and labour, is related to the flow of capital services. Electricity is a perfectly homogeneous input and hence there are no problems with aggregation or measurement. Also, electricity has no "hoarding" problem, i.e., electricity could not be stored and so the flow into a process corresponds exactly with what is currently used by the process. Although theoretically electricity consumption is an ideal indicator, there are a number of data problems, especially in the Indian context. Although the Annual Survey of Industries (ASI) have started recently publishing the industry-wise consumption of electricity, no time series data are available for various industries. Moreover, the ASI relates only to the organised sector in industry.

Review of Studies in India

A few attempts have been made to study the trends in capacity utilisation in India. One of the earliest attempts has been that of Morris and Paul (1961) based on installed capacity and actual production data published by CSO in Monthly Statistics of Production (MSP) for the period 1951-59. Their study showed an increasing capacity utilisation for the period 1951-59. Perhaps one of the most authoritative attempts to study underutilisation of capacities was done by Raghavachari (1969). Based on the data on installed capacity and actual production published by CSO for the five year period 1963 to 1967, Raghavachari (1969) found that underutilisation of capacity in industries increased from 17.7 per cent in 1963 to 21.4 per cent in 1965; the extent of underutilisation was found to be higher in chemical industries than in metal and engineering industries.

RBI's study (1970) based on the concept of peak level output as developed by Lawrence Klein (1960,1966,1967), and using the concept of monthly peaks (as against quarterly peaks used by Klein) based on the production data for the period 1960-73 showed a declining trend in capacity utilisation. The RBI study used use-based and input-based classification of industries. Samuel Paul (1974) studied capacity utilisation in India based on CSO data for the period 1961 to 1971, and found that capacity utilisation adjusted for shifts to be about 50 per cent as against the MSP definition based figure of 80 per cent. His empirical investigation based on cross-section regression exercise found that capacity utilisation (for 39 industries) for the year 1965 was positively related to demand pressure represented by rate of change in the peak output in the industry and size of firms; large size firms or capital intensive firms were found to have higher capital utilisation. A negative relationship was found between capacity utilisation and degree of monopoly (i.e., number of firms in the industry) implying that monopoly/oligopoly does not lead to a lower utilisation of capacity. Both import penetration and import content of production were found to have an adverse effect on capacity utilisation.

Sastry's study (1980) of capacity utilisation in the Cotton Mill industry for the period 1950-73 using alternative measures of capacity utilisation (like Wharton Index, RBI Index of Potential Capacity Utilisation and data on installed capacity) found that Wharton/RBI-Index of Potential Utilisation yielded higher levels of capacity utilisation. However, other measures based on CSO data on installed capacity yielded utilisation rates between 50 to 70 per cent. All indicators showed declining trends in capacity utilisation. The most important factor influencing capacity utilisation in Cotton Textile industry was found to be supply side factors namely raw material availability.

The Centre for Monitoring Indian Economy in a study (1987), based on data on installed capacity during the period 1980 to 1986, found that capacity utilisation has declined over the period of study. The study found that for the year 1986, around 35 per cent of industries in terms of weight in index number of industrial production operated below capacity utilisation rate of 60 per cent. IDBI studies (1981) which cover only IDBI assisted companies and are based on peak-output method as developed by Lawrence Klein (1960, 1966 and 1967): these also show a declining trend. RBI's study (1986) based on data compiled by IDBI in respect of 30 industries which have a weight of 50.75 per cent in general index number of industrial production (1970=100) found that improvement in capacity utilisation in the Sixth Five Year Plan Period (1980-85) was negligible. The study also found that capacity utilisation ratio in basic goods industries deteriorated during the Sixth Five Year Plan period , while that of capital goods and intermediate goods showed improvement.

Goldar and Ranganathan's (1992) cross-section study (based on installed capacity data published by DGTD (for 1983-84)) broadly endorsed the findings of Samuel Paul (1974).

Srinivasan (1992) studied some of the basic, capital, intermediate and consumer goods industries for the period 1970-83 and found that the reasons for excess capacity in Indian industries are mostly demand determined. Most of the basic and capital goods were found to be demand constrained. For capturing demand, Srinivasan has used income variable depending on the industry. The industries found to be supply constrained include cement, agricultural tractors, paper and paper boards and cotton textiles.

Capacity Licensing in India

In India, planning has been pre-occupied with directing industrial investment to planned demand. This has been sought to be served by licensing of capacities. Till 1991, a license was required to set up a plant or to move an existing plant, expand the capacity of an existing plant or to make a new product with an existing plant. The legal support for capacity licensing was provided by the Industries (Development and Regulation) Act, 1951. The various Industrial Policy Resolutions (IPRs) provided the direction of policy changes with regard to industry. For importing capital goods or intermediates or for having foreign collaboration, necessary licences have to be obtained from respective authorities.[5] Large companies were subject to the provisions of the Monopolies and Restrictive Trade Practices (MRTP) Act which required large companies to get MRTP clearance before they applied for an industrial licence[6]. Besides the MRTP Act, the government has also reserved since the mid-sixties, a list of items for the production of small sector. This also constitutes another form of restriction on capacity i.e., it bars a unit licence, if it grows beyond a certain size.[7]

Over a period of time the rigors of capacity licensing have undergone considerable change especially since 1975-76 when the New Economic Programme (NEP) was launched. Apart from permitting increase in capacity of 25 per cent arising out of replacement of old equipment and modernisation, the Industrial Policy Statement 1975-76 allowed automatic growth of capacity of engineering industry at the rate of 5 per cent per annum or up to a limit of 25 per cent in a plan period.[8] The Industrial Policy Statement announced in July 1980 went a step ahead and regularised excess capacities installed in 34 selected industries (basic and mass consumption goods).[9] The Industrial Policy Statement of 1983-84 announced a policy of "broad-banding" which allowed manufacturers to improve utilisation of installed capacities by diversification of their product range. In December 1985, Government announced a scheme for re-endorsement of capacity based on licensed capacity during any five years preceding March 31, 1985.. Under this scheme, for units which attained 80 per cent capacity utilisation, capacity on their licences were re-endorsed to the extent of the highest production achieved during any of the previous years plus one-third there-of. Thus, the concept of capacity that has been practiced in India is essentially a legally permissible level of output namely licensed capacity.

Licensed capacity, however, may differ from installed capacity due to lags between intentions and the actual achievement. In the Indian context, the pre-emption of industrial licences and creating barriers to entry has been a subject matter of much debate and discussion.[10] The concept of installed capacity in the Indian context approximates more to the engineering concept of capacity. Statistically, it is an approximation to the concept of capacity used by Central Statistical Organisation (CSO). CSO defines installed capacity as "...the practical output potential of the various units engaged in the particular industry after taking into account the manufacturing bottlenecks in the various production departments of the industry . This is worked out on the basis of full capacity during the first shift and 80 per cent of the single shift capacity for the second shift with an overall efficiency factor of 75 per cent".[11] This does not mean that industries' installed capacities are estimated on the basis of three shifts. For industries (such as typewriters, duplicators, etc.) which work on single shift due to peculiar local conditions, power availability, raw material availability, etc., their capacities are assessed on the basis of single shifts. However "... any unit regularly producing on three-shift basis and round the clock, their capacities have been assessed accordingly".[12] Samuel Paul's study (1974) for the year 1965 found that out of the 300 product groups for which data were reported by C.S.O about 275 product groups worked on single shift basis, 7 on the basis of two shifts and the remaining 18 product groups on the basis of three shifts. But given the fact that the industrial structure has undergone much change since then due to diversification and technological change, the shift system has lost much of its original meaning. Thus an analysis of the shift system of various industries in the year 1974 shows that only 31 per cent (i.e., 64 product groups) worked on single shift basis (as against 92 per cent in 1965), 18 per cent (i.e., 37 product groups) reported double shifts (as against 2.3 per cent in 1965) and the remaining 51 per cent (i.e., 206 industries) reported three shifts of operation (as against 6 per cent in 1965)[13].

Hypothesis of the Study

Capacity utilisation of an industry, as the above discussion shows, depends on a number of factors - both supply and demand. On the supply side, some of the major factors influencing capacity utilisation include availability of raw materials, energy, credit, etc. Supply factors are more relevant for intermediate goods industries especially agro-based industries. Sastry (1984) in his study of cotton textile industry, for instance has used availability of raw cotton as the supply factor. In our exercise, we intend to capture the effect of supply factor by imports of capital goods and intermediate goods after normalisation through the use of unit value index of imports. The theoretical justification here is that imports are a positive function of industrial growth although one may concede that imports of capital goods and intermediates could also act as a proxy for domestic raw material gap. Besides supply, the demand factors behind capacity utilisation are represented by changes in macro economic situation (recession or inflationary situation), changes in demand patterns (domestic or foreign) or tastes, etc. For example, in the case of industries such as cement, iron and steel, etc., a major source of demand comes from government. At the macro level, this is proposed to be captured by the income variable namely index of gross domestic product at constant prices. Another way to capture the demand pressure is to take the rate of growth of peak production as an explanatory variable.In fact this has been tried by Paul (1974) and Goldar and Ranganathan (1992).

There is a viewpoint cogently put by Paul (1974) and Goldar and Ranganathan (1992) that capacity utilisation depends on market structure i.e., the number of firms in the industry.[14] The link between market structure and capacity utilisation is mainly based on the standard 'structure-conduct-performance' (SEP) theory of industrial economics. SEP theory emphasises an inverse relationship between market structure and capacity utilisation, i.e., greater the degree of monopoly, the lower the rate of capacity utilisation. Recent figures show that the degree of monopoly as revealed by four-firm concentration ratio is between 80 to 100 per cent in more than one half of the industries.[15] However, studies in India by Paul (1974), Goldar and Ranganathan (1992) using cross-section data show a positive relationship between capacity utilisation and the degree of monopoly. In the absence of time series data on market concentration, it has not been found to be feasible to use this variable for our empirical exercise.

Tariff and trade policies also have a significant influence on capacity and utilisation since these policies had provided high levels of protection to many industries. The protection enjoyed by various industries has been brought out in the studies by Bhagwati and Desai (1970) Panchamukhi (1978), Nambiar (1983) and World Bank (1989). However, it is difficult to obtain on a comparable basis time series data on the effective rate of protection for industries covered in our study. To a considerable extent the degree of protection afforded by the policies of government is reflected in market concentration variable but as already pointed out data on this variable are not available on a time-series basis. The best which could be attempted is to use a dummy variable to reflect changes in policy regimes, wherein the value of zero could be given for the years upto 1980 when industrial policy regime was essentially restrictive and the value of one for years since 1980.

Table 1 : Details of Industries in each Use-Based Group and their Weighting Pattern

Sr. No.	Industry	Weight
	A. Basic Industries	**5.33**
1.	Nitrogenous Fertilizers	1.52
2.	Phosphatic Fertilizers	0.67
3.	Caustic Soda	0.40
4.	Soda Ash	0.20
5.	Oxygen Gas	0.11
6.	D/A Gas	0.07
7.	Steel Castings	0.80
8.	Steel Forgings	0.49
9.	Transmission Towers	0.00
10.	Steel Pipes and Tubes	0.58
11.	Aluminium	0.17
12.	Copper Cathodes	0.17
13.	Lead	0.00
14.	Zinc	0.00
15.	Aluminium Sheets and Circles	0.07
16.	Aluminium Foils	0.02
17.	Aluminium Extruded Product	0.05
	B. Intermediate Industries	**3.19**
18.	Newsprint	0.09
19.	Cycle Tyres	0.05
20.	Polythelene L.D.	0.31
21.	Polythelene H.D.	0.07

Sr. No.	Industry	Weight
22.	PVC Resins	0.09
23.	Viscose Filament Yarn	0.31
24.	Nylon Filament Yarn	0.34
25.	Viscose Staple Fibre	0.24
26.	Viscose Tyre Cord	0.12
27.	Nylon Tyre Cord	0.15
28.	Polyester Fibre	0.19
29.	Polyester Filament Yarn	0.16
30.	Vat Dyes	0.23
31.	Azo Dyes	0.11
32.	Paints and Varnishes	0.35
33.	Storage Batteries	0.16
34.	Dry Cells	0.20
35.	Optical Whitening Agents	0.04
	C. Capital Goods Industries	**6.71**
36.	Sugar Machinery	0.18
37.	Mining Machinery	0.08
38.	Metallurgical Machinery	0.05
39.	Chemical and Pharmaceutical Machinery	0.26
40.	Paper and Pulp Machinery	0.08
41.	Cement Machinery	0.11
42.	Machine Tools	0.65
43.	Cranes	0.15
44.	Lifts	0.23
45.	Power Driven Pumps	0.30
46.	Ball & Roller Bearings	0.39
47.	Road Rollers	0.07
48.	Domestic Refrigerators	0.15
49.	Air Conditioners	0.02
50.	Power Transformers	0.24

Sr. No.	Industry	Weight
51.	Electric Motors	1.29
52.	Winding Wires	0.16
53.	Railway Wagons	0.56
54.	Commercial Vehicles	1.37
55.	Jeeps	0.29
56.	Twist Drills	0.06
57.	Power Capacitors	0.02
	Consumer Goods (D + E)	**9.28**
	D. ConsumerDurables	**1.40**
58.	Sewing Machines	0.26
59.	Electric Fans	0.25
60.	Radio Receivers	0.05
61.	Motor Cycles	0.18
62.	Cars	0.14
63.	Bicycles	0.23
64.	Scooters/Scooterettes	0.10
65.	Mopeds	0.09
66.	Three Wheelers/Autorickshaws	0.03
67.	Typewriters	0.05
	E. Consumer Non-Durables	**7.88**
68.	Flour Milling	0.80
69.	Baby Food	0.38
70.	Biscuits	0.13
71.	Beer	0.58
72.	Cigarettes	0.58
73.	Leather Footwear (Western)	0.02
74.	Leather Footwear (Indian)	0.18
75.	Paper and Paper Board	2.77
76.	Soap	0.36

Sr. No.	Industry	Weight
77.	Matches	0.19
78.	Fluorescent Tubes	0.09
79.	Penicillin	0.50
80.	Streptomycin	0.36
81.	Chloramphenicol	0.08
82.	Vitamin "A"	0.37
83.	Synthetic Detergents	0.25
84.	Razor Blades	0.04
85.	Zip Fastners	0.01
86.	Linoleum	0.19

Data Base

The study is mainly based on data from Monthly Statistics of the Production of Selected industries of India (MSP) published by Central Statistical Organisation (CSO), for the initial period i.e.,1970 to 1985, and from Director General of Technical Development (DGTD)[16] for the later period. The study covers 86 industries for which comparable time-series data could be compiled. These industries account for about one-fourth of the weight in index number of industrial production (Base 1980-81=100) and covers the period 1970 to 1990. The selected 86 industries have been grouped using the Reserve Bank's use-based classification: the number of industries covered in each use-based group and their respective weights in index number of industrial production are given in Table 1. Basic industries account for 22 per cent of weights of 86 industries (24.50), intermediate industries 13 per cent, capital goods 27 per cent and consumer goods 38 per cent. For some industries for the period 1970-71 to 1974-75 data in respect of installed capacity have been estimated using the trends available in the earlier/later years. However, such estimated data constitute only 10-15 per cent of the total data used in the study.

Table 2: Trends in Capacity Utilisation - Use-based classification 1970 to 1990

		1970-80		1980-90		1970-90	
	Weight	Average	Rate of growth/ decline	Average	Rate of growth/ decline	Average	Rate of growth/ decline@
1. Baisc Goods Industries	5.33	57.8	-0.50	69.2	3.08	63.2	1.46
2. Intermediate Goods Industries	3.21	94.1	-0.43	87.1	-0.07	90.7	-0.59
3. Capital Goods	6.71	65.2	-1.97	66.9	-1.97	66.0	-0.34
4. Consumer Goods	9.28	74.3	-4.01	76.1	0.56	75.1	-0.29
a) Consumer durables	1.38	84.6	-2.30	78.9	-3.05	81.9	-1.11
b) Consumer Non-durables	7.9	76.8	-5.92	75.6	1.22	76.2	-0.64
General (1 to 4)	24.53	73.3	-2.27	76.1	0.33	74.6	-0.02

@ Calculated by fitting semi-logarithmic trend.

Methodology

The empirical analysis is mainly based on regression technique (ordinary least squares). Goodness of fit of the equation are judged in terms of R^2, Durbin-Watson statistic, signs of the co-efficient and the closeness between actual and estimated values.

Trends in Capacity Utilisation

The trends in capacity utilisation (based on data on installed capacity and actual production published by CSO) for 86 industries (accounting for one-fourth of weight in index number of industrial production) have been examined using a use-based classification. On an average, during the period of study i.e., 1970-90, nearly one-fourth of the installed capacity remained underutilised (Table 2, Graph A). Capacity utilisation in all industrial groups have shown a declining trend conforming the evidence provided by earlier studies (Raghavachari 1969, Paul 1974). Capacity utilisation of industrial sector recorded a marginal decline of 0.02 per cent per annum during the period of study 1970-90 . Yet in the eighties, the average capacity utilisation at 76.1 per cent was higher than the average capacity utilisation rate of 73.3 per cent in the 'seventies.

GRAPH A

CAPACITY UTILISATION - INDUSTRIAL SECTOR
(1970 TO 1990)

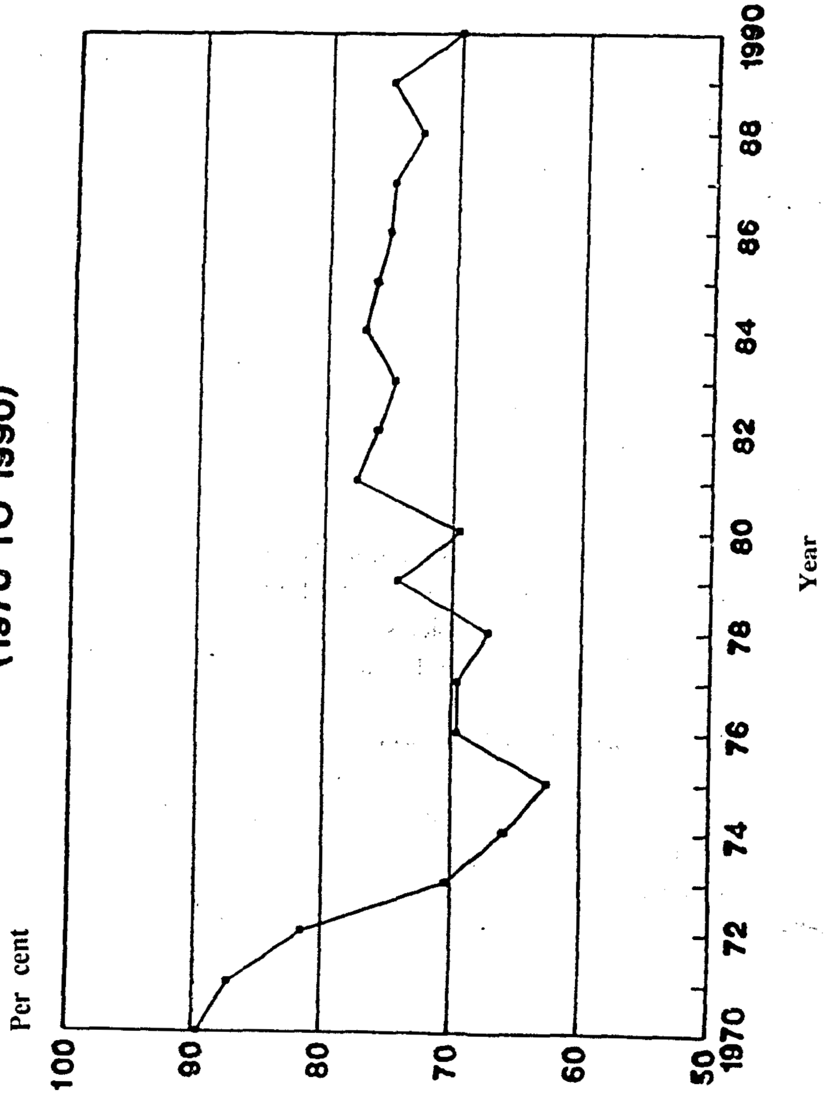


Table 3: Distribution of Industries and Their Weights According to Levels of Capacity Utilisation - All Industries

	1970		1980		1990	
Utilisation of Capacity (Percentages)	No. of Industrial group	Weights	No. of Industrial group	Weights	No. of Industrial group	Weights
Less than 40	8	2.19	10	5.79	11	2.99
40-50	7	1.72	7	3.45	8	1.23
50-60	7	1.72	6	1.56	6	2.11
60-70	7	2.51	13	4.19	6	1.99
70-80	5	0.46	6	4.08	13	5.33
80-90	14	4.17	18	5.79	11	4.48
90-100	13	4.86	8	1.85	13	3.33
Excess Utilisation	26	6.87	18	8.91	18	3.04

Thus in the eighties, capacity utilisation recorded a marginal rise of 0.33 per cent per annum as compared with a decline of 2.27 per cent per annum in the seventies. The improved capacity utilisation of industrial sector is a reflection of the relatively high and sustained growth rate of industrial sector in the eighties .

Notwithstanding the good output performance of the industrial sector, the number of industries with less than 40 per cent capacity utilisation increased from 8 (weight 2.19) in 1970 to 11 (weight 2.99) in 1990 indicating worsening of capacity utilisation levels (Table 3). The number of industries with higher levels of capacity utilisation, i.e., with more than 70 per cent capacity utilisation, declined from 58 in 1970 (weight 16.36) to 55 in 1990 (weight 16.18). The number of industries with excess capacity utilisation also declined from 26 (weight 6.87) in 1970 to 18 (weight 3.04) in 1990. This may be partly because of the shift in the level of technology between the seventies and eighties. Among the various use-based groups, the extent of underutilisation of capacity was the highest in basic goods industries (37 per cent), followed by capital goods (34 per cent), consumer goods (25 per cent) and intermediate goods (9 per cent) (Table 2).

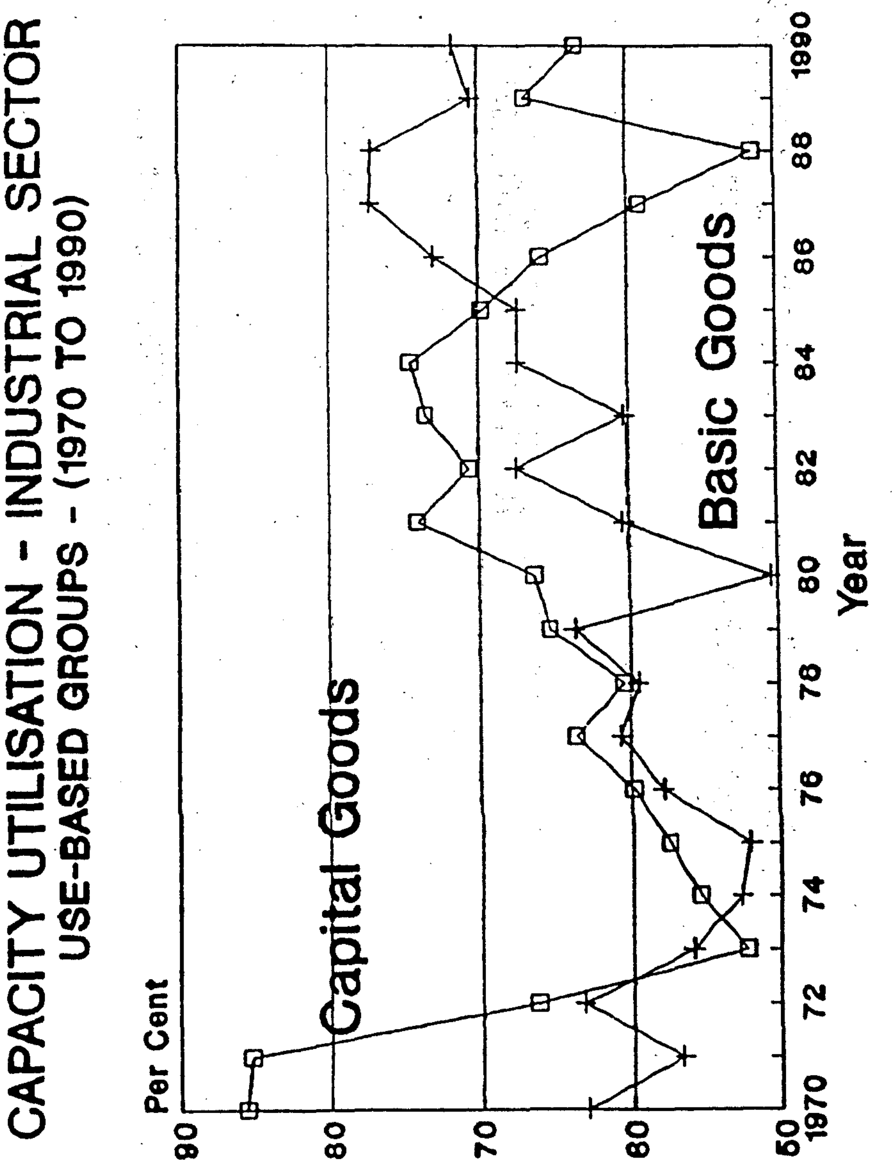
Table 4: Distribution of Industries and Their Weights According to Levels of Capacity Utilisation - Basic Industries

	1970		1980		1990	
Utilisation of Capacity	No. of Industrial groups	Weights	No. of Industrial groups	Weights	No. of Industrial groups	Weights
Less than 40	4	1.33	1	0.58	2	1.07
40-50	3	1.45	5	3.06	1	0.07
50-60	3	0.07	4	0.19	2	0.18
60-70	–	–	4	1.13	1	0.17
70-80	3	0.18	–	–	5	1.49
80-90	1	1.52	2	0.16	3	2.09
90-100	2	0.60	1	0.20	1	0.20
Excess Utilisation	1	0.17	–	–	2	0.05

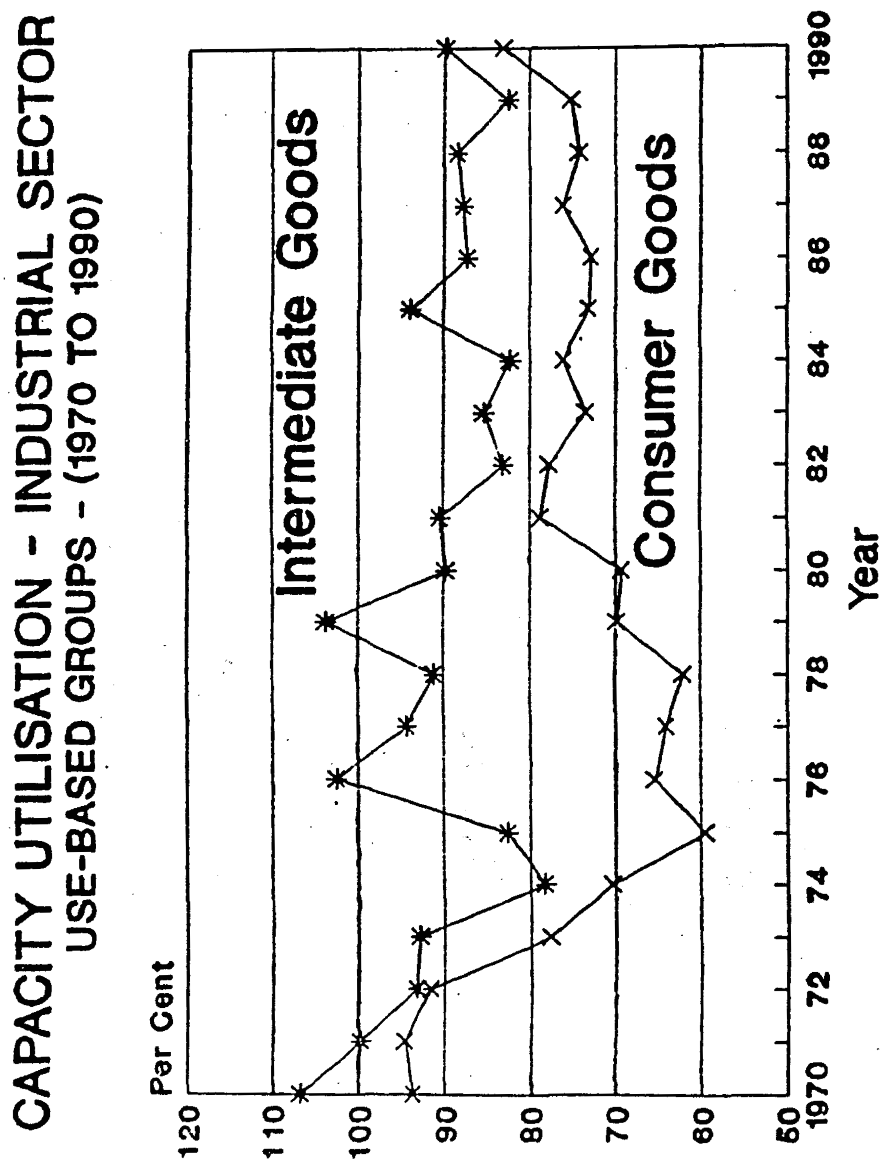
Table 5: Distribution of Industries and Their Weights According to Levels of Capacity Utilisation - Intermediate Goods Industries

	1970		1980		1990	
Utilisation of Capacity	No. of Industrial groups	Weights	No. of Industrial groups	Weights	No. of Industrial groups	Weights
Less than 40	–	–	–	–	–	–
40-50	–	–	1	0.23	1	0.23
50-60	–	–	–	–	2	0.31
60-70	1	0.11	3	0.53	2	0.12
70-80	–	–	2	0.32	2	0.65
80-90	5	0.80	3	0.50	2	0.13
90-100	4	0.52	2	0.43	3	0.75
Excess Utilisation	8	1.78	7	1.2	6	1.02

GRAPH B


CAPACITY UTILISATION - INDUSTRIAL SECTOR
USE-BASED GROUPS - (1970 TO 1990)
Per Cent
90
80
70
60
50
1970
72
74
76
78
80
82
84
86
88
1990
Year
Capital Goods
Basic Goods

GRAPH C


CAPACITY UTILISATION - INDUSTRIAL SECTOR
USE-BASED GROUPS - (1970 TO 1990)
Per Cent
120
110
100
90
80
70
60
50
Intermediate Goods
Consumer Goods
1970
72
74
76
78
80
82
84
86
88
1990
Year

Capacity utilisation of basic industries declined from 63 per cent in 1970 to 50.5 per cent in 1980 recording a decline of 0.50 per cent per annum during 1970-80 (Tables 2 and 4, Graph B). Capacity utilisation steadily improved to 69.2 per cent in 1990 recording a rate of growth of 3.1 per cent per annum in the eighties. In the case of basic industries, the number of industries recording low levels of capacity utilisation i.e., less than 40 per cent decreased from 4 in 1970 (weight 1.33) to two (weight 1.07) in 1990 (Table 4). The number of industries with high levels of capacity utilisation i.e., 70 per cent or more also improved from 7 (weight 2.47) in 1970 to 10 (weight 3.83) in 1990. The improved capacity utilisation during eighties may be taken to reflect the intensity of demand faced by these sectors.

In the case of intermediate goods industries the extent of capacity utilisation was relatively higher ranging from 90 to 107 per cent; however, over the period 1970-90, capacity utilisation has shown a declining trend (Graph C). It declined by 0.59 per cent per annum from 106.7 in 1970 to 89.8 in 1990. In all industries capacity utilisation was more than 50 per cent (Table 5). However, the number of industries having capacity utilisation more than 70 per cent declined from 17 (weight 3.1 per cent) in 1970 to 13 (weight 2.55) in 1990. The trends in this sub-sector give a clue that there may have been some technological improvement in the process of production of intermediate goods which faced a fairly robust demand, in view of the high growth rates of most finished goods industries during the eighties.

Table 6: Distribution of Industries and Their Weights According to Levels of Capacity Utilisation - Capital Goods Industries

	1970		1980		1990	
Utilisation of Capacity (Percentages)	No. of Industrial groups	Weights	No. of Industrial groups	Weights	No. of Industrial groups	Weights
Less than 40	4	0.86	4	1.07	4	0.42
40-50	-	-	1	0.16	4	0.74
50-60	2	0.81	2	1.37	1	1.37
60-70	3	1.41	3	0.27	3	1.7
70-80	1	0.23	2	1.76	-	-
80-90	1	0.08	4	0.68	3	0. 6
90-100	4	0.4	4	0.99	6	1.86
Excess Utilisation	7	2.92	2	0.41	1	0.02

In the case of capital goods industry, there has been a decline in capacity utilisation (Graph B). Capacity utilisation of capital goods industries on an average which was around 65.2 per cent in seventies improved marginally to 66.9 per cent in eighties. However, on an average the capacity utilisation has shown a decline of 0.34 per cent per annum during 1970-90. Number of industries with more than 70 per cent capacity utilisation marginally declined from 13 (weight 3.63) in 1970 to 10 (weight 2.48) in 1990 (Table 6). The developments in this sub-sector seem to indicate that the demand for these goods has shown some slack partly because of generalised underutilisation of full capacity, and partly also because there had been higher capacity build-up in the initial years of economic development.

Consumer goods industries showed a marginal improvement in capacity utilisation in the eighties (76.1 per cent) as compared with seventies (74.3 per cent), the rise in capacity utilisation comes to 0.56 per cent per annum in the eighties as compared with a decline of 4.01 per cent in the seventies (Table 7). The improved performance of consumer goods in the eighties was mainly due to improved performance of consumer non-durable segment in the eighties (Table 7).

Table 7: Distribution of Industries and Their Weights According to Levels of Capacity Utilisation - Consumer Industries

	1970		1980		1990	
Utilisation of Capacity (Percentages)	No. of Industrial groups	Weights	No. of Industrial groups	Weights	No. of Industrial groups	Weights
Less than 40	–	–	5	4.14	5	1.5
40-50	4	0.27	–	–	2	0.19
50-60	2	0.84	–	–	1	0.25
60-70	3	0.99	3	2.26	–	–
70-80	1	0.05	2	2	6	3.19
80-90	7	1.77	9	4.45	3	1.66
90-100	3	3.34	1	0.23	3	0.52
Excess Utilisation	10	2	9	7.3	9	1.95

Empirical Analysis

Capacity utilisation of industrial sector is postulated as a function of income (IGDP) (proxy for demand), imports of capital/intermediate goods (IIMP) and dummy (DUM) variable to capture the effect of changes in government policy. The regression equation was estimated using ordinary least square method and the results are given below.

Equation 1
Double Log
Period : 1970 to 1990

$$CU = 1.19 + \underset{(2.92)}{0.67\ IGDP^{*}} - \underset{(-\ 0.79)}{0.61\ IIMP}$$

$$+ \underset{(1.89)}{0.10\ DUM^{***}}$$

$\bar{R}^2 = 0.63$ D.W = 1.80 SEE = 0.4697

Mean =4.30

*,*** indicates significance at 1 per cent and 10 per cent level.
(Adjusted for auto-correlation using Cochrane-Orcutt procedure).

Where CU = Capacity Utilisation Rate of Industrial Sector.

IGDP = Index of GDP at 1980-81 Prices

IIMP = Index of Imports of Capital goods and Intermediates (Real).

DVM = Dummy Variable - Value of 0 upto 1980 and 1 since then.

The estimated equation (equation 1) had a reasonably good fit. Durbin-Watson statistic at 1.8 indicates near absence of auto-correlation. The income (IGDP) variable had the right sign and was significant at 1 per cent level. This indicates that the most important factor influencing capacity utilisation is demand.

The index of real imports of capital/intermediate goods (IIMP) did not have the right sign. An explanation of this paradox was provided by Samuel Paul (1974). According to Paul (1974), if government follows pro-rata allocation of imports, firms with high import content will get more hurt since the additional requirements cannot be met from the open market. This argument becomes all the more relevant in the context of the rising import-intensity of Indian Industries : imported raw material as a per cent of total raw material of Indian industries which was around 23.3 per cent in 1986-87 increased to 25.1 per cent by 1989-90[17]. The import intensity of industries such as chemicals and petro-chemicals was as high as 41.3 per cent followed by electrical equipment (33.8 per cent) in 1989-90.

The introduction of dummy variable (DUM) mainly representing changes in industrial policies (controls/regime) did improve the fit of the equation and was significant at 10 per cent level. This indicates that capacity utilisation would be low when government controls are high and the easing of government controls would lead to higher capacity utilisation. The reduction of physical controls and reduction of effective rate of protection of industries paves for entry of new firms which could induce existing firms to achieve better utilisation of their production capacities.

We tried to see how good and stable are these results. For this purpose, we divided the period into two parts - the seventies and eighties. We obtained the following results:

Equation 2
Double-Log
Period 1970-80

CU = 0.19 + 0.99 IGDP*** - 0.67 IIMP
(2.27) (- 0.48)

$\bar{R}^2$ D.W =2.2 SEE = 0.57

Mean =4.27

(Adjusted for auto-correlation using Cochrane-Orcutt procedure).

Equation 3
Double-Log
Period : 1981-90

$$CU = 4.09 + 0.90\ IGDP - 0.36\ IIMP$$
$$(0.81) \quad (-\ 1.00)$$

$\bar{R}^2 = 0.11$ D.W $=2.09$ SEE $= 0.23$

Mean $=4.33$

(Adjusted for auto-correlation using Cochrane-Orcutt procedure).

It may be seen from these equations (equation 2 and 3) that both IGDP and IIMP have the same signs in both sub-periods although in the eighties both the variables (IGDP and IIMP) are not statistically significant. It must, however, be cautioned that the result for the two shorter periods should be interpreted with considerable care and judgment.

Concluding Observations

Our study has shown that there has been a declining trend in capacity utilisation in industrial sector in India over the 20-year period, 1970 through 1990, although during the eighties there has been some albeit modest improvement in the capacity utilisation .Significant improvement in capacity utilisation was noticed in basic goods and capital goods industries in the eighties - a conclusion that was also supported by Rangarajan (1990). But capacity utilisation *per se* had little to do with the industrial growth during the eighties. There is considerable other evidence which suggests that there had been strong influences of productivity growth and policy initiatives in the form of deregulation,delicensing, lowering of tariffs, etc., in the industrial sector.

Among the factors influencing capacity utilisation, the predominant one for the 20-year period had been demand. This factor was somewhat suspect in the eighties, but this conclusion is not decisive. Ideally, one needs to look at the problem of capacity utilisation at the micro level of individual industries and see how strong are the demand and supply factors, and then assess the domestic investment needs of the industrial sector. Such an exercise was not attempted, since it would go beyond the scope of the present study.

Notes :

1. For a recent discussion on the literature on capital/capacity utilisation, See Winston G.C. (1974) and (1977).

2. For an exposition of this concept, See Divatia V.V. and Ravi Varma (1970).

3. For a critical review of this concept, See Sastry D.U. (1980).

4. Quoted in Healthfield, David F. (1972).

5. For an exposition of controls in the Indian context, See Mohan, Rakesh and Vandana Aggarwal (1990).

6. MRTP did not cover the public sector. The July 1991 Industrial Policy reforms has removed the sieze (asset) limit for expansion of large companies and will concentrate on only unfair and restrictive trade practices. Moreover, the public sector companies which were hitherto left out of the MRTP Act were brought under this Act.

7. The number of items reserved for Small-Scale Sector increased from 47 in 1967 to 836 in 1992.

8. Government of India, Ministry of Finance, *Economic Survey - 1975-76*, p. 12.

9. The 34 industries included basic industries and those producing mass consumption goods not reserved for small-scale sector, provided firms are not units to which MRTP Act, 1965 and FERA, 1973 applies.

10. In fact, a number of government sponsored studies were made on the subject, the most important one among them being the Report of Industrial Licensing Inquiry Committee, 1969.

11. Government of India, Central Statistical Organisation, *Monthly Statistics of the Production of Selected Industries of India*, Calcutta, March 1974, p. 339.

12. *Ibid*, 342.

13. *Ibid*, 337-342.

14. Some of the concentration indices used to measure market concentration are (1) Concentration Ratio (2) Hirschman-Herfindahl Index, (3) Hannah and Kay's Indices and (4) Entropy Index etc.

15. Centre for Monitoring Indian Economy, *Markets and Market Shares*, March 1992, p. VIII and IX.

16. It must be mentioned that data compiled by DGTD suffers from a number of limitations. According to Bhagwati and Desai (1970) ".... in the techno-economic

expertise of the DGTD" in this regard "was dismal" (p. 265). Bhagwati and Srinivasan (1975) explain the inadequacies of official data in terms of the dilemma involved in the sanction of actual user import licences, the argument being that while the entrepreneur exaggerates his/her capacity to get more actual user (AC) licences, the refusal of DGTD officials could occur also to recognised capacity augmentation.

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Estimating Money Demand Function: A Cointegration Approach

Ashok K. Nag & Ghanshyam Upadhyay*

Existence of a stable demand function for money is perceived as a prerequisite for the use of monetary aggregates in the conduct of monetary policy. The instability in money demand function reported in respect of many developed countries, it has been argued, may be due to improper specification of short term dynamics and failure to embed the latter in a properly specified long term relationships that may exist among the relevant variables. The recently developed method of co-integration is expected to overcome some of the existing problems that render application of Ordinary Least Square technique infructous. This paper makes an effort to estimate money demand function for India using this new method. The results appear to have some bearing on the choice of appropriate monetary aggregates for conduct of monetary policy. The long term relationship obtained is also found to be quite interesting.

Introduction

The existence of a stable demand function for money is an important building block for many macroeconomic models. In fact, a stable demand function for money "has long been perceived as a prerequisite for the use of monetary aggregates in the conduct of (monetary) policy" (Goldfield, 1990). For an economy undergoing an adjustment program, the existence of a stable money demand function, it is often regarded, gives hope to policy-makers in their search for a target fo/r the monetary aggregates consistent with other policy objectives like price stability. In this context one needs to note that the devastating nature of Lucas critique of policy ineffectiveness arises from the fact that the rational agents' forward looking expectations undermine the stability of any relationship between macroeconomic aggregates[1]. According to this view, estimated relationships between such variables based on historical data are of not much use to policy makers because of the impact of policy changes on the relationships themselves. Melnick (1990) specially addressed to this issue while estimating a demand for money function for Argentina, and concluded that the instability in the money demand function may

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be, to a large degree, due to "improper dynamic specification of the short run demand function for money". The money demand functions estimated in the Indian context also generally suffer from this problem of lack of non integration of long-term relationship with proper short term dynamic specification[2].

The parametric regression technique based on ordinary least square (OLS) has so far been the most popular statistical method for establishing relationship among macroeconomic variables, despite the known drawbacks of this method in the case of time-series data. Since most of the macroeconomic time series are nonstationary in their level, OLS regression technique may give misleading results in two respects. Firstly, it may show a significant relationship among variables in term of high R^2 even if not such relationship exists (indication of which may be found in low Durbin-Watson statistic) and secondly the usual t-statistic for individual regression coefficients does not possess even a limiting distribution and is expected to diverge to infinity under the assumption of independence of nonstationary regressors and regressand[3]. Since the publication of Granger & Newbold's oft-quoted paper (Granger & Newbold 1974), there has been enormous growth in literature to deal with such type of problems[4]. The concept of cointegration proposed by Granger & Engle (1987) is an attempt to salvage the regression technique from the problem of non-stationarity and is fast emerging as a potent method in the armoury of applied econometricians. Melnick's empirical exercise shows that the method of cointegration can be a useful empirical technique for estimating long term relationships.

The objectives of this paper are to estimate a money demand function that takes care of some of the shortcomings of the existing exercises on the demand for money in India; to introduce, as an exploratory approach, the cointegration method of viewing the demand for money; and to raiseanalytical issues emerging from the empirical exercise. The organisation of the paper is as follows: Section I presents a brief description of the concept of cointegration and Johansen's method of identification of the cointegrating space. We present this technical section at the beginning as some of the problems associated with our search for proper specification of money demand function hinges crucially on the time series properties of variables to be chosen. It may be noted here that Johansen's method is essentially a multivariate generalisation of Dickey-Fuller's unit root test and is based on likelihood ratio statistic and therefore is likely to possess a better power than the two step Granger-Engle procedure employed by Melnick. In section II, we discuss the specification of money demand function employed in this paper as well as the time series properties of chosen variables. Lastly, the results of exercise is presented in the section III.

Section I

The method of cointegration was originally proposed by Granger (9181), also Engle & Granger (1987), who also showed the important connection between the idea of cointegration and error correction model specified in dynamic setup by J.D. Sargan and associates. The basic idea of cointegration is very simple. Suppose we have two time series X_t and Y_t which are nonstationary in their levels but become stationary and invertible after differencing, say once. Obviously, any relationship obtained between the two variables by the method of regression which may arise specifically due to nonstationarity of the variables may be spurious. However, if it can be established that there exists a linear combination of the two nonstationary variables such that it is stationary, then that linear combination obviously describes an equilibrium relationship in the sense that X_t and Y_t cannot wander away indefinitely from the equilibrium position and must revert back to the equilibrium position, although individually each of the variables can wander away indefinitely from any starting point. More generally, let $X_t = [X_{1t}, X_{2t}, \ldots, X_{pt}]$ be a p-dimensional vector process such that each component of X_t is integrated of order one. If there exists a vector β such that $\beta' X_t$ is a stationary process, we will call β a cointegrating vector and X_t a cointegrated process. It is not necessary that β be unique. In fact (assuming that the vector process is not stationary to start with), there can be as many as (p-1) linearly independent such cointegrating vectors and the space spanned by them will be called cointegrated space. Therefore, any vector belonging to the cointegrating space will describe some sort of equilibrium relationship. If there does not exist any non-zero cointegrating vector, it may be surmised that no long term relationship exists among the components of X_t. Engle and Granger proved the following representation theorem, stating that any cointegrating process can be represented as an error-correcting process. In bivariate case this means that if $X_t = (X_{1t}, X_{2t})'$ is cointegrated, then X_{1t} and X_{2t} will have the following error-correction representation:

$$X_{1t} = -\alpha_1 Z_{t-1} + \text{lagged } (X_{1t}, X_{2t}) + \Theta(B)e_{1t}$$
$$X_{2t} = -\alpha 1 Z_{t-1} + \text{lagged } (X_{1t}, X_{2t}) + \Theta(B)e_{2t}$$

where $\Theta(B)$ is a finite degree polynomial in the lag operator B and is the same in each equation and Z_t is equal to $\beta' X_t$. The $e_{1t}$and e_{2t} are jointly white noise processes but they may be contemporaneously correlated. The error correction process in effect means that changes in

X_{1t} and X_{2t} in the current period are dependent upon deviation from equilibrium line in the previous period. The important point is to note that $|\alpha_1| + |\alpha_2| \neq 0$. This means that at least one of the processes will be better forecasted with the knowledge of its own past and past values of the other process. Therefore, there should exist Granger causality in at least one direction. To build an error correction model, Granger & Engle (1987) have suggested a two step procedure. Since, OLS gives a consistent estimate of the relationship (if one exists), the first step is to estimate a regression equation in the levels of variables to find the long term relationship among the variables, and in the second step an error correction model is built using the residuals of the first step as the departure from equilibrium. But, Johansen's method is based on likelihood ratio statistic and therefore is likely to have more power. Hence, we have used it to find the dimension of cointegrating space as well as the long term relationship among the variables. A brief description of Johansen's method is presented below.

Johansen's Method :

Johansen (1988) formulates the problem of cointegration in a multivariate setup as an exact analogue of testing of unit root in univariate case[5]. Let $Y_t = (y_{1t},....y_{pt})^T$ be a p-dimensional vector process, each component of which is an I(1) process. We are interested to find out whether there exists any linear combination of y_{it}'s such that it is stationary and also how many such independent linear combination can be said to exist. In other words we are interested to find out the dimension of cointegrating space. Let us consider the simplest case of an AR(1) process so that Y_t has the following representation:

$$Y_t = AY_{t-1} + E_t$$

where A is a p x p matrix and E_t is a vector white noise process. If all roots or eigen values of A are less than one in absolute value we know (I-A) exists and Y_t can be expressed as an infinite sum of white noise processes and hence it becomes stationary. If A = I (identity matrix), all roots of A are equal to one and no linear combination of Y_{it}'s can be stationary. The most interesting case is when some roots of A are less than one while some are equal to one. In that case we know that the eigen value-eigen vector decomposition of A (i.e A = TDT^{-1}) would produce D, a diagonal matrix of eigen values of A of the following type :

$$D = \begin{bmatrix} d_1 & & & & \\ & d_2 & & 0 & \\ & & d_3 & & \\ & & & \ldots & \\ & 0 & & & \ldots \\ & & & & dp \end{bmatrix}$$

where d_i's are eigen values of A and k of them are equal to one ($d_1 = d_2 = ... = d_k = 1 > d_{k+1} > .... > dp$).

Let $Z_t = T^{-1}Y_t$

then, $Z_t = T^{-1}AY_{t-1} + T^{-1}E^t$

$= T^{-1}ATT^{-1}Y_{t-1} + T^{-1}E_t$

$= DZ_{t-1} + \eta_t$

Since first k diagonal elements of D are equal to 1 we have $z_{1t} = z_{1t-1} + \eta_{1t}$, $z_{2t} = z_{2t-1} + \eta_{2t}$, ..., $z_{kt} = z_{kt-1} + \eta_{kt}$, $z_{k+1t} = \emptyset_{k+1} z_{k+1,\ t-1} + \eta_{k+1,\ 1}$, ... , $z_{pt} = \emptyset_p z_{p,\ t-1} + \eta_{pr}$, where $\emptyset_i$, i = k+1, k+2, ..., p are less than one in absolute value. Thus this transformation has given rise to two separate sets of processes, one of which comprise only k pure random walks and the other one a set of stationary process. Since $Y_t = TZ_t$, we find that each component of Y_t process can be decomposed into two parts - one, a linear combination of common stochastic trend components (pure random walks) and the other, a linear combination of stationary processes. So the problem of existence of stationary z_i's boils down to existence of non unitary eigen values of A. Johansen reparameterises the problem exactly in the way done in univariate case, i.e., $\Delta Y_t = \pi Y_{t-1} + E_t$, where $\pi = I - A$ and $\Delta Y_t = Y_t - Y_{t-1}$. Obviously if there are k unit eigen values in A matrix, π matrix will have rank of p-k. Therefore we can find p-k linearly independent vectors β's so that they together will span the column space of π which can be expressed as $\alpha\beta^\tau$, β being p x p-k matrix and β being p x p-k matrix of β_i's. If $X_t = \beta^\tau Y_t$, it may be easily verified that X_t is stationary and β_i's are a set of cointegrating vectors. So the problem of testing the hypothesis of k unit root or equivalently p-k linearly independent cointegrating vectors boils down to testing the rank of π matrix. Johansen derived the likelihood ratio test for the hypothesis of r cointegrating vectors (i.e p-r unit roots) in a general k-th order autoregressive process. Let Xt be such a process satisfying the following stochastic differential equation

$$X_t = A_1 X_{t-1} + ... + A_k X_{t-k} + E_t,$$

where E_t's $t = 1,2,....$ are i.i.d p-dimensional Gaussian random variable for given values of $X_{-k+1},...X_0$. This equation can be reparameterized as

$$\Delta X_t = \pi_1 \Delta X_{t-1} + ... + \pi_{t-k+1} \Delta X_{t-k+1} + \pi_{t-k} X_{t-k}$$

where $\pi = (I - A_1 -....- A_k)$.

Johansen assumes that the vector process is difference stationary i.e. ΔX_t is stationary and calls the π matrix impact matrix. If the impact matrix is of full rank (i.e. the characteristic equation of the X_t process has all roots less than 1), then the process is stationary. However, by assumption π is of rank $r < p$. So $\pi = \alpha\beta^{\tau}$ for some p x r matrices α and β. Although estimate of π will always be of full rank in a strict numerical sense, many of the eigen values of estimated π will not be statistically significant. So testing a null hypothesis of r cointegrating vector is equivalent to testing the null hypothesis of p-r zero eigen values of π matrix. The main result, Johansen obtains is as follows :

The maximum likelihood estimator of the space spanned by β is the space spanned by r canonical variates corresponding to the r largest squared canonical correlations between the residuals of X_{t-k} and ΔX_t corrected for the effect of lagged difference of the X_t process. The likelihood ratio test statistic for the hypothesis that there are at most r cointegrating vectors is $-2\ln(Q) = \sum_{i=r+1}^{p} \ln(1-d_i)$, where $d_1, d_2,..d_p$ are the smallest squared cononical correlations.

So to carry out Johansen's test, we have to run two multi variate regression: regression of ΔX_t on $\Delta X_{t-1},...,\Delta X_{t-k+1}$ and the regression of X_{t-k} on the same set of lagged differences. The square of canonical correlation between the residuals obtained from these two set of regressions will give the required eigen values of the impact matrix.

SECTION II

It is best to begin with Cagan's specification of money demand function developed in the context of hyper-inflationary environment for developing countries[6]. Since no market related interest rates are available in many developing countries, it is believed that a proper opportunity cost of money may be represented by the expected inflation rate-proxy for the rate of return on real goods. However, in the Indian case, we find that inflation rate (measured as first difference of log of Wholesale

Price Index (WPI)) is an I(0) and not an I(1) variable. Therefore a long term relationship cannot be estimated using expected inflation rate as one of the possible co-variates. In our search for a alternative I(1) variable proxying for a rate of return on an alternative competing asset we experimented with yield on government securities as well as yield on ordinary shares both of which are found to be I(1) variables. On experimentation we settled for yield on ordinary shares (YOS) as the proxy for rate of return on a spectrum of alternative assets. It may be mentioned here that the relation between stock prices and monetary growth has been studied in the context of developed countries like U.S.A. For example, Sprinkel (1964) compared the level of index of stock prices with a moving average rate of changes in the narrow money supply. Although Sprinkel's method of establishing causal direction was found to be statistically deficient, the existence of a relationship between these two variables could not be disputed. Cooper (1974) using a more advanced spectral technique also found a causal link between these variables, although in an opposite direction. Since our interest does not lie in the direction of causality, we may argue that returns in stock market may be taken as one of the determinants of portfolio choice behaviour of households and business in respect of their financial assets. Recently, Brahmanada et al (1992) alsso explored this relationship and their results suggests that a possible link may exist[7]. Furthermore, during the eighties the growth in share prices was much higher than the general inflation rate. For example, RBI index of prices of ordinary shares at all India level increased from a level of 118.9 (yearly average) for the year 1981-82 to 500.3 in the year 1990-91, indicating an annual compound growth rate of around 17.3 per cent. During the same period the wholesale price index rose at a rate of 6.9 per cent only. The increasing depth and maturity of stock markets in India also provides at present more liquidity to the stock holdings of individual and therefore reduces the liquidity premium that the demand deposit with banks may command otherwise. The large fluctuation in stock prices on the other hand is expected to generate substantial speculative demand for money, particularly for those with large unaccounted stock of currency. Furthermore, this influence is more likely to show up in respect of narrow money i.e. M_1, than in respect of M_3 as the latter include savings of pure households not given much to speculation in the Indian situation.

As regards the relevant monetary aggregates to be chosen for our exercise, we observe that it is M_1 and not M_3 which exhibit the required time series properties for application of our chosen method. In other words, while M_1 shows the existence of a stochastic trend in it, M_3 shows no such stochastic trend. In fact, a deterministic trend along with a stationary component captures the time series properties of M_3 very well. The relevant results of Augmented Dickey-Fuller (ADF) tests are given in Table 1. It may also be noted that a forecast of M_3 based on trend stationary model outperforms the forecast based on a difference stationary model[8]. The presence of a stochastic trend in M_1 and an absence of it in M_3 which is inclusive of M_1 indicates that a linear combination of M_1 and M_3-M_1 becomes a trend stationary variable although individually both of them are difference stationary variables. This is an interesting observation by itself and requires further study. In so far as this paper is concerned, we have considered M_1 as our monetary aggregate.

As regards the scale variable proxying for the level of economic activities determining the transaction demand for money stock, the only available relevant monthly data is that of Index of Industrial Production (IIP) which is also found to be an I(1) variable. The ADF test in this regard, however, is not as conclusive as in the case of other variables. Ideally, one should use aggregate production data, including agriculture and service sectors but in the absence of reliable data even on a quarterly basis, we are constrained to use IIP, being fully aware of the fact that the share of industrial income in GDP is relatively low. Furthermore, to examine the sensitiveness of our exercise to the use of IIP as a scale variable, we experimented with the quarterly estimates of GDP (at 1980-81 prices) prepared by Burman et al (1983) and found that the broad nature of long term relationships obtained from the monthly IIP series remains invariant even when quarterly GDP and relevant quarterly variables are used. Finally, the other determinant of nominal demand for money is obviously price level, which is clearly an I(1) variable. Since the price homogeniety of money demand function could not be accepted at a desired level of confidence, we settled for estimating a nominal money demand function. It may be pointed out that some of the earlier studies also used nominal money instead or real money as the relevant monetary aggregate in a money demand dunction (or inverted money demand fuction) [see Rangarajan-Arif (1990)]. Therefore, the speficiation of long term equilibrium relationship that we are interested in estimating may be written as :

$$\log M_1 = \alpha + \beta_1 \log IIP + \beta_2 \log WPI + \beta_3 YOS$$

where, IIP = Index of Industrial Production
WPI = Wholesale Price Index
YOS = Yield on Ordinary Shares.

SECTION III

The Data

The sample period for our data is April 1982 to March 1991. Although observations on all the variables were available till March 1992 we deliberately omitted them in our main samples so as to test the stability of our results when more observations become available. In co-integration relationship seasonal dummies were used although experiment shows that results do not change in a substantial manner. All variables except yield on ordinary shares (YOS) was used after log transformation.

Empirical Results : The unrestricted model

$H_1 : X_t = A_1 X_{t-1} + A_k X_{t-k} + \mu + E_t + D_i$'s, $(t = 1, 2, \ldots T)$ where $E_1 \ldots\ldots E_t$ are independent and identically distributed (i.i.d.) multi-variate normal residuals with mean zero, D_i's are seasonal dummies and $X_{-k+1} \ldots\ldots X_0$ are fixed were first fitted for the data. To begin with, the X_t's are four dimensional vectors of $\ln(M_1)$, $\ln(IIP)$, $\ln(WPI)$ and YOS. Using the F test, we first decided upon the number of lags to be used. The number of lags chosen was 9. To test the correctness of lags so chosen we tested the residuals of the fitted model for normality and autocorrelations. Bera-Jarque test of normality was employed. The results show that residuals pass the tests at reasonable levels. On experimentation, we also observed that residuals obtained from a model with fewer lags could pass the normal i.i.d. assumption about residuals but not the F test for joint non-significance of higher lags (i.e. lags between 5 to 9) with some attendant risk of overfitting. We also took care to see as to what extent our results are sensitive to the proper specification of unknown lags and we observe that our results are sufficiently robust in this respect.

For test of co-integration the reduced model under $H_2 : \pi = \alpha\beta^{\tau}$ is fitted and the estimated eigen values d_i's, the normalized eigen vector v for the data set were calculated. The test statistics for cointegration cannot be rejected by the data. The estimated long term relationship given by the normalised eigen vector corresponding to the largest eigen value works out to

$$\text{Ln}(M_1) = 1.80\ \text{Ln}(IIP) - 0.22\ \text{Ln}(WPI) - 0.04\ YOS$$

The negative sign of the price variable is rather unexpected and led us to search for another long-term relationship that may exist amongst a subset of the four variables. It is observed that if YOS is dropped from the data set and test for co-integration is applied to the 3-dimensional vector process ($\ln M_1$, lnIIP, lnWPI), the test statistic shows that these three variables are not cointegrated. The estimated trace statistic given in Table 5 bring out the point clearly. We have also tried to find out whether M_1 and IIP or M_1 and WPI are co-integrated. The results show that the answer is in the negative. However, it is observed that existence of a co-integrating relationship between M_1, IIP and YOS can not be rejected at 5% level although the trace statistics is only marginally significant at 1% level. Since the value of trace statistics are dependent upon the number of lags chosen and it is statistically more desirable to use more lags than less, we settled upon 12 lags for the vector auto-regression on the basis of F-tests as stated above. The results of Bera-Jarque test of normality as well as chi-square test of auto-correlations of residuals obtained from this vector auto-regression are reported in Table 2. The estimated eigen values and normalized eigen vector for this three dimensional set is reported in table 3. The graphs of original data and also of cointegrating relations corresponding to the three eigen values are presented in Figure (1) and Figure (2). The test stitistics given in Table 4 indicate that presence of exactly one cointegration vector can not be rejected by the data. Since the power of Johansen's test of non co-integration declines with more lags thrown in than actually required, we experimented with much longer lag structure and it is observed that the value of the trace statistics increases substantially with higher lags, thereby indicating that presence of cointegrating relationship is well validated by the data. The estimated long term relationship, therefore, works out to

$$\text{Ln}\ (M_1) = 1.62\ \text{Ln}\ (\text{IIP}) - .05\ \text{YOS}$$

One heuristic way to examine the stability of the broad features of our estimated relationship is to estimate the cointegrating relationship over different sub-samples, which we tried. The results obtained in this experimentaion is quite encouraging and gives confidence in our reported results. When we include more observations from the financial year 1991-92 we find that between April 1991 and September 1991 the results of cointegration become somewhat weak, i.e., the p value of the trace statistics become around 10 to 20 per cent. This is understandable as the unprecedented jump in WPI during the financial year 1991-92, coupled with steep devaluation in rupee and simultaneous slow-down in IIP due to stringent monetary policy introduced to douse the inflationary potential building up in the economy forced the variables under study to move away from the long term relationship so far exhibited by them. Nonetheless, despite the policy intervention, it is indeed surprising to note the discernible tendency to revert back to the long term relationship when the effect of unprecedented shocks has run its course. This enables us to claim that the relationship obtained by us is indeed long-term and not merely a statistical artifact.

An error-correction model is then fitted taking the lagged co-integrating relationship as the error. In our error-correction model we also included inflation rate as measured by first difference in log of WPI as well as changes in log gold prices as an additional explanatory variable. This was done to examine whether gold prices contain any additional significant information about price movement and thereby having a bearing on the current demand for money. Since gold is an important saving instrument in India and is very often used as a hedge against inflation, it is expected that gold may be looked upon as an alternative asset for those holding idle money for speculative purposes. The chosen error-correction model confirms that hypothesis of significant effect of changes in gold prices on movement in money demand. The coefficients of error correction model finally estimated is given in Table 6.

Finally, a comparison of forecasts of M_1 based on error-correction model is compared with a univariate Box-Jenkins forecasting model as well as various formulations of partial adjustment model which has been generally tried in the Indian context. The results of this exercise are given in Table 7 and Table 8. It is observed that error-correction model gives a better forecast than the univariate Box-Jenkins forecasting model as well as various formulations of partial adjustment model.

Interpretation of the result

The long term estimated relationship shows that elasticity of narrow money with respect to level of economic activity as measured by IIP is around 1.62. The semi-elasticity of demand for narrow money with respect to yield on ordinary shares, as given by the long term relationship estimated by us, is of the expected sign and the magnitude of the coefficient is quite large as compared to the coefficient of opportunity cost of money variable obtained in the earlier estimated money demand functions in India or in other countries.

Our exercise also throws light on the issue of sources of prices rise during the last decade. The fact that long term movement in M_1 is highly correlated with IIP which is a proxy for level of economic activity and YOS, and much more weakly with WPI and the fact that the given data do not indicate presence of any long term relationships between M_1, WPI or between M_1, WPI and IIP strongly suggest that the growth in narrow money can not be held a causal determinant of growth in prices. In other words a monetarist explanation of Indian inflation is not empirically supported if M_1 is taken as the relevant monetary aggregate.

Conculsion

Johansen's method of estimating co-integrating vector shows the existence of a reasonably stable money demand function for India with yield on ordinary shares emerging as a good proxy for opprotunity cost of narrow money. The principal source of change in money stock demanded emanates from the changes in transaction level while a rise in opprotunity cost of money, as expected, depresses the demand for money. An error correction model for money demand is identified and it is observed that movements in gold prices does have an impact on the level of money demand in the short run. Our exercise also sheds light on the empirical relevance validity of the monetarist explanation of Indian inflation during the eighties.

Table 1: Augmented Dickey Fuller test

Variable Name	Statistics Used & Their Values	$\varnothing_3$
Ln (M_1)	$\hat{T}_\mu$ = -1.5616	4.92
Ln (WPI)	$\hat{T}_\mu$ = 2.5046	3.49
Ln (IIP)	$\hat{T}_\tau$ = -3.6729	6.79
YOS	$\hat{T}_\mu$ = -1.5616	3.56
Ln (M_3)	$\hat{T}_\tau$ = -4.2874	9.57
	$\hat{\beta}_\tau$ = 4.266	
INF. RATE	$\hat{T}_\mu$ = -8.4104	36.90
Ln (GOLD)	$\hat{T}_\mu$ = -1.0301	3.76

Tab. values at 5% : T_μ = -2.89 T_τ = -3.45 $\varnothing_3$ = 6.49

Table 2 : Bera-Jarque and Box-Pierce Statistics

DEP. VARIABLES	Ln (M1)	Ln (IIP)	YOS
τ_1 : Chi Sq. (2)	0.04	0.20	2.89
τ_2 : Chi Sq. (12)	4.61	3.82	10.37

Chi-Sq. (2,0.01) = 4.61 τ_1 = Bera-Jarque Statistic
Chi-Sq. (12,0.01) = 18.55 τ_2 = Box-Pierce Statistic

Table 3 : Sq. Cononical Correlations and Cointegrating Vectors

	(1)	(2)	(3)
SQ. CAN. CORRLNS :	0.001	0.120	0.234
	Co-integrating Vectors (Normalised)		
Ln (M1)	1	1	1
Ln (IIP)	-1.47	-1.85	-1.62
YOS	-0.02	-0.01	0.05

Table 4: Test Statistics to Find Dimension of Cointegrating Space (R)

H_0 :	Trace (Calculated)	Trace (Tabulated at 5%)	Trace (Tabulated at 1%)
R < or = 2	00.05	8.08	11.56
R < or = 1	12.31	17.84	21.96
R = 0	37.96	31.26	37.29

Table 5 : Trace Under the Hypothesis of no Cointegration

Combination of Variables	Trace (Calculated)	Trace (Tabulated)	
		At 5% L.S.	At 1% L.S.
M_1, WPI	9.56	17.84	21.96
M_1, IIP	4.17	17.84	21.96
M_1, WPI, IIP	26.99	31.26	37.29
M_1, WPI, IIP & YGS	44.43	48.42	55.55

Table 6 : Error Correction Model

Dependent Variable : 1st Difference of LN (M_1)

Explanatory Vartiables (in 1st DIF)	LAGS	Estimated Coefficients	T-Stats. (Absolute)	Other Statistics
Constant	-	0.0287	0.0110	SEE = 0.0003
LN (IIP)	1	-0.6102	6.1001	
	2	-0.6243	6.1232	R^2 = 0.5936
	3	-0.4807	4.6698	
	6	0.1127	3.1811	
YOS	1	0.0328	3.0795	$\bar{R}^2$ = 0.5381
	3	0.0427	3.6799	
LN (WPI)	3	-0.6238	1.9380	D.W. = 2.2649
LN (GOLD)	1	0.1248	1.6399	
CR*	1	-0.3395	5.5776	
	4	0.2904	5.0737	
	5	0.0323	1.7068	
	6	0.1127	4.1389	

* CR, the cointegration relation corresponding largest eigen value is without any difference.

Table 7: Forecast Performance of ECM

No. of Obsns. used	One Step Ahead Forecast Using		ACTUAL	Percentage Error	
	Box-Jenkins	ECM		Box-Jenkins	ECM
100	83495	84045	83088	0.49	1.15
101	84573	84545	86185	-1.88	-1.91
102	87602	85424	86224	1.60	-0.93
103	88139	88977	88704	-0.63	0.31
104	92336	88926	89358	3.33	-0.48
105	88913	89688	90028	-1.24	-0.38
106	90666	91364	92857	-2.36	-1.61
107	95076	95553	92892	2.35	2.87
			MAPE*	1.74	1.21

* Mean Absolute Percentage Error.

Table 8 : Performance Statistics for Different Models

Model	SEE	MAPE@	MIN#	MAX#
ECM	0.0003	1.21	0.31	2.87
Box-Jenkin's	-	1.74	0.49	3.33
P-Adjustment* Models				
1	0.0005	1.84	0.12	4.02
2	0.0005	2.09	0.75	5.06
3	0.0005	2.10	0.69	5.22

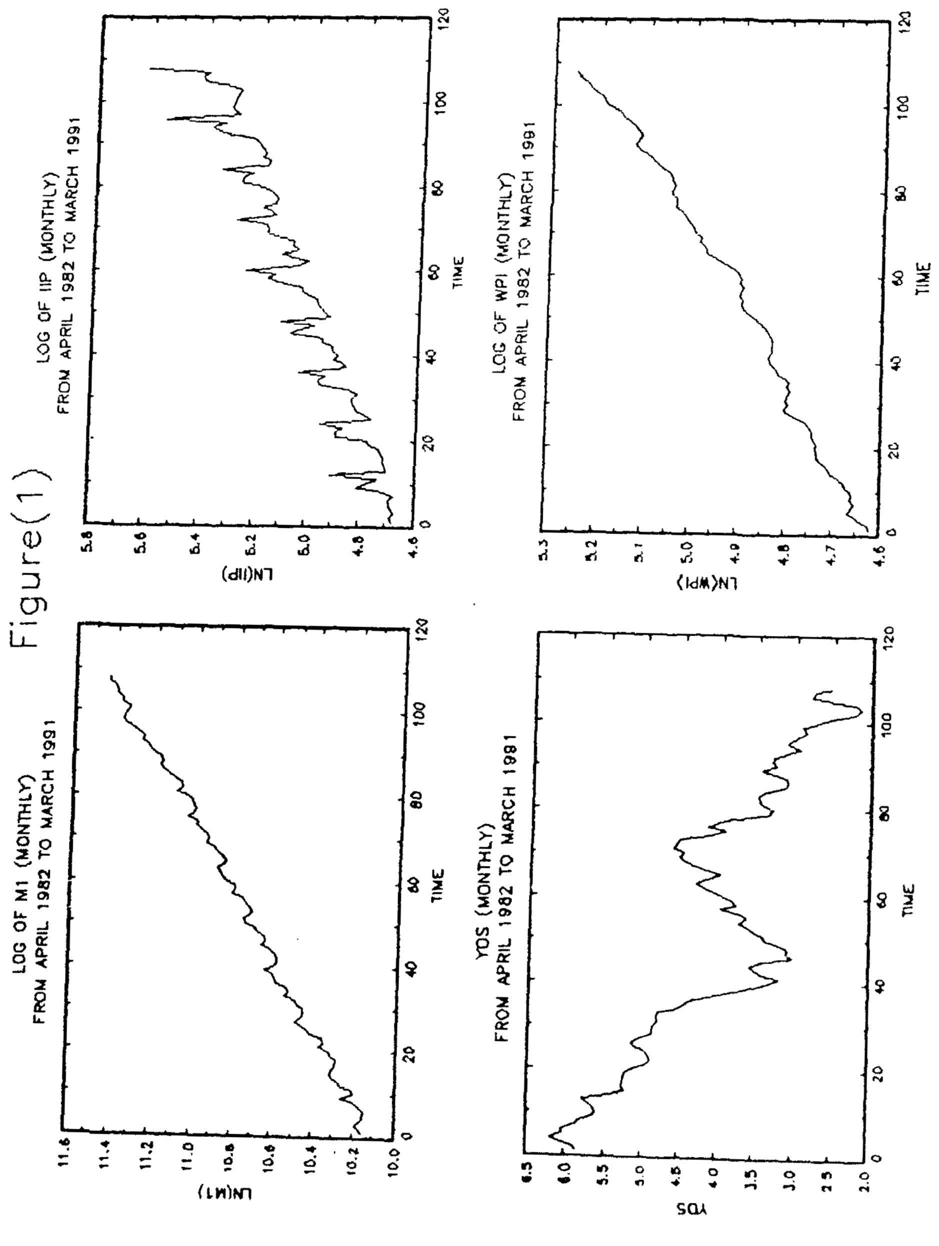
* The three partial adjustment models are:

1. M_1 (t) = f{M_1 (t-1), IIP (t), YOS (t)}
2. M_1 (t) = f{M_1 (t-1), IIP (t), WPI (t)}
3. M_1 (t) = f{M_1 (t-1), IIP (t), YOS (t), WPI (t)}

(All the variables are in logarithm except YOS)

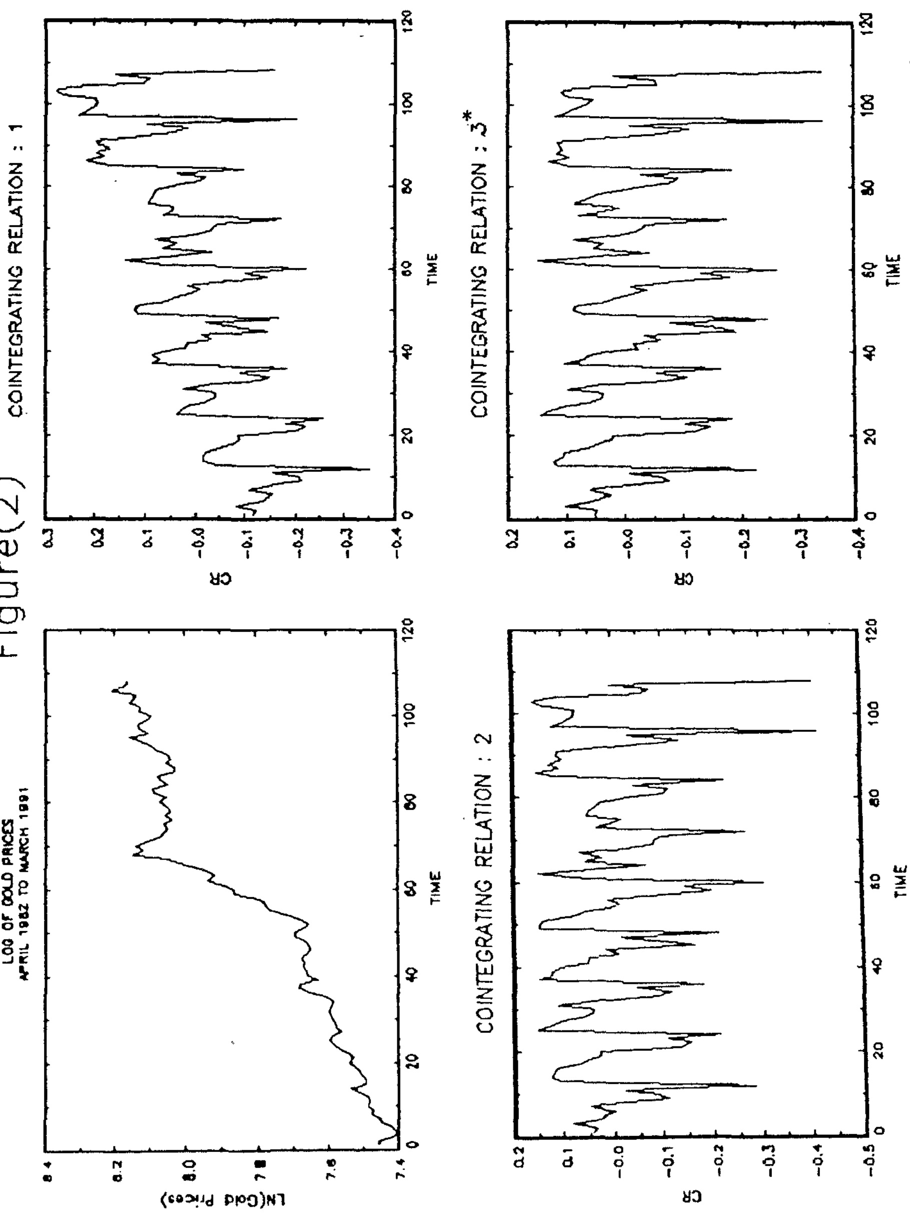
@ Mean Absolute Percentage Errors (MAPE) for one step ahead forecasts (out of sample) are based on 8 repetitions.

Minimum and maximum percentage errors (forecast) among 8 repetitions.


LOG OF IIP (MONTHLY)
FROM APRIL 1982 TO MARCH 1991
LN(IIP)
TIME
LOG OF WPI (MONTHLY)
FROM APRIL 1982 TO MARCH 1991
LN(WPI)
TIME
LOG OF M1 (MONTHLY)
FROM APRIL 1982 TO MARCH 1991
LN(M1)
TIME
YDS (MONTHLY)
FROM APRIL 1982 TO MARCH 1991
YDS
TIME

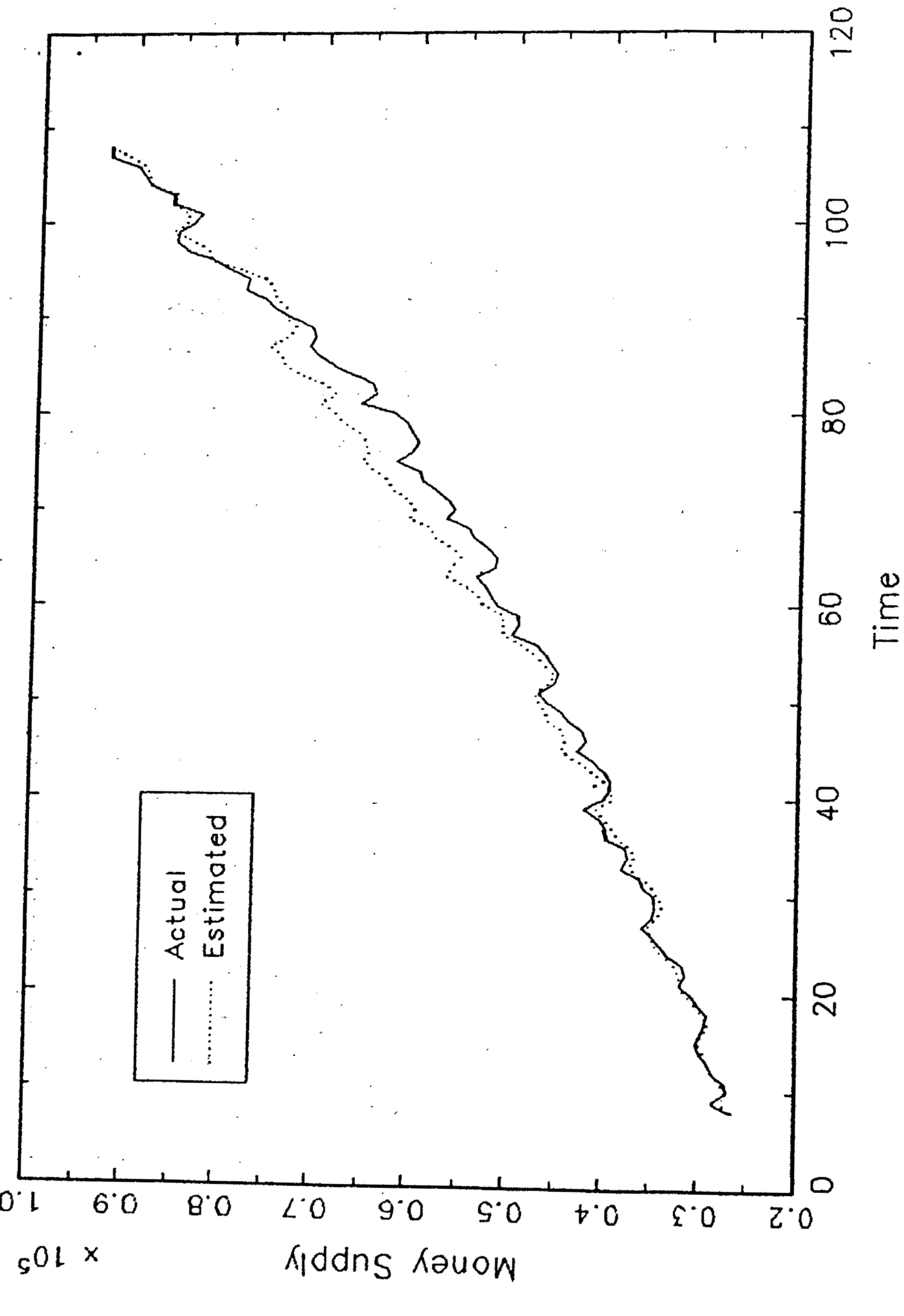
Figure(1)

Figure(2)



* Corresponding to largest eigen vector (see table 3).

Figure 3 : M1 (ACTUAL & ESTIMATED)



Footnotes

1. See Lucas (1976).

2. For example see Gupta (1987); The results of estimated money demand functions given in the paper show that in many cases the estimated equations are characterised by high R^2 and low D-W statistic, indicating the problem of non-cointegration. Such a situation arises whenever lagged dependent variable is not taken as one of the regressor, as done in a partial adjustment framework.

3. See Phillips, P.C.B. (1986) for the relevant results.

4. Some of the more important articles in this genre are published in a special issue of Journal of Economic Dynamics and Control (1988). Also see the special issue of Oxford Bulletin of Economics and Statistics (1986).

5. For a lucid discussion of the unit root problems in regression set up for univariate time series data see Dickey et al (1986).

6. See Cagan, P. (1956).

7. See Brahmananda, P.R. and others (1992).

8. These two concepts of stationary and their implications for economic data are elaborated in Nelson and Plosser (1982).

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BOOK REVIEWS

Why Developing Countries Fail to Develop, by P.N. Mathur, MacMillan Academic and Professional Ltd, London, 1991, pp.XIX + 303,Price not given.

Economic paradigms like mercantalism, Neoclassical, Marxian economics and the Drain theory of Dadabhai Naoroji rose mainly as efforts to explain the economic issues faced by the creative cum dominant minority of the modern commercial industrial civilisation, but are inadequate as explanations to understanding the economic plight of workers in the colonies and dependencies. Thus modern macro economics has to depend on a different paradigm of economic reality. The book by P. N. Mathur, on why developing countries fail to develop, attempts to examine in detail, whether the current 'Country Centric' theories of development need to be recast so as to incorporate the causes of change in the world commodity prices as an integral part. The book is also an effort to relieve the developing economies from the strangle hold of neoclassical calculus and adopt the more flexible input-output approach for explaining the 'development dilemma'.

The pattern of development mainly available to the developing countries is through adaptations of the technical know-how of developed countries while creating the modern production facilities, by installation of capital equipment as well as by creation of an industrial infrastructure. This investment was mainly rendered possible by a recourse to finance from international agencies and multinational firms. The investment is of two types, one of the self-financing kind and the other where repayments had to be made from the usual export earnings of the country, rather than from the earnings of the production possibilities created. Theoretically, the developing countries should provide a substantial saving in wage costs, which essentially leads one to an analysis of the price structure prevailing in the country. But it does not happen. The failure of development in the post-1945 period is essentially because aid-based development, with little of grant component, and with only limited technical transfer would imply that a considerable amount of surplus from the modern sector gets transferred to the industrialised world, and thus not available for local savings and investment. To ensure increase in foreign exchange availability, developing countries will have to increase their exports, but given the narrow specialisation, prices of primary goods will decline, and the wage rates will decline as a consequence. The wage rates cannot be easily raised to transform the price structure in such a way that the modern techniques of producing agricultural goods become economically feasible. Wages in a country should be less than that in partner country which receives its exports to help sustain the development process. But if the country in question is import dependent with high wages, development dilemma becomes more acute.

The title of the book is bold and challenging; and Mathur in an enticingly titled 'Meta Economics', elucidates the fact that the country centric economic analysis is not an illumination, but only leads to economic dogmatism if one attempts to theorise without accounting for the essential extra dimension of international constraints.

Tracing historically the developments of economies from the tribal, slave, feudal and mercantalist states, Mathur moves on to describe the development of the industrial technology and places industrialisation in a theoretical perspective. According to him, apart from the basic technology, it is the presence of risk capital, cheap labour and a buoyant market which has made industrial revolution a reality. While British banks advanced working capital, German and French ones encouraged the establishment of complementary industries by risk distribution over a large number of industries. As industrialisation progressed and became more sophisticated, the need for institutions which would guide the trends in development was felt. Here Japanese 'zaibatsu' filled the need. The Industrial Corporates' 'zaibatsu' with their forward and backward linkages designed and led the course of the Japanese economy. Even in the international scene their operations protected the industries from the vagaries of the International price trends. With these expositions the author moves on to classify developing economies. Though termed ' illustrative', this classification is precise and makes further theorising comprehensible.

a) Labour constrained dual economies where the output of the traditional sector is almost proportional to labour force remaining there. This implies that with development of the rest of the economy, the real wage rate of agricultural workers will decrease. A development theory for these countries therefore has to take cognisance of the problem of providing sufficient foodgrains to the people and also of the fact that rise in the price of foodgrains leads to a loss of international competitiveness. These problems get compounded when one realises that increase in foodgrain availability is linked to the availability of imported inputs like fertilisers which in turn demands access to more foreign exchange.

b) In land contained economies like India and Egypt; the current techniques of productions of agricultural output is not sufficient to employ the whole labour force. There is considerable amount of unemployed or underemployed labour force which cannot be employed in the formal sector; as the economy cannot produce sufficient amount of wage goods to satisfy the extra demand that would be generated. The dilemma of increasing wage goods supply, requiring more imports and its consequences on the price structure making exports more costly and thus tending to reduce them, is a major hindrance to the development of these economies. But by judicious use of tariffs and subsidies these economies can be transformed into being exporters of manufactures.

c) The colonial economies of Latin America are the best illustrative examples of foreign exchange constrained economies. These economies are susceptible to the gyrations of price level in internationally traded commodities, consequently leading to fluctuation in real wage rates as well as employment levels.

d) Then again there is the group called sovereign entities like Hongkong and Singapore which serve as service centre and locations for offshore assembly plants.

e) The oil exporters, according to Mathur, have the best potential to organise themselves along the lines of Lewis development model.

Thus these economies, the author opines, display different types of production structure, technology mixes and price structure; on interaction with various international agencies, there could therefore be with various and differing implications for development strategy for each of the types.

Delineating the determination of commodity prices both diagrammatically and mathematically, the author explains that the short term commodity supply curve is of the standard variety rising slowly with quantity till it reaches full capacity production after which it rises sharply. Its height during its flatter portion depends on the real wage rate and the purchasing power parity of currency for necessities. In countries having chronic unemployment this real wage rate is at the subsistence level. Short period fluctuations in commodity price can be explained as the movement of the intersection with the demand curve oscillating with fluctuations in world economic activity. The elasticity of price with respect to economic activity as per the model will depend on the gradient of the supply curve, at the intersection. In the medium term period, with the creation of new capacity, this curve keeps on shifting to the right. But empirically, it has been inferred that the rate of capacity creation is greater than that of the increase of demand, making the intersection of the demand curve move to the left and thereby decreasing the relative price of commodities over time. As this process proceeds, the rate of capacity creation falters and the demand outstrips the capacity, which in its turn moves the intersection point perceptibly up on the steep portion of the supply curve. This completely changes the short term econometric relationship between commodity prices and world economic activity.

It also gives a favourable jolt to investment activity in commodity production shifting the supply curve to the right and restoring the long term price relationship.

Analysing the commodity price shocks and effects on world economics, the author establishes the fact that deterioration in terms of trade of the commodity exporting countries is a necessary consequence of the international commodity market structure and organisation. Indicating that the reversal of development in the 1980s in those countries was itself a natural consequence of the way the world economy works, the author makes a rather harsh judgment that in the current set up continuation of poverty is a necessary concomitant to export promotion. For, if during the temporary supply stringency in commodity markets there is a decrease in poverty it is reimposed with a vengeance as soon as normalcy returns. Also inherent in the development strategy which is dependent on long term loans, is the compulsion to develop commodity exports. This triggers a mechanism which keeps the commodity prices so low that poverty is a necessary requirement for development. Reinforcing this argument is the diagrammatic representation which brings out the fact that every developing country which wants to speed up its development is required to increase its exports to acquire foreign exchange. This in turn requires that wages are at the subsistence level only, thus ensuring that the price structure remains uncompetitive.

During the discourse on the macro economics of economic subordination and drain, Mathur highlights the fact that in these 'over populated countries' the problem is not one of reducing numbers but of modernising agriculture. But the wage goods constraints and inflation act as constraints to the effective implementation of any action programme that is proposed as a correction.

Tracing the concept of scarcity value, through the different paradigms of classical and neoclassical convulsions, Mathur contends that the concept of scarcity value is general and can be used in the context of constrained development. As the price system does not necessarily reflect the opportunity cost, scarcity values would perhaps be the answer.

Discussing the need for technological transformation both in industry and agriculture separately, the author concludes, that the burden of making technological transformation feasible falls directly or indirectly on the wage rate. Quoting the UN Study (1982, Kravis et al), he explains that in low wage countries, the prices of wage goods are lower, thus limiting the successful modernisation of agriculture.Besides,subsidisation of agriculture by other sectors does not seem possible beyond a point. While examining the economics of technical transfer, he seems to caution against the technical transfer if such a move imposes upon the recipient country a need to export, for in this case it would imply import of technologies which often are obsolete, leading to the phenomenon of further lowering of wage rates.

While studying the question of subsidies and import controls, Mathur cites the Indian example where the cross financing strategy has enabled the country to modernise almost every branch of economic endeavor. But he feels that the rate of growth of the economy and industry has been negligible ,nay dismal. Also inflation plagues the economy such that only its cure will open contours of the way forward. Only such an exercise will make amends about the inefficient resource allocation and lead to the establishment of natural profitability in industries. Further, he advises that it is better to desist from incurring foreign debt even on concessional basis. From the domestic side the removal of subsidies would make the labour cost more realistic. The essential cure for the ills of the developing countries seems to lie in the establishment of South-South common markets or entering into multilateral project based partnership agreements. Treating foreign exchange constrained economies separately, he indicates that import substitution can be adopted as a policy along with the creation of some sort of a Latin American payment system with repayment of the interest and capital in semi-convertible dollars and calls for the revision of the International Bankruptcy law to impose limits on the maximum amounts borrowed.

To the targeted audience of the book as indicated by the author - students and practioners interested in comprehending the working of the economy of under developed countries in the context of international trade, - it gives new insights into the developing countries' 'development dilemma'. Since it is non-mathematical in its approach, the book appeals to every body who is interested in the dynamics of economic development processes.

The theoretical base of the book is essentially from the UN study of Kravis et al of 1982, with the underlying framework being a Leontief type of input output analysis. While this is useful, it may not incorporate dynamic programming to capture structural changes occurring in the process of growth.

Even though the author highlights the facts that prices of internationally traded non fuel commodities of the agricultural and mining origin increased by 60 per cent in 1973 and 20 per cent in 1974 (Page 104), in a way promising to break new ground away from the usual analysis of oil shocks, the chapter deals with them in a somewhat generalised fashion, leaving one with very little deeper understanding of the phenomena of commodity price increases. Case studies illustrating the experiences of individual countries could have been more informative.

Further, the title 'Demographic Myth' (PP 164) indicates that he holds the traditional views about the issue. Agreed that population growth is not the primary cause of low level of living and gross inequities but it does serve to intensify the problems of the developing world thus needing separate treatment in its own merit.

While analysing the aberrations like inflation in Chapter 11, the author could have analysed the weighted contribution of foodgrains to WPI (PP 174) rather than adopt the simplistic proportions method. For a period of 24 years from 1966-67 to 1989-90 the inflation rate in India worked out to be only 8 per cent, notwithstanding the limited availability of foodgrains and agricultural raw materials, the oil shocks and the huge budgetary deficits. Some of the statements about the progress of the Indian Economy (PP 241) are also too generalised . The Indian Economy has moved away from the 'Hindu Growth Rate' of 3.5 per cent to a new growth rate of 5 per cent per annum during the eighties. And, as various studies indicate,this has been because of higher industrial growth, and a higher than trend rate of expansion in agricultural output. Yet the balance of payments position and fiscal balances showed deterioration in the latter half of the eighties, fed to a large extent by external borrowings. The problem with the evolving growth rate in India is not so much on account of tied aid, as on account of absence of sustained productivity and competitive efficiency. This issue hardly figures in Mathur's account.

The author's preoccupation with the 'need to export' as the bane of developing economies seems to brush aside other crucial structural problems which confront developing countries of the day. In this context his prescriptions could well be severe in many cases. Of course international cooperation is required to be on a more realistic basis and the 'country centric' approach needs to be modified to include international dynamics into its periphery. Here it is interesting to cite Patnaik who while expounding on the growth process of the Indian Economy, advocated trade between different sectors of the economy so as to put it on the path of sustained growth (EPW Annual Number May 1987). This argument gains weight when one considers that by mid eighties the agricultural sector which had earlier remained a net exporter of producer goods had turned a full circle and became a net importer of both producer and consumer goods with important implications for the size of the home market.

But these few observations should not be taken to question the merits of the book. Infact the book provides a new angle to the development problems and would merit the consideration of academics and policy makers. Apart from being concise and well written, jargons, both economic and ideological,have been completely eschewed.It can be a valuable addition to the literature on the analytical issues on the new international economic order.

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Principles and Practices of Value Added Tax–Lessons for Developing Countries by Mahesh C. Purohit (National Institute of Public Finance and Policy), Gayatri Publications, New Delhi, 1993 pp. 235.

This century is marked by fiscal innovations and experiments. The Value Added Tax (VAT), a hybrid form of tax, is one such epoch making innovation. Though the parent-hood of VAT belongs to the industrialised western world, it has gradually gained wide acceptability in other parts of the globe, especially in those countries which have embarked on large scale economic restructing process. Nevertheless, it is yet to get sufficient popularity and has remained virtually unexploited in the developing world apprently due to limited understanding and highly intricate character of the system. Although the literature on VAT is wide (see works of Alan A. Tait, 1988 and Henry J. Aaron (ed) 1981, IMF, 1991), discussions in the context of developing countries are conspicous by their limited coverage. Professor Mahesh C Purohit's work, "Principles and Practices of Value Added Tax - Lessons for Developing Countries" would fill up this vaccum. The book, which runs into eight chapters, is an invaluable educative piece on VAT, more specifically in the context of developing countries.

The introductory chapter unravels the historical evolution and basic characteristics of VAT. The genesis of VAT is traced as far back as the writings of F. Von Siemens who in 1918 propounded it as a alternative for the German turnover tax. However, France was the first country to introduce VAT in 1954. As of day, more than 60 countries in Europe, Latin America, Asia and Africa have embraced VAT as the principal core of the tax system.

As defined in the book, VAT is a multi-stage sales tax levied, as a proportion of the value added, at each stage of production and distribution process. The hallmark of VAT is its equally intensive coverage of services. The rapid acceptability of the VAT is attributed to its inherent qualities like revenue buoyancy, neutrality, allocative and administrative efficiency and transparency. Revenue buoyancy stemmed from the fact it is a more reliable alternative resource-source in countries that have limited income tax base. Being a consumption tax, neutrality means being neutral to the choice of technique by the producers. Therefore, it ensures efficiency in the allocation of resources. Administratively, VAT provides an opportunity to sweep away the cobwebs and revamp a substantial part of tax administration. The transparency provides limited scope for tax evasion under VAT.

There are three specific variants of VAT viz., gross product variant, income variant and consumption variant, depending upon the economic base on which VAT is imposed. The economic base of product variant is equivalent to Gross National Product while that of income variant is Net National Product. Total private consumption forms the economic base for the consumption variant. The differences in approaches entail methodological variation in the estimation of value added, the ultimate economic base to impose VAT. Accordingly, the three alternative methods adopted in the computation are addition method, substraction method and tax credit method. Under the addition method (or income approach), value added is estimated by summing up all the element of value addition such as wages, profits, rent and interest. The substraction method (or product approach) estimates value added by taking the difference between the output and input. The substraction method, has again got three different variants *viz.* direct substraction method, intermediate substraction method and indirect substraction method. Direct substraction method is equivalent to a business transfer tax whereby tax is levied on the difference between the aggregate tax-exclusive value of sales and aggregate tax-exclusive value of purchases. Intermediate substraction method is based on deduction of the aggregate tax-inclusive value of purchases from the aggregate tax-inclusive value of sales and taxing on the difference. The indirect substraction method entails deduction of tax on inputs from tax on sales for each tax period. The indirect substraction method which is also known as tax credit method or invoice method is the most commonly used VAT system today.

Chapter two is an illustration of the economic effects of the VAT. A unique feature of VAT is its direct influence on the economic variables like savings, investment, employment, distribution, and prices. Therefore, the economic effects of VAT can be broadly categorised into price effect, distribution and growth effects. The experiences of VAT countries reveal that VAT's influence on prices depends upon whether it is a new tax or a substitute for the existing tax. By and large, the inflationary effect of VAT is determined by the elasticity of demand and supply of the commodity concerned. The distributional effect, which refers to the incidence and equity aspects of the tax, however, is conditioned by the possibility of tax shifting by the producers. Generally, firms with monopsony market situation for factors or inputs would shift VAT backward, although the extend of such shifting is limited by supply and demand elasticities. As regards progressivity or regressivity of VAT is concerned, factors like exemptions, zero ratings and other compensatory features have larger influences. VAT also ensures equity by giving sufficient provisions for exemptions and concessions. Coming to the growth effect, being tax on consumption, VAT helps to promote frugality and thereby accelerate the saving ratio. Since capital goods and depreciation on capital are exempt under VAT, it would boost investment and growth.

The sequence of discussion then goes to an analysis of the structure of VAT. Here the author touches upon areas like structure of tax rates, coverage and exemptions, drawing heavily upon the experiences of VAT countries. Regarding the rate structure, most countries have a three to four-tier rate VAT system. The normal rate (called general or standard rate) applies to all transactions excluding the exempted items. In order to reduce the burden of the poor, there are provisions for low tax rate on commodities that are used more by the lower income groups. At the same time, high rates are applied to luxuries to make the tax more progressive.

As regards coverage, in practice, VAT is imposed at manufacture level, wholesale and retail levels. Wholesale VAT is considered superior to a manufacture because it is closer to the consumer and takes care of the value added from manufactures to wholesaler. However, VAT, at retail level, extending across all the retailers, is considered to be the most preferred one, since economic distortion and administrative complexities are conspicuous by their absence in the retail VAT. In the case of VAT on services, two approaches are applied such as, the integrated approach and selective approach. While under the former all the services are taxed except those specifically exempted, under the later some stipulated services are singled out for taxation. The integrated approach is prevalent in countries that have adopted VAT at manufacturing level.

As in the case of other system of tax, VAT suffers from certain inherent weakness of heterogeinity in tax rates and exemptions which result, in fiscal frontiers and segmentation of markets within an economic entity. Harmonization of VAT, therefore, is a desired panacea. In chapter four, the author makes a case for tax harmonization quoting the experiences of the European Community. Size-wise and in terms of value addition, the EEC constitutes the largest market in the industrialised world. However, owing to wide tax differential among the constituents, the EEC remained highly fragmented and as a result, it has lost ground against the more integrated markets of the USA and Japan in terms of growth of demand, output and trade. The unified market of EC, beginning from

January 1993, has been designed not only to reap the advantages of economies of scale but also to meet the challenge from the other emerging trade blocks. The message conveyed is the urgency on the part of other outward looking developing countries for restructuring and rationalisation of their tax system to cope with the changing scenario of globalisation of world trade.

The success of any tax system rests upon its sound administration, for in its absence, the imposition of a tax defeats its very cannon of equity. It is all the more significant in respect of VAT, because any administrative lapse would result in a situation in which full payment of tax is made by those who cannot avoid it. Chapter five, therefore, is devoted to a comprehensive description on the managerial aspects of VAT. The entire process of administration of VAT involves registration of dealers, submission of returns, assessments and payments of tax by registered dealers. Registration is considered as the 'alpha and omega' of VAT management and it is compulsory on every taxpayer to register with the VAT department. However, most of the countries prescribe an exemption threshold, which would not only keep the number of registered traders within manageable proportion but would also reduce the compliance cost of dealers. Regarding submission of returns, registered dealers have a declarative obligation to submit a return showing their turnover as well as gross and net VAT liability. Many of the countries in Europe require a monthly return though in some countries there is a provision of an annual return. The dealers get the credit for VAT payment on their inputs when the return is submitted and tax paid by them.

For a greater understanding of the working of VAT, the author presents a narrative explanation of its management through a case study of France, one of the most successful countries in the administration of VAT. The management of VAT in France commences with the compulsory registration of dealers. The accounting practice pursued is that the larger dealers come under the actual assessment system, the middle-size dealers fall under the simplified taxation system and small dealer is assessed according to notional system. A special feature of the management of VAT in France is its treatment of small dealers and small farmers, the areas which have special relevance for backward economics. For small dealers, a comprehensive scheme of lumpsum taxation (forfeit) is adopted whereas a simplifed system, called Regime Specifique de Agriculture (RSA) is applied to small farmers.

An efficient management information system (MIS) is a pre-requisite for an effective administration of VAT. MIS enables sound evaluation of. tax policy and correct appraisal of alternative policy measures. The reliable statistical information which is the cornerstone of an efficient MIS provides invaluable help in deriving insights into important facets of the economy also.

The final Chapter is dovetailed to place an agenda for tax reforms in those developing countries that are yet to adopt VAT on a fulfledged scale. The author suggests that these countries should develop feasible design and structure of VAT to integrate it into their respective tax systems and economies for which they can heavily drawn upon the experiences of the VAT countries. The system evolved in these countries should be within the framework of growth, equity and stability, among other things.

For countries like India, keeping in view the overall fiscal structure and recognizing the federal constraints, the author suggests a package of reforms which are to be attempted at two stages viz., 'immediate run' initially, and then the 'medium-run'. The immediate-run reforms, which are intended to pave the way for the major reforms in the medium run, include reduction in the number of rates and harmonisation of excise and sales tax system. The medium-term reforms necessitate two major policy changes viz. adoption of VAT and broadening the tax base. The adoption of VAT at Central level is to substitute union excise duties, and at State level to replace States' sales tax. The broadening of tax base could be achieved by bringing services under tax net. The Modified Value Added Taxation (MODVAT) practiced in India since 1986, is appreciated as a step towards adopting a fulfledged VAT.

Thus, the worthfullness of the book under review is manifold. Apart from being an illustrative reference, it gives a comprehensive account of the inherent weakness of the existing tax system in the developing countries. The message of the book is that VAT must be a long term solution to the distorted tax system in such countries for which a set of agenda has been put forward. The measures suggested in the book however, have already found their place in the reports of the Tax Reforms Committee constituted by the Government of India under the chairmanship of Professor Raja J. Chelliah. In fact, the major plank of the strategy suggested by the Committee in its Final Report is an exhaustive coverage of the existing Modified Value Added Tax (MODVAT) as the immediate step and, hence after, switching over to a fulfledged VAT. Thus VAT has gained as the most-preferred alternative system of taxation in the Indian context. However, compleccency should not rule over hard realities. First of all, VAT is a highly complex tax system and for that matter the successful implementation necessitates a viable and efficient administrative machinery which India lacks. In the absence of a sound administrative machinery, VAT should be highly succeptible to mismanagement and large scale evasion. As illustrated in the book itself, even in the case of successful countries like France, there exists a fair amount of tax evasion under VAT because of the operation of parallel economy (p. 166). Secondly, as studies have shown, to achieve the best result from VAT, the tax should provide very few exemptions, zero rating only for exports and there should be only one or atmost two rates (Alan A Tait (ed), Value Added Tax : Administrative and Policy Issues, IMF Occasional Paper No. 88). In this context, the successful implementation of VAT in India would largely depend upon the capability of tax machinery to cover the informal sector where large scale clandestine manufacturing activities take place to avoid tax payments. At the same time, it is equally important to protect the low income petty traders and marginal farmers of the informal sector on equity grounds. Thirdly, as reports have shown (ibid), to make VAT anti-inflationary, a tight monetary policy is presupposed. This trade-off may, however, defeat revenue buoyancy since credit squeeze would affect industrial growth in developing countries like India. Finally, another question that needs to be attended to in the Indian context is the horizontal equity and resource transfer from the Centre under VAT. This issue should be reviewed from the possible weak points along the full stretch of VAT implementation process. For instance, tax compliance would be more effective in respect of VAT at manufacturing stage since refund of tax paid on inputs necessitates it. On the contrary, tax evasion can be quite possible at wholesale as well as retail levels causing ineffeciencies in resource flows to State governments. In such an eventuality, the States where the value addition process is heavily concentrated will be the major beneficiaries, while the States that gain tax share out of sales will be the loosers. This issue will be all the more significant in the years to come when tax proceeds would form the major plank of federal financial transfers from the Centre. In short, in the context of developing countries like India, the above issues need to be adequately addressed before embarking on a fulfledged VAT.

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