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Identification of Monetary Policy Shock and its Effects on Output and Price: A Structural VAR Approach

A.K. Srimany & G.P. Samanta*

This paper analyses the dynamics of monetary policy shocks and their impact on output and prices in the post reform period of the Indian economy. The study adopts the Structural VAR framework of Bernanke (1986) type. The results confirm the impact of monetary policy on both prices and output. An attempt has been made to identify the nature of monetary policy shocks and draw a judgement regarding whether the policy was "tight" or "easy" during the various phases of the sample period.

Introduction

In recent years there has been a resurgence of interest in understanding the effects of monetary policy shocks on output and prices. There are two distinct aspects of this type of analysis. First, the debate surrounds the transmission channel of monetary policy shocks. The second aspect is to understand the intensity of the economic responses to monetary policy shocks. On both these aspects, the empirical evidences on Indian economy do not point towards a definite answer. However, the second aspect has gained increasing importance given the recent experience of monetary reforms and coming into being of a relatively independent monetary policy regime. In view of this, the paper examines the effects of monetary policy shocks on prices and output.

The central problem in establishing the facts about the effects of monetary policy shocks on economy is to distinguish the policy

makers' reaction to the state of economy (feedback rule) and the exogenous component of a monetary policy action (Christiano, Eichenbaum and Evans (1996)). With this definition, monetary policy actions are the sum of two components: feedback component and exogenous policy shocks. It is important to distinguish between these two components because to isolate the effects of RBI induced monetary policy shocks we need to identify the component of RBI policy actions that is not reactive to other variables. Thus the problem boils down to deciding the appropriate structural model covering the important economic aggregates and intermediate targets of monetary policy. Any wrong specification of the structure, as revealed subsequently in our three variable VAR specification of money, output and price, may lead to inappropriate and/or misleading conclusions.

The rest of this paper is organised as follows. Section I discusses the methodological issues relating to VAR and Structural VAR. Section II presents the empirical evidences on the effectiveness of the monetary policy shocks on the economy under the framework of structural VAR model. Based on the structural model developed therein, Section III analyses the true nature of monetary policy actions. Section IV concludes.

Section I
Methodological Issues

In the empirical macroeconomic analysis, the Vector Auto-Regression (VAR) model of Sims (1980) is extensively used. The VAR is a reduced form time-series model of the economy that is estimated by OLS. A vector-valued time series X(t) with jointly stationary time series component is said to have been generated from a VAR system if we can express X(t) as

$$X(t) = \Psi_1 \, X(t\text{-}1) + \Psi_2 \, X(t\text{-}2) + \ldots\ldots\ldots\ldots$$
$$+ \Psi_p \, X(t\text{-}p) + e(t) \qquad\qquad \ldots\ldots(1)$$

where elements of X(t) are jointly stationary, Ψi's i=1,2, ..., p are coefficient matrices and e(t) is the vector of uncorrelated innovation processes.

Impulse Response Functions (IRF) and Variance Decompositions (VD), the hallmarks of VAR analysis, illustrate the dynamic characteristics of empirical models. These dynamic indicators are initially designed by what seemed to be a mechanical[1] technique which was believed to be unrelated to economic theory. As such, often the standard VAR approach is described as "atheoretical". However, Cooley and LeRoy (1985) argued that this method implies choosing a particular economic structure with a given ordering of variables which is difficult to reconcile with economic theory.

This criticism led to the development of Structural VAR approach by Bernanke (1986), Blanchard and Watson (1986) and Sims (1986). This technique allows the researchers to use economic theory to transform the reduced-form VAR model into a system of structural equations. The crucial difference between atheoretical and structural VARs is that the latter yields impulse responses and variances decompositions that can be given structural interpretations.

In atheoretical VAR approach, the residuals of standard VAR are separated into orthogonal shocks by calculating a Choleski decomposition of the covariance matrix (M) for the residuals. This decomposition is obtained by finding the unique lower triangular matrix L such that $M = LL'$. This statistical decomposition depends on the sequence in which variables are ordered in the VAR. If the vector-valued time series $X(t)$ has k components then the residual vector $e(t)$ also has k components and Choleski decomposition of the covariance matrix of $e(t)$ is algebraically equivalent to estimating the following recursive structure :

$$
\begin{aligned}
e_1(t) &= v_1(t) \\
e_2(t) &= a_{21}\, e_1(t) + v_2(t) \\
e_3(t) &= a_{31}\, e_1(t) + a_{32}\, e_2(t) + v_3(t)
\end{aligned}
$$

$$\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots \qquad \dots\dots (2)$$

$$
e_k(t) = a_{k1}\, e_1(t) + a_{k2}\, e_2(t) + \dots + a_{k,k-1}\, e_{k-1}(t) + v_k(t)
$$

where $e_i(t)$, $i=1,2,\dots,k$ is the i-th component of $e(t)$; a_{ij}'s, $i>j$, $i=1,2,\dots,k$; $j=1,2,\dots,k-1$, are unknown parameters and by construction $v_i(t)$, $i=1,2,\dots,k$ are uncorrelated shocks at time point t.

In matrix notation this can be summarised as

$$
\begin{bmatrix} e_1(t) \\ e_2(t) \\ e_3(t) \\ . \\ e_i(t) \\ . \\ e_k(t) \end{bmatrix} = \begin{bmatrix} 0 & 0 & 0 & . & 0 & 0 & . & 0 & 0 \\ a_{21} & 0 & 0 & . & 0 & 0 & . & 0 & 0 \\ a_{31} & 0_{32} & 0 & . & 0 & 0 & . & 0 & 0 \\ . & . & . & . & . & . & . & . & . \\ a_{i1} & a_{i2} & a_{i3} & . & a_{i,i-1} & 0 & . & 0 & 0 \\ . & . & . & . & . & . & . & . & . \\ a_{k1} & a_{k2} & a_{k3} & . & a_{k,i-1} & a_{ki} & . & a_{k,k-1} & 0 \end{bmatrix} \begin{bmatrix} e_1(t) \\ e_2(t) \\ e_3(t) \\ . \\ e_i(t) \\ . \\ e_k(t) \end{bmatrix} + \begin{bmatrix} v_1(t) \\ v_2(t) \\ v_3(t) \\ . \\ v_i(t) \\ . \\ v_k(t) \end{bmatrix} \quad ....(3)
$$

i.e. $e(t) = A\ e(t) + v(t)$ or equivalently $(I-A)e(t) = v(t)$

where $(I-A)$ is a lower triangular matrix and $(I-A) = L^{-1}$, I being the identity matrix of order kxk. Notice that number of free parameters in A matrix equals to $k(k-1)/2$. The reason behind this is as below :

Suppose M is the covariance matrix of the residual vector e(t) obtained from VAR system. As this matrix is generally not diagonal we require to orthogonalise the components of e(t) for carrying out the IRF and VD analysis. Therefore, we try to find a matrix 'A' such that covariance matrix of $(I-A)e(t)$ is diagonal. In other words, if Σ is the diagonal covariance matrix of $(I-A)e(t)$, then matrix A is solved by equating sample moment to the population moment.

i.e. $(I-A)M(I-A)' = \Sigma$ ..... (4)

Now notice that M, being a covariance matrix, is symmetric, and it has $k(k+1)/2$ distinct elements. Therefore we get only $k(k+1)/2$ distinct equations from (4) and thus we can estimate $k(k+1)/2$ free parameters in (I-A). Among these, k equations are required for k diagonal elements of Σ (for which diagonal elements of (I-A) is kept equal to unity). Using remaining $k(k-1)/2$ equations we can estimate $k(k-1)/2$ off-diagonal parameters in (I-A) or A. In particular, if we consider Choleski decomposition, then $(I-A) = L^{-1}$, is a lower triangular matrix (which has exactly $k(k+1)/2$ free parameters) and Σ is an identity matrix.

The system as indicated above is a recursive contemporaneous structural model. If theory predicts such a contemporaneous structure, then the Choleski decomposition analysis will provide the true economic structure. However, it is widely agreed that economy does not function under such a recursive structure. For the time being, let us assume the true structure of economic interactions as

$$e(t) = B \ e(t) + u(t) \qquad\qquad .....(5)$$

with u's being uncorrelated structural shocks. Then through simple matrix manipulation, it can be shown that

$$v(t) = (I-A) \ (I-B)^{-1} \ u(t) \qquad ..... (6)$$

and thus the shocks as derived through Choleski decomposition, though uncorrelated by construction will be a combination of structural shocks. The essence of Structural VAR is the imposition of a theoretically relevant structure on observed disturbances to derive the orthogonal structurally interpretable shocks. Thus, the Structural VAR will be independent of ordering of variables, in contrast to "atheoritical" VAR. Given that the vector of residuals (disturbances) 'e' has been obtained from standard VAR, the problem is to estimate the structure as in (5). While Blanchard and Quah (1989) utilized long-run restrictions to identify the economic structure, we have followed the Barnanke (1986) methodology. This methodology involves equating the population moments with sample moments. From equation (5) we get

$$Cov(u) = (I-B) \ Cov(e) \ (I-B)' \qquad\qquad .....(7)$$

Where Cov( ) denotes the Covariance matrix.

If sample covariance matrix of e(t), i.e. residual from standard VAR, is 'M', then the estimate of Cov(u) can be obtained by equating the sample moments and population moments, which yields

$$Cov(u) = (I-B) \ M \ (I-B)' \qquad\qquad .....(8)$$

The individual parameters will be identifiable if the number of estimable parameters does not exceed the number of distinct covariances in 'M'. As stated earlier, the number of distinct covariances in k variable VAR is $k(k+1)/2$; thus we will be able to identify k diagonal elements of Cov(u) and $k(k-1)/2$ free parameters of B. Thus to make the system just identifiable $k(k-1)/2$ a priori restrictions must be imposed on $k(k-1)$ off-diagonal elements of B (the diagonal elements of 'B' are necessarily zero). In such a situation the estimates are obtained numerically in two steps.

Step 1 : To find $k(k-1)/2$ parameters of 'B', first set all below-the-diagonal elements of the symmetric matrix on the right-hand-side of (8) equal to zero. This yields a system of $k(k-1)/2$ simultaneous equations in the same number of unknown parameters of 'B'.

Step 2 : Given the estimated elements of 'B', equation (8) will provide the estimates of k diagonal elements of Cov(u). Given the above estimates and model (5), one can construct structurally interpretable decomposition of the standard VAR residuals into orthogonal shocks and usual dynamic analysis in the form of impulse response functions and variance decompositions.

Now, consider the standard VAR system of order 'p' defined in (1)

$X(t) = \Psi(L) X(t) + e(t)$, where the elements of $X(t)$ are (jointly) stationary variables and L is the lag operator with $\Psi(L) = \Psi_1 L + \Psi_2 L^2 + ... + \Psi_p L^p$.

Now define a matrix F as

$$F = \begin{bmatrix} \Psi_1 & \Psi_2 & . & . & . & \Psi_{p-1} & \Psi_p \\ I & 0 & . & . & . & 0 & 0 \\ 0 & I & . & . & . & 0 & 0 \\ . & . & . & . & . & . & . \\ . & . & . & . & . & . & . \\ 0 & 0 & 0 & 0 & I & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & I & 0 \end{bmatrix}$$

where I is the identity matrix with order equal to the order of Ψ_i matrices.

If the eigen-values of F all lie inside the unit circle, the above representation for X(t) can be expressed as its MA(∞) representation in the following form :

$$X(t) = (I-\Psi(L))^{-1} \, e(t) = e(t) + \Phi_1 \, e(t-1) + \Phi_2 \, e(t-2) + \ldots$$
$$\ldots \ (9)$$

Where Φi's, i=1,2,3, ... are dependent on Ψj's, j=1,2,3, ...,p.

Then with structural model as in (2), the variance of the forecast error at horizon 'h' will be given by

E [{X(t+h)-X̂((t+h)It} {(X(t+h)-X(t+h))It}'] where X((t+h)It) is the h
                                              periods ahead forecast
                                              made at time t

$$= \sum_{i=1}^{n} \Phi_i \, E \, [e(t)e'(t)] \, \Phi_i'$$

$$= \sum_{i=1}^{n} \Phi_i \, (I-B)^{-1} \, E \, [u(t)u'(t)] \, ((I-B)^{-1})' \, \Phi_i' \qquad \ldots \ (10)$$

and the effect of j-th structural disturbance on i-th variable will be given by (i,j)-th element of matrix $\Phi_i \, (I-B)^{-1}$.

Section II
Empirical Analysis

As mentioned earlier, our primary interest is in understanding the intensity of impact of monetary policy shocks on output and prices. Since 1991 a number of major policy reforms have been introduced to enhance the effectiveness of monetary control in the Indian economy. The most critical of these measures are: the abolition of the practice of automatic monitisation of the Central Government deficit through the system of "ad-hocs", deregulation of interest

rate in almost all segments of financial market, and development of a market for Government security. These measures were intended to improve the degree of monetary control in the economy and to provide the required operational autonomy to the Reserve Bank in the conduct of monetary policy. The monetary policy measures in the recent period have exhibited certain pro-active elements to improve the growth and price situation in the economy. Keeping in view the above aspects, we restrict our analysis of monetary policy shocks to the period beginning with July 1991 and ending March 1997.

Given the large data requirement of a VAR model, there is a natural preferance to base the analysis on monthly data. The money supply (m) and price (p) series relate to M1 (narrow money) and Wholesale Price Index (WPI). The preference for M1 stems from the fact that all innovations in monetary sector from the point of view of monetary authority are channeled through this variable. As regard output (y), data set relates to Index of Industrial Production (IIP), which is the only output variable available on a monthly basis.

Analysis Based on Choleski Decomposition (Standard VAR)

Our data set on 'm', 'p' and 'y' consists of monthly series from August'91 to March'97. While the data on money and price are used in original form, the data on output was passed through HP-Filter (The details about HP-Filter are given in Annexure). The reason behind this is that the seasonal variation (as judged by the variation in the monthly seasonal factors) on the data series in case of output (IIP) is highly significant. The behaviour of IIP series is somewhat peculiar. The IIP figures in the month of March in every year are observed to be substantially higher compared to other months. If we do adjustment for seasonality in IIP by using standard seasonal adjustment methods like "X-11", it is observed that though the March figures are smoothened out, the values in other months are severely affected (mostly overestimated to a great extent). The advantage in case of HP-Filter is that it is possible to smoothen the March figures with relatively less disturbance in the

figures for other months. We estimated the standard VAR system in difference of log (i.e. rates of growth) form of output (dly) price (dlp) and money (dlm), to ensure that all variables are I(0). We have allowed four lags for each variable. The lag selection is well consistent with Akaike Information Criteria (AIC) and Schwarz-Bayes (SB) Information Criteria.

Thus the estimated VAR model (with output-price-money ordering) is as follows.

$$
\begin{bmatrix} dly(t) \\ dlp(t) \\ dlm(t) \end{bmatrix} = \sum_{i=1}^{4} \Psi_i \begin{bmatrix} dly(t-i) \\ dlp(t-i) \\ dlm(t-i) \end{bmatrix} + \begin{bmatrix} e_y(t) \\ e_p(t) \\ e_m(t) \end{bmatrix} \qquad \ldots\ldots(11)
$$

where $dly(t) = \log|HPIIP(t)| - \log|HPIIP(t-1)|$, $dlp(t) = \log[WPI(t)] - \log[WPI(t-1)]$, $dlm(t) = \log|M1(t)| - \log|M1(t-1)|$, .HPIIP(t) is the value of smoothen IIP at time t as obtained from HP-Filter, Ψi's, i=1,2,3,4 are coefficient matrices and $e_y(t)$, $e_p(t)$ and $e_m(t)$ are VAR residuals for dly(t), dlp(t) and dlm(t) respectively.

As our VAR system includes three variables, we have k=3 and thus we can estimate k(k-1)/2=3 free off-diagonal parameters in A (for Choleski decomposition) and B (for structural VAR). The Choleski Decomposition of the covariance matrix of residual vector $e(t) = [e_y(t), e_p(t), e_m(t)]'$, yields the following recursive equations (figures within brackets being approximate t-ratios of the coefficients)

$$e_y(t) = v_y(t)$$

$$e_p(t) = 1.0883\ e_y(t) + v_p(t) \qquad \ldots\ldots (12)$$
$$(1.26)$$

$$e_m(t) = 0.6346\ e_y(t) - 0.2251\ e_p(t) + v_m(t)$$
$$(0.37) \qquad\quad (-0.95)$$

This system implies that instantaneous response of output comes from its own innovations, the prices respond instantaneously to

output disturbances plus its own innovation, and money instantaneously responds to output and price disturbances and its own innovations. We have kept $e_m(t)$ at the bottom of the structure because of the necessity of identifying the induced component of monetary policy shocks, which in this structure is identified by $v_m(t)$, under the basic assumption that the "feedback component" of policy is a function of output and price disturbances. Empirical estimates of the coefficients in equation for $e_m(t)$ are of proper signs. But though the sign of $e_y(t)$ in the equation for $e_p(t)$ a priori is expected to be negative, the empirical estimates possess improper (+)ve sign.

The results of variance decomposition based on the ordering of output-price-money are contained in Table 1. The ordering of price-output-money provides almost similar results.

Table 1 indicates that the effect of monetary shocks on variance of output at 2-months ahead forecast is 1.4 % which gradually increases to 15.3% at 24-months ahead forecast (though it is very difficult to choose appropriate forecast horizon for this type of study, we have restricted the analysis to 24-months ahead forecast only, presuming it to be satisfactory).

In case of price, the monetary shocks contribute to around 24% in 24-month ahead forecast. Actually the contribution of monetary shocks on price remained very stable at around 24% after the lead period of 10 months. In short term (2-months ahead forecast), the contribution of monetary shock to price is about 17%. Thus the analysis based on standard VAR analysis indicates that the influence of monetary shocks on the output and price is not very significant and strong. In Section I we have indicated the lacunae in dynamic analysis based on standard VAR, because of its dependence on the assumption that the model relating to VAR innovations is recursive. Thus we intend to impose a realistic model on VAR innovations in the next subsection and analyse the effects of money on output and prices.

Table 1 : Analysis of Variance Decompositions Based on
Standard Choleski Decomposition
(Order : Output-Price-Money)

Shocks to Months	Variance decomposition of output			Variance decomposition of price		
	output	price	money	output	price	money
2	97.71	0.94	1.35	1.69	81.17	17.14
4	90.89	2.48	6.63	12.24	68.69	19.07
6	86.05	3.13	10.82	12.00	64.76	23.24
8	83.41	2.99	13.60	16.14	60.28	23.58
10	82.36	2.66	14.97	16.53	59.40	24.07
12	82.24	2.39	15.37	16.56	59.39	24.04
14	82.45	2.20	15.35	16.64	59.32	24.03
16	82.66	2.09	15.25	16.66	59.23	24.11
18	82.75	2.03	15.22	16.78	59.13	24.08
20	82.76	1.99	15.25	17.01	58.90	24.08
22	82.74	1.95	15.30	17.09	58.82	24.09
24	82.75	1.92	15.33	17.10	58.80	24.09

Note : Entries show percentage of forecast variance of output and price at
different time horizons attributable to shocks in column variables.

Structural VAR Based Analysis

As mentioned in Section I, in our innovation model of a three
variables VAR system, we have to restrict the number of free pa-
rameters to 3 to make the model just identifiable. The proposed
model is as below;

$$e_y(t) = u_y(t)$$
$$e_p(t) = B(1) \, e_m(t) + u_p(t) \qquad\qquad ..... (13)$$
$$e_m(t) = B(2) \, e_y(t) - B(3) \, e_p(t) + u_m(t)$$

where $e_y(t)$, $e_p(t)$ and $e_m(t)$ are residuals as obtained at time point t
through standard VAR based on 'dly', 'dlp' and 'dlm' and $u_y(t)$,
$u_p(t)$ and $u_m(t)$ are assumed to be uncorrelated shocks. The coeffi-
cients, B(1), B(2) and B(3), a priori, are expected to be (+)ve.

In matrix notation equation (13) can be expressed as

$$
\begin{bmatrix} e_y(t) \\ e_p(t) \\ e_m(t) \end{bmatrix} = \begin{bmatrix} 0 & 0 & 0 \\ 0 & 0 & B(1) \\ B(2) & -B(3) & 0 \end{bmatrix} \begin{bmatrix} e_y(t) \\ e_p(t) \\ e_m(t) \end{bmatrix} + \begin{bmatrix} u_y(t) \\ u_p(t) \\ u_m(t) \end{bmatrix} \qquad \dots (14)
$$

The system of equations (14) is of the form $e(t) = B\ e(t) + u(t)$ as mentioned in (5). It is also clear that the matrix B is not a lower triangular matrix and the model in (14) can not be represented by a recursive structure through any rearrangement of variables. The assumption on uncorrelated components of $u(t)$, admittedly strong, will at least allow us to specify the elements of 'B' in a relatively unrestricted way.

The first equation postulates that output disturbance enters into the system exogenously. As the above model says only about instantaneous relations, it does not nullify the lagged impacts of other variables on output. The second equation incorporates a contemporaneous monetarists view. Note that this assumption also does not say that price is uncorrelated with output; it only speaks about the instantaneous effect, while the other effects will be determined by the standard VAR lag structure. The last equation is the monetary authority's reaction function. The formulation indicates that monetary policy is accommodating in nature in the case of higher output growth, while in the case of higher inflation it will initiate counter cyclical measures. Thus the model is quite conventional, but can not be described through a recursive structure.

The system of equations were jointly estimated by using Bernanke methodology as mentioned in Section I. We have carried out the computation using TSP and Gauss software package/language. The estimated structural restrictions are as below (figures within brackets are approximate t-ratios) :

$$
e_y(t) = u_y(t)
$$

$$
e_p(t) = \underset{(3.46)}{0.0841}\ e_m(t) + u_p(t) \qquad \dots (15)
$$

$$e_m(t) = 75.5783 \; e_y(t) - 1.3460 \; e_p(t) + u_m(t)$$
$$\qquad\qquad (1.92) \qquad\qquad (-2.21)$$

$var(u_y(t))=4.3452 \times 10^{-9}$; $var(u_p(t))=1.8667 \times 10^{-5}$; $var(u_m(t)) = 5.3338 \times 10^{-4}$

It is interesting to note that the monetary disturbances have a significant impact on the price disturbances. The feedback coefficients (from output and price) for central bank's instantaneous reaction are also quite significant. The more important aspect of the estimated structural restrictions is that the coefficient estimates have proper signs. In contrast note that in standard VAR analysis we also tried with the specification of price disturbances as a combined effect of output disturbance and its own shock, with an a priori assumption of a (-)ve sign of the output coefficient. However, as presented in eqn. (12) the data does not support this structure in the sense that the estimated coefficients do not have proper signs.

The variance decomposition based on the above estimated structural model is presented in Table 2. This Table certainly looks different from Table 1 (which uses standard Choleski decomposition). Now the effect of monetary shocks on 4-months ahead forecast variance of output is estimated as 8.3% as compared to 6.6% in previous case. In the case of 24-months ahead forecast variance of output, the contribution of monetary shocks has also been improved to 17% from 15.3% as in previous case. The glaring difference can be observed in the case of decomposition of forecast variance of price. Now we observe that in short term (2-months ahead) the monetary shocks contribute around 31.6% in the forecast variance of price in contrast to only 17.1% in the previous case. These improvements may be attributed to the better understanding of economic interactions among the variables under structural VAR framework.

Table 2 : Variance Decompositions Based on Structural Model

Shocks to Months	Variance decomposition of output			Variance decomposition of price		
	output	price	money	output	price	money
2	97.71	0.42	1.87	1.69	66.69	31.61
4	90.89	0.78	8.33	12.24	56.85	30.91
6	86.05	0.80	13.15	12.00	54.30	33.70
8	83.41	0.60	15.99	16.14	50.40	33.46
10	82.36	0.44	17.20	16.53	49.44	34.04
12	82.24	0.36	17.40	16.56	49.44	33.99
14	82.45	0.32	17.24	16.64	49.36	34.00
16	82.66	0.29	17.05	16.66	49.29	34.05
18	82.75	0.27	16.98	16.98	49.21	34.01
20	82.76	0.25	16.99	17.01	49.00	33.98
22	82.74	0.24	17.02	17.09	48.92	33.99
24	82.75	0.23	17.02	17.10	48.91	33.99

Note : Entries show percentage of forecast variance of output and price at different time horizons attributable to shocks in column variables.

Having convinced about the importance of monetary shocks for output and prices we will be naturally interested in the impulse response function. These are presented in Table 3.

In the impulse response function, the effect of money on output is found to be important till 24 months, though very short run effects (1-2 months) are negligible. Although the effect slowly dies down with the passage of time, it remains positive. The influence of monetary shocks on output increases till the 8th month and slowly recedes in the subsequent months. Thus the monetary shock remains influential on output for a substantial period. In case of price, the effect of monetary shocks on price is very significant till the 8th months. It remains highly positive upto the fourth month. Subsequently the impact decays towards zero following an oscillating path. A close look at the table shows that while the price

shocks have negligible influence on the output, the output shocks have a high degree of influence on price till about 8 months.

Table 3 : Impulse Responses Based on Structural Model

Shocks to Months	Response of Output to shocks in			Response of Price to shocks in		
	output	price	money	output	price	money
1	0.19	0.01	0.03	0.50	0.67	2.11
2	0.34	0.03	0.09	1.46	-0.41	0.86
4	0.63	0.06	0.25	0.33	-0.51	1.15
6	0.78	0.06	0.37	-0.93	0.05	-0.63
8	0.77	0.03	0.39	-0.48	-0.23	-0.60
10	0.67	0.00	0.32	0.06	0.07	-0.03
12	0.58	-0.00	0.26	0.15	0.16	0.11
14	0.53	-0.00	0.22	0.12	-0.02	0.16
16	0.50	0.00	0.21	-0.10	-0.03	0.01
18	0.46	0.00	0.20	-0.24	-0.03	-0.14
20	0.40	0.00	0.19	-0.16	-0.02	-0.12
22	0.34	-0.00	0.16	-0.06	0.02	-0.04
24	0.30	-0.00	0.13	-0.02	0.02	0.00

Note : Entries show dynamic response of output and price to a one-standard deviation shock in the estimated equations associated with each column variables. Month 1 is the contemporaneous month. All entries are multiplied by 1000.

Section III
Identification of Monetary Policy Shocks

As discussed earlier, the $u_m(t)$ will provide us the measure of pure monetary shocks introduced in the economy, after due consideration of the present state of the economy through feedback rule. Under "neutral" policy stance the extent of the shock $u_m(t)$ will be insignificant (statistically zero). On the other hand, significant non-zero $u_m(t)$ indicates non-neutral policy stance. More particularly the positive shock will indicate an "easy" monetary policy stance while the negative shock will reveal a "tight" monetary policy. The plot of

$u_m(t)$ is presented in Figure 1. The monthly data correspond to

Figure 1 : Plot of Um(t)
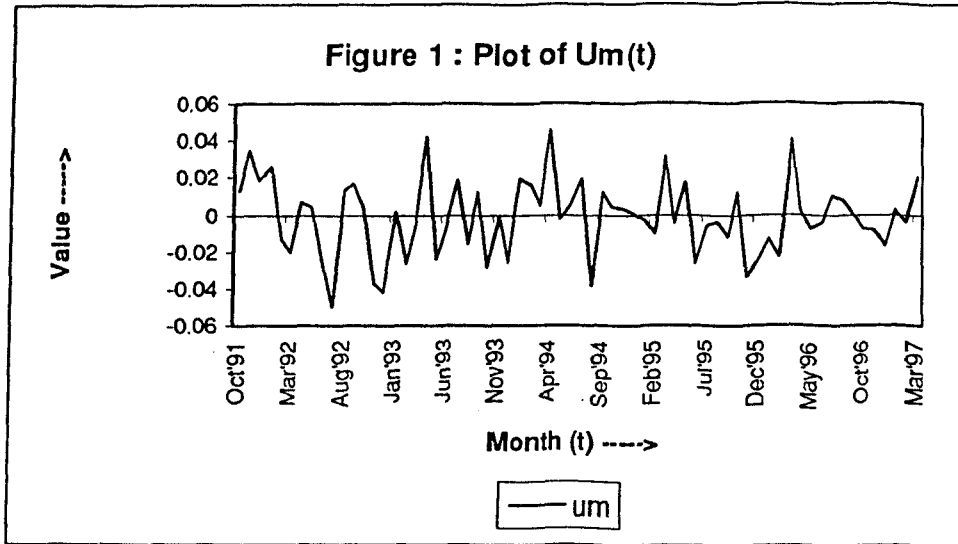
October'91 through March'97. As expected, the series under consideration is quite volatile. To have a meaningful analysis, the series is converted to half-yearly averages (say, u_m^*), coinciding with the '1st Half' (April to September) and '2nd Half' (October to March) of credit policy. The policy stance in any half-year period can be classified as "easy", "neutral" and "tight" when the average shock (i.e. u_m^*) for the period is significantly "positive", "zero (i.e. insignificant)" and significantly "negative" respectively. The derived data on u_m^* are plotted in Figure 2.

Figure 2 : Plot of Um *(t)
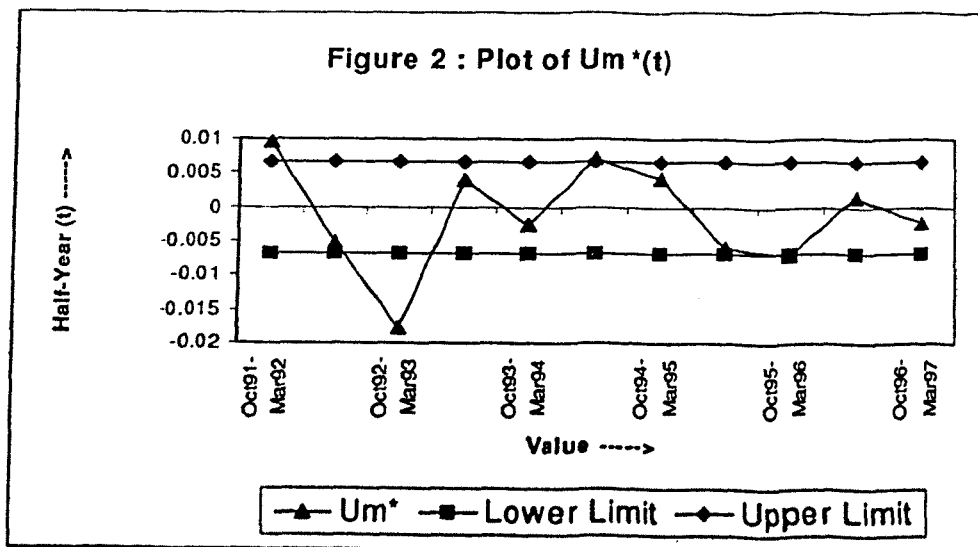
The presentation in Figure 2 requires some further explanation, which is as follows :

In order to classify the u_m^* into "tight", "neutral" and "easy" policy stance, we search for an interval around zero which indicates the band of statistically insignificant value of u_m^*. Accordingly, we devide the distribution space of u_m^* in such a way that with a (+)ve critical value k;

(i) $u_m^* < -k$ ((um*) will indicate "tight" monetary policy stance

(ii) $-k \ \sigma(u_m^*) < um^* < k \ \sigma(u_m^*)$ will indicate "neutral" monetary policy stance, and

(iii) $u_m^* > k \ \sigma(u_m^*)$ will indicate "easy" policy stance,

where $\sigma(u_m^*)$ is the standard deviation of um*.

As is conventionally used in testing of hypothesis, we chose k satisfying probability $[-k \ \sigma(u_m^*) < u_m^* < k \ \sigma(u_m^*)] = 0.95$, i.e., with 95 % confidence we classify monetary policy as "easy", "tight" or "neutral". Thus k can be viewed as the critical value for testing the local mean of u_m (i.e. u_m^*) equal to zero. Assuming normality of the $u_m(t)$ series we observed that k = 1.96.

Now, at any time point/period, $u_m(t)$ and hence $u_m^*(t)$ will have mean zero under the null hypothesis of neutral policy stance. In previous section we saw that variance $v(u_m)=0.00053338$. Thus $v(u_m^*)=v(u_m)/6$.

In Figure 2, the lower limits and upper limits so derived are plotted. An analysis of the plot clearly brings out the nature of the monetary policy stance during October '91 to March '97. It can be observed that, the monetary policy exhibited certain degree of tightness during October '92 to March '93. During October '95 to March '96 also the monetary policy stance was reasonably "tight". On the other hand, the monetary policy stance can be identified to be "easy" during the periods October '91 to March '92 and April

'94 to September '94. In the rest of the period, the data indicates that the monetary policy can be termed as "neutral".

Section IV
Conclusion

This paper has used the structural VAR methodology based on the works of Bernanke to analyse the dynamics of monetary shocks in the economy and their impact on output and prices. While approaching the problem, we found the evidence that atheoretical standard VAR analysis may lead to sub-optimal results. Imposing structural model based on economic theories, it was found that monetary shocks exert significant effect on output and prices for a substantial period. We have also extended the analysis to statistically identify the monetary policy stance of the authority into "tight", "neutral" and "easy" policy. The statistical results indicate that the policy was reasonably tight during October '92 to March '93 and October '95 to March '96, while it was "easy" during October '91 to March '92 and April '94 to September '94. In the rest of the period, a neutral policy stance was in evidence.

Notes

1. A Choleski decomposition of the covariance matrix for the VAR residuals.

2. Off diagonal elements of V(u) are zeros because the components of u(t) are constrained to be uncorrelated.

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Appendix : Smoothening IIP Using
Hodrick-Prescott (HP) Filter

The HP filter (see Claude Giorno, Pete Richardson, Deborah Roseveare and Paul van den Noord, 1995 and Mikael Apel, 1995) fits a trend through the time series data, regardless of any structural breaks, by making the regression coefficients vary over time. With regard to IIP, this is done by finding a trend that simultaneously minimizes a weighted average of the gap between actual IIP and trend IIP at any point of time and the rate of change in trend IIP at that point in time. More precisely, the trend IIP, say HPIIP for t=1,2, ..., is estimated to minimise

$$\Sigma\{\ln Y(t)\text{-}\ln Y^*(t)\}^2 + \lambda \Sigma |\{\ln Y^*(t+1) - \ln Y^*(t)\} - \{\ln Y^*(t) - \ln Y^*(t-1)\}|^2$$

where $Y(t)=\text{IIP}(t)$, $Y^*(t) = \text{HPIIP}(t)$, Σ indicates the summation over time, λ is the weighting factor that controls smoothness in trend line. A low value of λ will produce a trend that follows actual IIP more closely, whereas a high value of λ reduces sensitivity of the trend to short-term fluctuations in actual output and, in the limit, the trend approaches the mean growth rate for the whole estimation period. Subjectivity is involved in choosing the appropriate valc of λ. While a very low value of λ will lead to a smoothed series which is close to the original series, a very large value of λ will generate a smoothed series close to the trend path. In this exercise we have smoothened IIP series in such a manner that the high degree of fluctuation in the original series is reduced but the smoothed series remains as close to the original series as possible. Accordingly, λ is assigned a value of 720.

Excess Returns, Risk-Premia and Efficiency of the Foreign Exchange Market: Indian Experience in the Post Liberalisation Period

Himanshu Joshi & Mridul Saggar*

This paper tests the market efficiency hypothesis for Indian foreign exchange market by estimating spot and forward Indian rupee – US Dollar exchange rate regressions. It also presents a dynamic model of the spot and forward exchange rates as a vector ARMA process. The sample and model-generated moments are analysed to obtain information on the behaviour of spot and forward exchange rates, including that of their transitory and permanent components. Empirical evidence suggests that: (i) the Indian foreign exchange market is not efficient, (ii) forward premiums are persistent, and (iii) the volatility of expected depreciation is larger than implied excess returns. The empirical evidence also points out that the permanent or fundamental component of the exchange rate predominates in determining its variations. This evidence implies that the stability of exchange rate in the Indian economy depends on the fundamentals.

Introduction

The counter-intuitive behaviour of excess returns encountered in foreign exchange markets has been a long-standing puzzle. Ex-ante, expected home currency returns on foreign deposits in excess of domestic deposits should be zero. Yet, empirical evidence overwhelmingly supports the presence of deviations from the uncovered interest parity (UIP), implying the existence of excess returns in the foreign exchange markets. There are many potential explanations of this observed irregularity and the issue warrants proper empirical investigation. With this objective in view, this paper attempts to model the dynamics of spot and forward exchange rates in the Indian foreign exchange (FOREX) market. Forward exchange markets have come into play only recently following the far-reaching reforms initiated in mid-1991 and phased move towards liberalisation of current and capital accounts, which led to full current account convertibility in 1993. With the convertibility of the

rupee in 1993, the exchange rate essentially became market determined and market participants activated an otherwise dormant forward market. With significant capital account convertibility for the non-resident flows over last six years and integration of the domestic capital markets with global markets, exchange market became volatile for the first time in 1995, bringing to fore the importance of the forward market. Presently, the foreign exchange market has become closely integrated with the short-term money market. Liquidity changes are seen to spill over quickly to the FOREX markets in recent times and vice-versa. In this backdrop, the forward rates have become significantly associated, both with the spot rate of rupee and the short-term interest rates in general. The central bank has intervened time and again in both the spot and the forward markets, largely to influence the value of the currency and to a lesser extent to affect the monetary conditions. FOREX markets in India have three main segments – spot, forward and swap. Trading takes place among "authorised dealers (ADs)", which are mainly commercial banks. They primarily trade on their own behalf or on behalf of large customers, besides conducting retail business for individuals or small business. Some ADs also buy/sell on behalf of the Reserve Bank, facilitating central bank intervention. Central bank intervenes in all three segments of the market, but not all its swap operations are conducted with a view to influence the exchange rate. Many of its swap operations are conducted with the objective of managing domestic liquidity.[1] Recently, in view of the disturbing developments in the East Asian markets, the intervention in forward market was stepped up to control the contagion effect. However, the pressures on rupee abated with the announcement of a series of monetary and credit policy measures.[2] The later measures were addressed at the basic demand and supply factors affecting the exchange rate. To the extent that excess returns and risk premia in the Indian foreign exchange market have become a recurrent phenomenon, the nature of the movements need a thorough examination in the context of exchange rate policy. This paper attempts to bridge the gap in the literature by modeling the spot and the forward Indian rupee-US dollar rates and examining the prevalence of excess returns and risk premia in the market over the period 1993:04-1998:01.

The rest of the paper is schematized as follows: Section I surveys the efficiency hypothesis of exchange rate and provides possible explanations for puzzles regarding the empirical regularity of excess returns, unbiasedness, market inefficiencies, systematic inefficiencies and risk premia. Section II traces the recent development in Indian foreign exchange markets, particularly the forward market and its links with money market. Section III provides the test for market efficiency. Section IV develops a model of spot and forward rates and estimating it as a vector autogressive moving-average (VARMA) process using maximum likelihood procedure. The model provides evidence on the behaviour of excess returns and risk-premia, and the permanent and transitory components of exchange rate. Section V concludes by presenting a synoptic view of the findings in terms of its policy implications.

Section I
Market Efficiency and the Excess Returns

The prevalence of excess returns in the foreign exchange markets is one of the intractable puzzles in the international finance literature. If markets were efficient, then forward rates must be unbiased predictors of future spot rates and no excess returns should exist in the markets. Traditionally, this was tested by regressing k-period ahead spot rate on the k-period forward rates prevailing at a particular time-t:

$$S_{t+k} = \beta_0 + \beta_1 f_{k,t} + u_{k,t} \qquad \qquad ....(1)$$

Where S_{t+k} is the spot exchange rate prevailing at time t+k, $f_{k,t}$ is the k-period ahead forward rate prevailing at time, β_0 and β_1 are parameters, while $u_{k,t}$ is the white noise term. The efficient market hypothesis was considered to hold if the joint hypothesis of $\beta_0=0$, $\beta_1=1$ and E $(u_t\ u_{t-i}) = 0\ \forall\ i \neq 0$ is not rejected. Bilson (1981) and Frankel (1981) may be cited as examples. In most such empirical studies this simple test yielded mixed evidence. On the one hand, when the equation was estimated after subtracting forward rates from both sides of the equation, in most cases it was not possible to reject the hypothesis of constant and slope coefficients.

But the equations were often affected by presence of serial correlation. Besides, in many cases, the slope equation of the transformed equation was closer to -1 rather than being zero indicating that forward premium may be unrelated to actual rate of depreciation. Evidence against efficient market hypothesis was also obtained by Hansen and Hodrick (1980) and Hakkio (1981), though they cautioned that rejection of the hypothesis should not be readily identified with inefficiency in the exchange market as possible statistical explanations exist for the results.[3]

Simple OLS regressions of the above kind suffered from problems of stationarity and inferences drawn by them were soon realised to be spurious. Cumby and Obstfeld (1984) and Fama (1984) overcame this problem by transforming the data so as to test market efficiency by regressing future depreciation on forward premiums:

$$\Delta_k S_{t+k} = \beta_0 + \beta_1 f^p_{k,t} + \upsilon_{k,t} \qquad \ldots (2)$$

Where $\Delta_k S_{t+k}$ denote the depreciation of the spot rate between periods t and t+k, $f^p_{k,t}$ denote the k-period forward premium prevailing at time t, and as before β_0 and β_1 are parameters, while $\upsilon_{k,t}$ is the error term obtained by ordinary least square (OLS) regression. Again, the efficient market hypothesis would hold if it was found that $\beta_0=0$ and $\beta_1=1$ and have t-ratios such that the constant and slope coefficients are statistically significant. Lewis (1995) points out that the regression could be analogous to testing:

$$er_{t+k} = \beta_0 + \beta_1 (f_{k,t} - S_t) + u_{k,t} \qquad \ldots (3)$$

Where er_{t+k} denote the excess returns of k-period future spot rate (S_{t+k}) over k-period ahead forward rate prevailing at time t ($f_{k,t}$). However, the equality of equations (2) and (3) depend on $\beta_0=0$ in (2) and the slope coefficient being equal to '1 plus the slope coefficient of (3)'. Note that excess returns are regressed on forward premiums to test for efficiency in this case, with S_t denoting the spot rate prevailing at time-t. The efficient market hypothesis is tested in this case with the null hypothesis of $\beta_1=0$. In either case of (2) or (3), it is recognised that excess returns consist of a pre-

dictable excess return component and statistical error terms, which equals the expression $(S_{t+k}-E_t S_{t+k})$, where E_t denote expectations operator denoting statistical (or expectation can be market-based) expectation prevailing at time t of spot rate at time t+k. Empirical evidence based on (2) or (3) have also tended to reject the efficient market hypothesis in general. This includes the findings of Cumby and Obstfeld (1984) and Fama (1984).[4]

The unbiasedness hypothesis has also been rejected using time-series evidence in a number of studies. For example, Domwitz and Hakkio (1985), model forecast errors as an autoregressive conditional hetroscedasticity (ARCH) process and obtain evidence for non-zero constant risk-premium for some countries in their sample. Kaminsky and Peruga (1990) and Baillie and Osterberg (1991) specify GARCH-in-mean models to provide evidence of non-zero risk premiums. In this paper, we model market efficiency through simple cointegrating process and employ a time-series VARMA model to provide additional information about the relationship between spot and forward rates.

Widespread evidence on existence of bias in forward premia/discount in the FOREX markets has been a puzzle, which has defied easy explanations. If agents are rational and risk-neutral and transaction costs do not matter, then forward premia/discount should be an unbiased predictor of future spot rate depreciation/appreciation. Generally this is not the case. Exchange rate literature has advanced several possible explanations for this. Existence of time-varying risk-premium is most popular of these. However, empirical models incorporating risk premia (Hodrick, 1987; Cumby, 1988; and Baillie and Bollerslev, 1990) have provided an inadequate explanation for the bias. Also, theoretically, the estimates of risk premia are much smaller than observed bias (Frankel, 1988; Engel, 1992). Alternative explanation has been provided by Rogoff (1979) and Krasker (1980) who raise the possibility of small samples and peso problem. Lewis (1989) suggests that small period can also result in absence of learning effects for the market participants. Gruen and Gizyaki (1993) propose the possibility of anchor for exchange rate expectations as one of the possible reasons for bias.

Baldwin (1990) raises the possibility of transactions costs arising such that for small interest rate differentials, it is not optimal for capital flows to operate to restore interest parity. Yet, the empirical results are generally inconsistent with market efficiency, even when we take into account these possible explanations. In any case if forward rates are biased predictors of future spot rates, there are important implications for exchange rate management and for central bank intervention.

Section II
The Spot and the Forward Rate in the Indian FOREX Markets

Across the globe, FOREX markets are found to be notorious in terms of efficiency in that the prevailing forward rates do not fully reflect the available information. In India, FOREX markets are still underdeveloped in terms of instruments and practices and market efficiency is even more unlikely to prevail. Bokil (1995) attributes the thinness of the market to regulations preventing interest arbitraugers and speculators to freely operate in the market. He notes that large interest differentials prevail, but they have no relation with corresponding annualised premia. Yet, the forward market despite being thin is growing rapidly. Far-reaching changes have occurred in the 1990s and the joint dynamics of the spot and forward rate for the Indian rupee has become increasingly relevant in the conduct of exchange rate policy. The reforms of the FOREX market were initiated with a two-step downward adjustment of rupee in mid-1991. This was followed by the initiation of a system of dual exchange rates from March 1, 1992 under the Liberalised Exchange Rate System (LERMS), following the recommendation of the High Level Committee of Balance of Payments (Chairman: Dr. C. Rangarajan) (RBI, 1993). The dual exchange rate system constituted an implicit tax on exporters and on remittances and the exchange rate was quickly unified after a year by modifying the LERMS. The modified LERMS set up the system of market determined exchange rate effective March 2, 1993 and after further removing some of the remaining restrictions on current account transactions, India accepted the obligations under Article VIII of the

IMF's Articles of Agreement, making Rupee fully convertible on current account.

The reforms in the forward exchange market began in March 1992, with the RBI granting permission to corporates for unrestricted booking and cancellation of forward contracts for genuine exposures, both trade-related and others. Trading in forward market, however, remained thin as the nominal spot rate of Indian Rupee-US Dollar remained fairly stable till mid-1995. One of the reasons for apparent illiquidity was the lack of freedom to book cross-currency options. Customers with cross-currency exposures were permitted to split their cover through the dollar since February 1992, but it was only in December 1994 that the central bank permitted customers to take cover in a currency of their choice, which could be a currency other than one in which the payables / receivables were denominated. Cross-currency options as a hedge product was introduced in January 1994, but only on a fully covered basis. The rupee based cross-currency options are still not introduced in absence of integration of the term-structure of interest rates and a well-defined yield curve. Tarapore (1993) notes that increased interaction between domestic and international monetary policy began during this phase. During the LERMS period, the inter-bank swap premia ruled consistently above the RBI premia up to November 1992 – a period marked by tight conditions in the call money market, but the premia rates got aligned during November 1992 – March 1993. Following the unification of the exchange rate the inter-bank premia declined, specially in the period July-August 1993.

The forward market in India became active only since mid-1995. Forward premia after remaining high in early 1993, settled down and the FOREX market remained remarkably stable during the period August 1993 – September 1995. The annualised 3-month forward premia averaged 3.55 per cent, while the 6-month premia averaged 3.97. Though the premia had risen somewhat in the first quarter of 1995, it remained much below the 10 per cent mark. The 3-month forward premia, however, touched a peak of 27.06 per cent per annum in March, 1996 in anticipation of depreciation and prevailing tight liquidity conditions reflected in relatively high

short-term interest rates. Forward premia, declined however since mid-1996, with improvement in liquidity condition and reached moderate levels of a little over 3 per cent by mid-1997. The decline in the forward premia was accompanied by wider divergence between the real effective exchange rate of rupee (REER) and the nominal effective exchange rate of rupee (NEER), indicating that the currency was becoming somewhat overvalued (Figure-1).

Figure 1 : REER & NEER
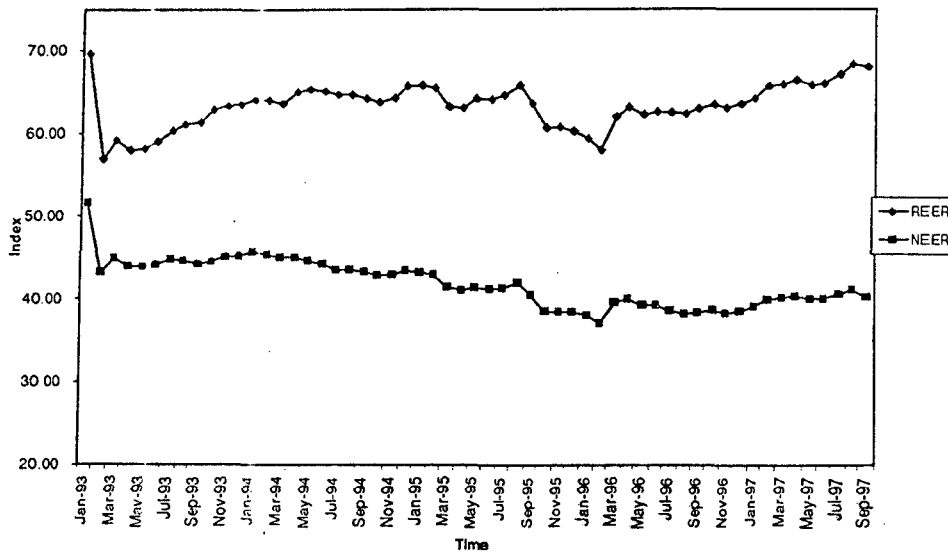
The exchange market, however, did not react to indication of currency overvaluation until quite later. The RBI responded in the later half of 1997 by further relaxing the monetary policy by a 100 basis point cut in bank rate and planned reduction in reserve requirements by 2 percentage points of net demand and time liabilities. However, excess liquidity spilled over and led to speculation of depreciation of Rupee with contagion arising from on-going financial crisis in East Asia. Large currency depreciations in East Asia generated expectations of competitive depreciation of Rupee. These sentiments resulted in forward premia rising once again and the 3-month premia crossed 15 per cent mark in early 1998. The 6-month premia has generally mimicked the 3-month premia, though the divergence between spot and forward rates has arisen, whenever the forward premia came under pressure (Figure-2).

Fig. 2 : SPOT & FORWARD INR-USD RATES
(monthly averages: spot, 3-month & 6-month forwards)
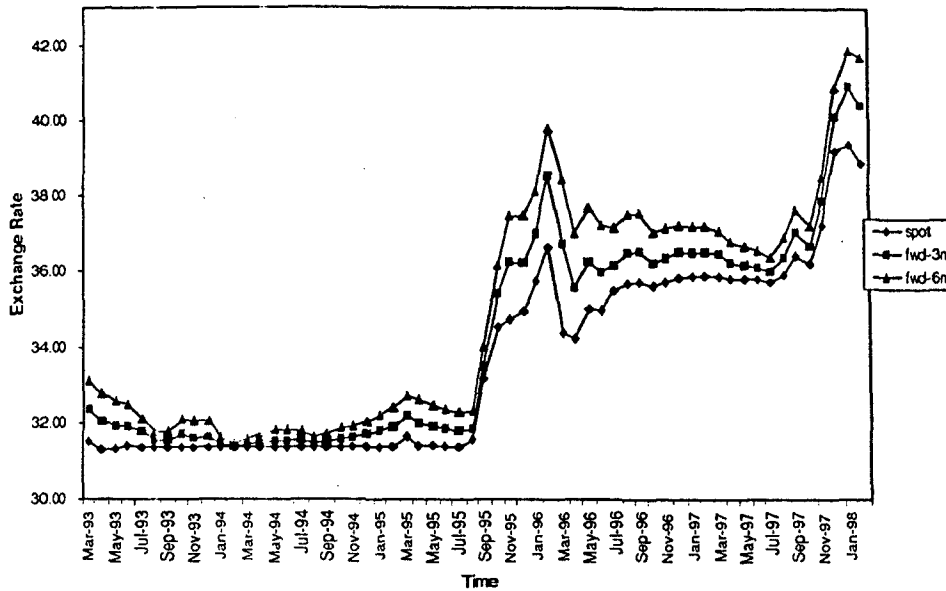
The growing forward market in India has brought about integration of the FOREX market with other financial markets, particularly the short-term money market. While the linkage of the FOREX market with the money market was weak during the pre-LERMS period the transmission mechanism got greatly strengthened once the exchange rate got market determined and forward market was activated. Two factors played an important role in this transition. First, with frequent changes in local currency reserve requirements for commercial banks, the banks resorted to frequent use of swaps to augment their level of reserves and meet their reserve requirements. Second, in events of tight money conditions reflected in high call money rates, banks took recourse to swaps acquiring spot rupees for forward dollars. The swap premia tends to rise along with call rates as a result. However, the market still remains underdeveloped due to a number of factors. First, a cautious approach requires the banks to maintain a square or near-square end-day positions. Second, banks are not permitted to take cross-currency positions overseas. Third, the rupee-based derivative market is nearly non-existent. Fourth, there is lack of depth in the market on account of moderate liquidity of money markets. Fifth, the trading base remains nar-

row on account of virtual absence of non-bank participation in trading. The Sodhani Committee Report (RBI, 1995) has made several recommendations to activate trading in forward markets. While, exchange market reforms are being pursued with caution, the role of forward markets have become central to the currency risk management for the financial institutions and corporate entities. As a result, statistical evidence on market efficiency, excess returns and risk premia have become important in the present dispensation.

Section III
A Test for Market Efficiency

As discussed in Section II, the empirical verification of efficiency of foreign exchange markets has been a subject of extensive investigation in empirical literature. Sadly, most of the research in this area pertains to the markets in developed economies and research for testing efficiency in less developed markets has been scanty. This is partly because most developing economies have only recently begun liberalising their exchange markets. Here we explicitly test the market efficiency for the Indian FOREX markets using the Indian rupee-US dollar rate using both equations (1) and (2), though for obvious statistical reasons, earlier enumerated in Section II, we base our inferences on the second equation, treating the first merely for expository purposes. The results are given in Table-I below:

The empirical estimates in Table I suggest that, even though equation (i) fails to establish cointegration between the future spot and the current forward rates, the coefficient β_0 is not significantly different from one, which establishes the existence of efficiency in the Indian exchange market. However, since not much reliance can be placed on inferences based on generic unit root tests in finite samples; the alternative is to estimate equation (ii). The estimated equation (ii), however, suggests that the hypothesis of efficiency can be rejected since the estimated β_1 turns out to be insignificant.[5]

Table I : Testing the Efficiency of Indian Foreign Exchange Market

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Equation (i)

$$S_{t+k} = 0.32 + 0.90\ f_{kt}\qquad,\ k=3$$
$$\quad\ (1.55)\quad (15.15)$$

Rbarsq = 0.80,   SEE = 0.03,   DW=0.36 and

PP Test (residuals) = -1.208; 5% MacKinnon (1991) critical value of -3.34 against the null of random walk.

Equation (ii)

$$\Delta_k\ S_{t+k} = 0.0056 + 0.28\ f^p_{kt}\qquad,\ k=3$$
$$\qquad\quad (0.45)\quad (0.69)$$

Rbarsq = 0.49,   SEE = 0.02,   DW = 1.31, Q(11) 23.74

Note to Table I :

(i) The period of estimation was from April 1993 to January 1998.

(ii) Both regressions are estimated for 3 month forward exchange rate of the rupee to US dollar.

There could be several possible explanations for rejections of the efficient market hypothesis. Under the rational expectations hypothesis (REH), ex-post excess returns should match market's true expected returns, plus a forecast error that may be unpredictable ex-ante. If this is true, then the existence of excess returns must be identical to foreign exchange risk-premia. But, excess returns could exist as systematic forecast errors and not necessarily as risk premia if market forecasts are irrational or if the distribution of errors measured statistically are different from distribution of disturbances perceived by the traders. It is also possible, that absence of a vibrant forward market with adequate liquidity and availability of hedge instruments, makes the market inefficient.

Section IV
A Time-series model for spot and forward rates

While one of the purposes of the present paper is to test for the exchange market efficiency in the Indian economy, an equally important objective is to develop a parametric time series model of the spot and forward rates so as to understand the mechanism of exchange rate dynamics including its relationship with forward rate. This model would then be employed to generate estimates of the unobserved expected currency returns and expected depreciation and the results compared with actual data to test the adequacy of the empirical exercise. The methodological approach taken here is that of Hai *et.al* (1997), who estimate a two component parametric time series model of the spot and forward exchange rates for Yen, Franc and the British Pound by setting up a vector autoregressive moving average (VARMA) model and solving it by Kalman Filter (KF) and maximum likelihood (ML) methods. In a departure from this original method, we attempt a direct estimation of VARMA through ML method and thus bypass the KF routine. This simplification is not expected to produce any significant changes in the direction of results due to the choice of a structurally uniform sample, which spans the post liberalisation era in the exchange market from April 1993 to January 1998.

The model assumes that both spot and forward foreign exchange rates can be represented as having a driftless common random walk component but with different temporary (or disequilibrium) components, each represented as a persistent stochastic process as follows:

Spot Exchange Rate : $s_t = z_t + x_{s,t}$ ....(4)

Forward Exchange Rate : $f_t = z_t + x_{f,t}$ ....(5)

Common Random Walk : $z_t = z_{t-1} + \varepsilon_{z,t}$ ....(6)

where x_{st} and x_{ft} are the structural stochastic processes associated with the spot s_t and forward f_t exchange rate, respectively and z_t is

the random walk element common to both the spot and the forward rates. In addition, it is also assumed that:

$$\{\varepsilon_{zt}\} \sim N(0,\sigma^2_z)$$

$\{(x_{st} \text{ and } x_{ft})'\}$ is a stationary bivariate stochastic process,

$f^p_t = x_{st} - x_{ft}$ is the implied excess returns from forward speculation and,

$$x_{st} = \theta\xi_t$$

where θ is inverse of the economy's speed of adjustment coefficient which depends on the other parameters of the model and ξ theoretically measures the state of disequilibrium in the goods market. As can easily be observed, the proposed structure is essentially a two component model of the spot and forward rates where the common random walk component is the 'implied' value of the exchange rate in the absence of nominal rigidities and can be thought of as the 'fundamental' or 'long-run equilibrium' value of the exchange rate' and can also be designated as the permanent component of the exchange rate. The fundamental component of the exchange rate is theoretically a function of domestic and foreign money stocks, income and aggregate demand shocks. On the other hand, the temporary but persistent components x_{st} and x_{ft} are deviations from their respective fundamental values of the spot and forward exchange rates and are interpreted as disequilibrium errors. As Hai et al (1997) indicate, the two component model is actually a stochastic generalisation of Dornbush's (1976) exchange rate overshooting model developed in Mussa (1982) where the operation of frictionless asset markets combined with commodity price adjustments lead to a two component representation for the exchange rate – a permanent value and a transitory component. The fundamental value being a stochastic trend modeled as a pure random walk.

In terms of the methodological procedure, no a-priori restrictions are placed on the behaviour of (x_{st},x_{ft}) except that the process is

stationary (or I(0)). Thus if the stochastic process (x_{st}, x_{ft}) satisfies the criterion of stationarity, the model for spot and forward exchange rate disequilibrium can be set up as an unrestricted vector ARMA process. The VARMA (1,1) process in this case may be represented as:

$$\begin{bmatrix} 1-\varnothing_{ss}L & -\varnothing_{sf}L \\ -\varnothing_{fs}L & 1-\varnothing_{ff}L \end{bmatrix} \begin{bmatrix} x_{s,t} \\ x_{f,t} \end{bmatrix} = \begin{bmatrix} c_s \\ c_f \end{bmatrix} + \begin{bmatrix} 1+\theta_{ss}L & \theta_{fs}L \\ \varnothing_{fs}L & 1+\theta_{ff} \end{bmatrix} \begin{bmatrix} \varepsilon_{s,t} \\ \varepsilon_{f,t} \end{bmatrix} \quad ....(7)$$

Where the innovation vector is normally and independently distributed.

Alternatively, the model written in a complete form as:

$y_t = \zeta z_t + x_t$, where $y_t = (s_t, f_{k,t})'$, $\zeta = (1,1)'$, $z_t = z_{t-1} + \varepsilon_{zt}$, $\varepsilon_{zt} \sim N(0,\sigma^2_z)$

ε_{zt} being i.i.d. and,

$x_t = c + \phi x_{t-1} + \varepsilon_t + \Theta\varepsilon_{t-1}$, $\varepsilon_t = (\varepsilon_{s,t}, \varepsilon_{f,t})'$ i.i.d. $\sim N(0, \Sigma)$, with

$$\Sigma = \begin{bmatrix} \sigma^2_s & \rho_{sf}\sigma_s\sigma_f \\ \rho_{sf}\sigma_s\sigma_f & \sigma^2_f \end{bmatrix} \quad ...(8)$$

ϕ and Θ are (2x2) parameter matrices of the AR and MA terms respectively, and c is the (2x1) vector of constants and $x_t = (x_{st}, x_{ft})$ as already defined is a bivariate stochastic process and Σ is the variance-covariance matrix of the error process $(\varepsilon_{st}, \varepsilon_{ft})$.

Empirical results of the model are presented in Table-II below:

Table II : VARMA (1,1) Model of Spot and Forward Exchange Rates for India - April 1993 to January 1998

c	ϕ		Θ		σ_s^2	σ_f^2	ρ_{sf}
-0.0026	-0.38	-0.12	1.04	0.14	0.0014	0.00016	0.147
(0.00003)	(0.029)	(0.0003)	(0.02)	(0.02)	(0.00002)	(0.00003)	(0.00002)
-0.00018	0.77	-0.88	0.37	0.76,	Qs(13) = 6.30, p-value =0.93		
(0.00084)	(0.04)	(0.07)	(0.07)	(0.08),	Qf(13) = 6.81, p-value =0.91		

Optimized log-likelihood = -492.03

Notes to Table II :
(i) Exchange rate is the nominal rupee equivalent of one US dollar.
(ii) $Q_s(13)$ and $Q_f(13)$ statistics are the respective Ljung-Box $\chi 2$ statistics for testing the whiteness of the implied random walk innovations in the spot and 3 month forward exchange rates..
(iii) ρ_{sf} is the implied correlation between the random walk innovations of the spot and the forward exchange rates.
(iv) Figures in parantheses are asymptotic standard errors.
(v) The nonlinear optimisation routine of Berndt, Hall, Hall and Hausman was used to maximise the log-likelihood function.

As the empirical results in Table II, especially the estimated Box-Ljung statistics for the random walk innovations suggest the null hypothesis for both spot and the forward rates cannot be rejected, thus, validating the rationale of the choice of our specification. Of the other properties, the standard errors pertaining to the estimated coefficients are generally small, thus lending statistical significance to the empirical results. As in the case of many other studies, the exchange rate variability in the Indian market is dominated by random walk component. While the standard error of the percentage changes in exchange rate is 1.58; that of random walk innovations is estimated close to 1.68, which is not significantly different from the former. It is for the reason that the permanent component shows unpredictable changes that most macroeconomic exchange rate forecasting studies end up in failing to outperform the random walk model.

In Table III are presented a comparison of several sample and implied (model generated) information which is expected to shed a

good deal of light on the behaviour of the dynamics of the spot and the forward rates:

Table III : Sample and Model Generated Information on Exchang Rate Dynamics

	Rupee/US dollar Exchange Rate	
	Sample Based	Model Generated
Var (TC Innovations-Spot)	n.a	0.0081
Var (TC Innovations-Forward)	n.a	0.0087
Cov (TC Innovations Spot/Forward)	n.a	0.0079
Var (Depreciation)	0.0082	0.0088
Var (Forward Premium)	0.00017	0.00015
$\beta 1$	0.28	0.04
First Order Auto Correlation of Forward Premium	0.82	0.79
Var (3 Month Excess Returns)	0.0010	0.0012
First Order Autocorrelation of 3 Months Excess Returns	0.75	0.66

Notes to Table III :
(i) 'TC innovations' implies the innovations of the transitory components, viz., $(\varepsilon_{st}, \varepsilon_{ft})$. Var(.) implies a variance estimate.

The estimates in Table III indicate that the model performs reasonably well. Of notable significance is the higher first order autocorrelation of the implied forward premium and excess returns, both of which not only match well with their respective sample estimates but are also marked by considerable persistence. All other estimates, except the coefficient β_1, are also found to compare adequately with their respective sample estimates. The estimated β_1 does not match very well with the traditional sample estimate even though it has a correct positive sign. Interestingly, the parametric value of β_1 is not negative as is generally obtained in empirical studies for developed foreign exchange markets. The results in Table III also suggest that the variance of implied excess returns is

less' than that of implied depreciation which once again points towards the importance of fundamental factors in exchange rate dynamics and the market's failure to correctly foresee future depreciation of domestic currency.

Of critical importance in any empirical exercise is the tracking performance of the estimated model. Plots of model generated spot and forward rates and of forward premia and excess returns are presented in figures V and VI, respectively, against the sample of actual data (see Tracking Performance of VARMA (1,1) model, Figures III-VI). The visual evidence suggests that the performance of the estimated model is quite reasonable in terms of its ability to capture temporal variations of the actual data, which makes it a useful tool for foreign exchange market analysis. This is also striking in a sense that though the Indian FOREX market has not been completely dergulated, the market participants do appear to have been taking into account the importance of the fundamentals of the economy in determination of the exchange rate.

Section V
Conclusions

In terms of the empirical results presented in this paper, the Indian foreign exchange market like many others does not pass the test of efficiency implying that the forward exchange rate cannot be said to be an unbiased predictor of the future spot rate. One of the policy implications of this result is that since the events in the spot and forward markets are somewhat insulated from each other, intervention in one market needs to be supplemented by intervention in the other. The RBI intervention has generally been passive during periods when exchange rate has been relatively stable. However, on occasions the central bank has been compelled to step-up intervention, by selling dollars forward to cool forward premia, or by conducting buy/sell operations to dampen high intra-day or day-to-day volatility. It also undertakes swaps when forward premia goes out of alignment with domestic short-term interest rates or sometimes even to simply smoothen the maturity profile of forward liabilities and ensure that forward liabilities remain prudent in size. Ordinarily

swaps would not influence the forward rate, but swaps are useful not just for altering monetary conditions, but also for exchange rate management. However, there are limits to forward market intervention, specially in the long-run. A time series model of the spot and the forward exchange rate estimated as a VARMA process provided insights into the exchange rate dynamics. A notable inference is the presence of higher volatility of the permanent component of the spot exchange rate against its temporary component thus implying the dominant role played by fundamentals in determining exchange rate variations. The predominant role of the permanent component established in the paper supports the RBI strategy of concentrating on fundamentals in the economy and modulating the monetary conditions, whenever necessary for bringing orderly conditions in the exchange market. From a policy point of view, the results underscore the importance of the policy of intervention in different market segments as needed and its emphasis on continuous monitoring of the critical fundamentals of the economy to ensure their reflection on the exchange rate.

Notes:

1. Such swap operations are typically associated with the central bank selling dollar forward and supplying rupee in spot market, when forward premia and domestic interest rate comes under upward pressure, but risks pressures on domestic currency if monetary conditions ease out as a result, as indeed happened in early 1996.

2. The measures in the currency markets were successfully complemented by a set of monetary and credit policy measures. These included raising the bank rate, interest rate on fixed repo, interest rate on post-shipment rupee export-credit and the cash reserve ratio (CRR). Also, the export credit refinance to banks was sharply reduced.

3. More recently, Bansal (1997) has explained the existence of forward premium puzzle on the basis of the sign of interest rate differential which may arise from a particular term structure of interest rate.

4. Empirical findings suggesting unbiasedness is scanty. Krasker (1980) presents evidence to show that peso problem may explain rejection of efficiency in some cases. In few studies, where cointegrating relations between forward rates and future spot rates with a unit slope for forward rate in the regression have been found indicating unbiasedness, supplementary evidence on persistence from autocorrelations of forward premia indicate presence of small size risk premia showing that markets may not be as efficient as indicated otherwise. Castro and

Novales (1998) may be cited as an example.

5. These results hold even when tested for the sub-sample 95:06-98:01, i.e., for the period when the forward market became active. The results for this sub-sample are:

$$S_{tuk} = 2.30 + 0.35 f_k \text{ for } k=3,$$
(5.03)   (2.77)

.....(1)

PP test (no trend) = -0.43; 5% MacKinnon (1991) critical value of -3.90 against the null of random walk.

$$\Delta_k S_{tik} = 0.015 + 0.042 \ f^p_{kt}$$
(0.53)   (0.747)

.....(2)

Rbarsq = 0.56,   SEE=0.02,   DW=1.27, Q(7) 6.30

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TRACKING PERFORMANCE OF THE VARMA (1,1) MODEL
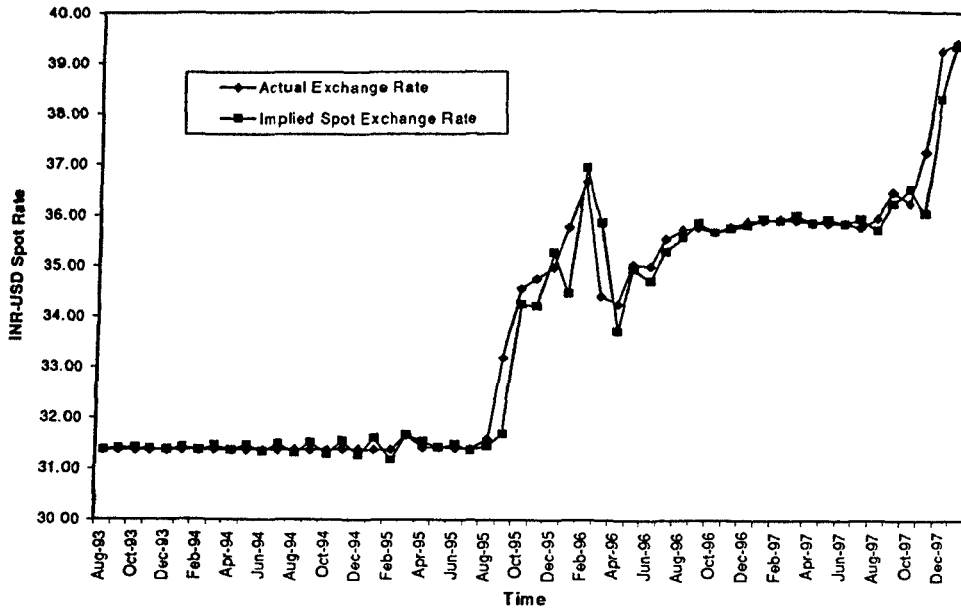
Fig. III. ACTUAL & IMPLIED SPOT EXCHANGE RATE

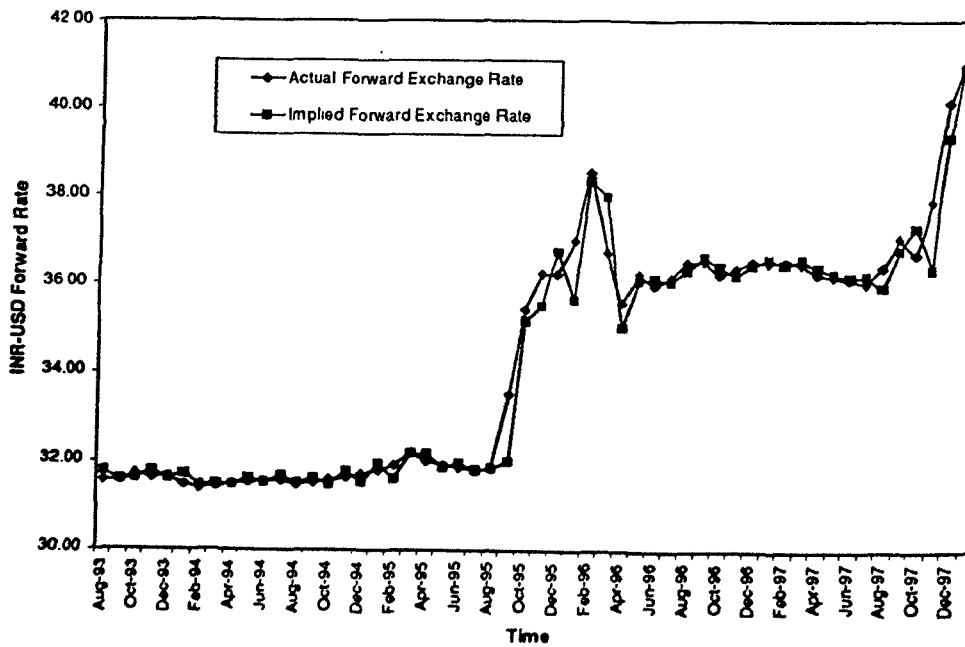## Fig. IV. ACTUAL & IMPLIED FORWARD EXCHANGE RATE

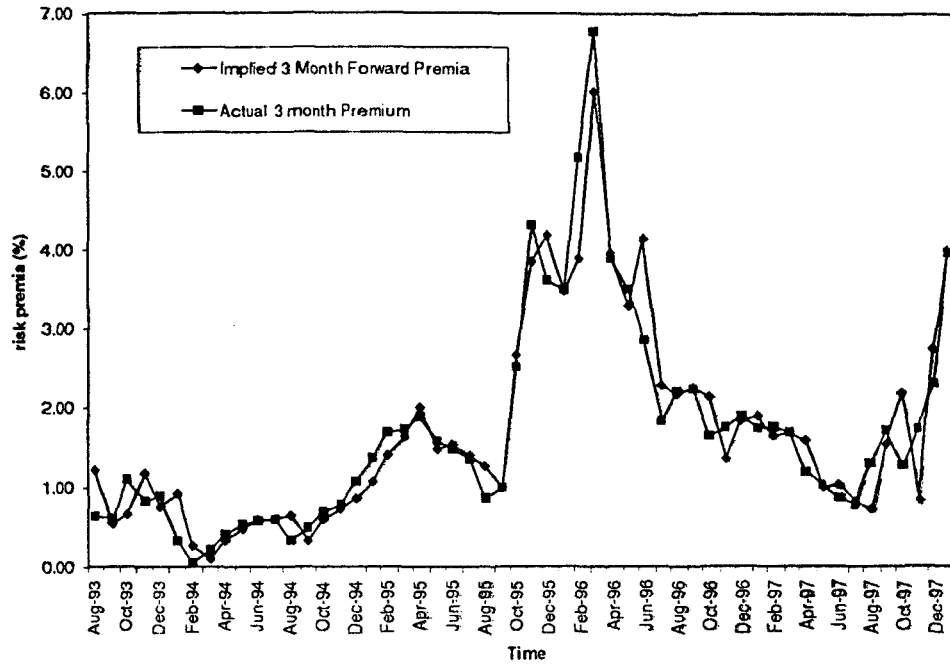## Fig. V. RISK PREMIA - Actual & Implied Forward Premia

Fig. V. RISK PREMIA - Actual & Implied Forward Premia

Fig. VI. ACTUAL & IMPLIED EXCESS RETURNS

Fig. VI. ACTUAL & IMPLIED EXCESS RETURNS
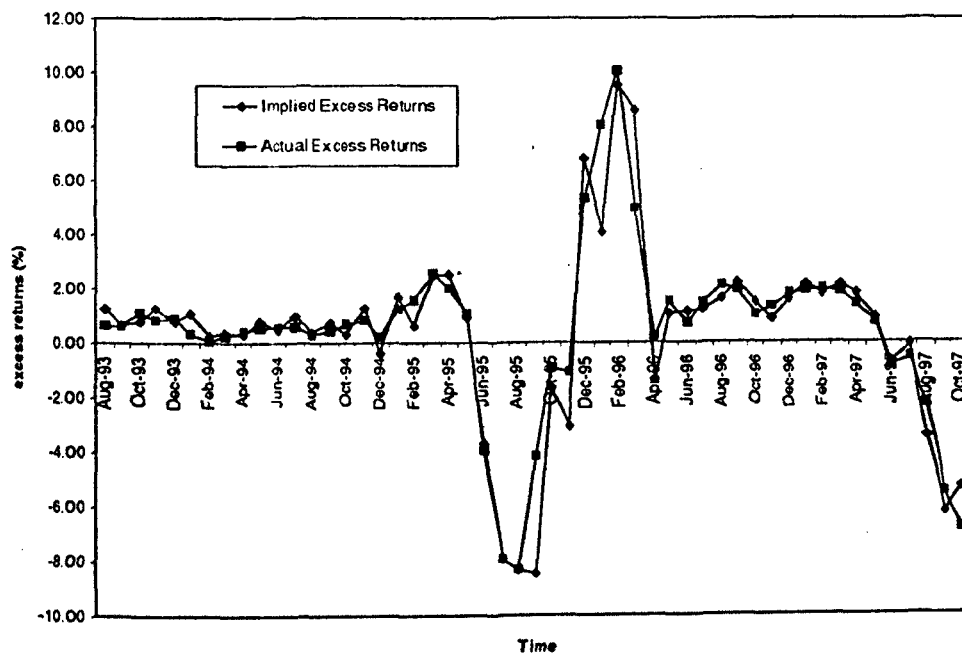
BOOK REVIEWS

Modern Public Economics, **Raghbendra Jha,**
London : Routledge, 1998, pages xv + 558, Price £ 19.99.

A good graduate textbook in Economics is perhaps intended to perform two major functions. First, it is supposed to deconstruct the Journal articles, which often suffer from the 'tip of the iceberg' syndrome, in the form of a do-able model and discern the general principles so as to guide the students in their pursuit of further modeling, extensions or empirical verification. Secondly, and more importantly, a textbook is supposed to place a model locationally, strip it of the apparent niceties so that the student gets a sense of perspective of the general class of models within which this particular model can be located. This is what one gets from a Handbook-type survey article. A good textbook has to have both these attributes. Looked at from these two functional angles, Raghbendra Jha's *Modern Public Economics* is clearly a winner.

To put the claim in specific terms, one may note that the universally followed standard comprehensive graduate textbook on public economics by Atkinson and Stiglitz was published in 1980.[1] As a result the progress in the field of public economics during the last seventeen years is not captured in it. To give an example, the revolution in informational economics, in which Stiglitz himself played a pioneering role, being largely a phenomenon of the eighties is absent in Atkinson and Stiglitz (1980).[2] Again topics like dynamic fiscal policy, tax-reform, regulation, or fiscal federalism, which are of recent origin, do not find a place in Atkinson and Stiglitz (1980). Although in between fundamental works in public economics appeared in book from, yet if one does not consider Jha's effort, there has been no substitute to Atkinson and Stiglitz (1980) for comprehensiveness.[3]

Public Economics, as the author has aptly put, is "loosely defined as the study of government intervention of the marketplace.." (p. xi). Thus, from an applied micro-theoretic standpoint, it is largely devoted to the study of welfare implications of government intervention. The author's coverage of this traditional aspect of public economics is complete. Starting with a digression on welfare economics, the author gives a quick account of the "basics of consumer demand" (Chapter 1), "perfect competition and Pareto optimality" (Chapter 2), and "forms of social welfare function" (Chapter 3). While every student of public economics is expected to be exposed to the topics of the first two chapters (as the author himself has pointed out), the chapter on social welfare function is particularly interesting. The author does a commendable job in introducing topics like Sen's interpretation of information in Arrow framework, neo-utilitarianism, or Rawlsian maximin, that would have been normally skipped from a chapter in the nature of digression, although these topics deal with realistic concerns of welfare economics and help improve our understanding of public economics.

Three chapters of the book are devoted to theory of public expenditure. The chapter on "external effects and market mechanism" (Chapter 5) discusses both the traditional issues like Pigovian taxation or subsidisation, as well as the advanced material on tragedy of commons or depletable and non-depletable externalities. In a similar vein the chapter on "theory of pure public goods" (Chapter 6), starting from Samuelson's 1956 model on conditions of Pareto optimality with pure public goods, goes to more recent development of solutions to the problem of incentive compatibility that is associated with provision of pure public good. Apart from discussing the standard Lindahl-Wicksell mechanism of a linear tax, associated with the benefit derived from a particular public project, the author takes up a number of more recent mechanisms of solving the free rider problem of public good; notable among them are Groves-Lob mechanism (wherein private parties have no incentive to lie), or Clarke-Groves-Vickrey mechanism (wherein revelation of true individual preferences becomes profitable). However, the author rightly notes that all these mechanisms to solve the free rider prob-

lem are in the nature of assuming away its very existence. Two other examples of provision of public good have been considered in this chapter, *viz.,* its private provision, and pubic choice theoretic voting models. In the last chapter of this part (Chapter 6: "Topics in the theory of public goods"), the author introduces the theory of clubs in the context of Tiebout hypothesis of local (as opposed to national) nature of public goods. The discussion on provision of public goods with asymmetric information in this chapter is found to be most exciting. Based on his own earlier joint work (with R. Broadway and I. Horiba), the author shows that supply of public good in the asymmetric information case will be smaller than that in the full information case. However, if the agencies have same marginal cost, and differ only in their fixed cost, then the iso-profit curves will not be crossing each other and the optimal policy will lie in a pooling equilibrium. The author also takes up the issue of rent-seeking as a problem area in the provision of public good.

Spanning over ten chapters, the coverage of theory of taxation is perhaps the most complete in the book. It discusses the traditional issues like effect of taxation on savings, labour supply, investment behaviour, and risk taking or optimal non-linear income taxation. While these subjects are very essential to any complete book on public economics, what is interesting to find in the book is inclusion of a number of more recent topics like dynamic taxation, tax-reform, taxation in an endogenous growth model. Even in the discussion of the traditional topics the author incorporates a number of recent developments. The following list is illustrative, *viz.,* (i) extended life cycle model of saving in the chapter on "effect of taxes on savings", (ii) tax incidence in a model of involuntary unemployment in the chapter on the "theory of tax incidence", and (iii) optimal taxation under asymmetric information in the chapter on "aspects of income taxation".

The author discusses "tax incidence in dynamic models" (Chapter 12) in the context of a Solowian growth model, as well as in its monetary version. Taking real wealth as comprising of real money balances and real value of corporate bonds, the author,

as a comparative static exercise, shows that an increase in inflation will increase the capital intensity of the growth process. This apart, in the same chapter the author discusses two other important issues, *viz.*, Ricardian equivalence proposition in the context of Blanchard version of life-cycle model, and comparison of tax and debt as revenue instruments in a Feldstein model. An important inclusion of a topical nature in the chapter on "some results in commodity taxation" (Chapter 13), is a descriptive discussion on value-added tax, as well as its comparison with retail sales tax.

Four specific topics have been dealt with in the chapter on "topics in the theory of taxation" (Chapter 15), *viz.*, (i) taxation in endogenous growth models, (ii) income tax indexation, (iii) time inconsistency problems, and (iv) tax compliance. All the four are of current interest. In particular, in an endogenous growth model it is shown that the growth rate depends positively on the rate of inheritance tax, and not on the rate of income tax. The discussion of time inconsistency problems in the context of a dynamic tax model, giving an example from Fischer shows that a finite repetition of Fischer model is capable of generating a unique time consistent equilibrium. Tax compliance (or evasion) has, of late, become an increasingly important topic of tax policy. There is, in fact, an enormous literature on the underground economy. In the context of a dynamic tax evasion model, the author shows that in the presence of· an imperfect capital market with borrowing constraint, tax evasion cannot be ruled out even with full auditing. After all, for a liquidity constraint taxpayer it may make sense to evade a tax in the current period and pay a higher tax, along with penalty, in future when the income level is sufficiently high.

Against the backdrop of international experience in tax reform, Jha takes up issues relating to tax reform (Chapter 16) both in static and dynamic contexts. The static theory of tax reform, primarily following Guesnerie, makes a distinction between equilibrium-preserving tax reform and Pareto-improving tax reform. In the context of dynamic tax reform it is shown that, under some fairly

general conditions, substitution of a consumption tax for a wage tax may turn out to be inefficient.

In the part on "applied problems in public economics", the author takes up three major issues, viz., pricing in the public sector, international aspect of taxation and cost-benefit analysis. On "pricing in the public sector" (Chapter 17), the author discusses topics like Ramsey-Boiteux linear pricing problem, redistributive Ramsey-Feldstein pricing, non-linear pricing, and peak load pricing. Normally textbooks on public economics pay scanty attention to problems of "international aspects of taxation" (Chapter 18). While it is a welcome change to see that the author takes extremely important issues like interest taxation in international fiscal coordination, and Ramsey optimal taxation in this context, it is little intriguing to see the inclusion of the theory of optimum tariff in this chapter. The chapter on "cost-benefit analysis" is fairly standard and takes up topics like shadow pricing, Little-Mirrless and UNIDO criteria.

The part on fiscal federalism is perhaps one of the more non-standard material incorporated in the text. In the penultimate chapter on "issues in fiscal federalism" the author delves into diverse issues like rationale for the existence of subcentral authorities (primarily in terms of Arnott and Grieson model), and optimal size of local jurisdictions. In the final chapter on "grants and taxes in federal countries", issues like different purposes of grants, and tax assignment in federal countries are discussed.

It may not have been possible, within the span of the present review, to do full justice to a book that literally discusses hundreds of models in a tractable and easily derivable manner. Readers will be thankful to Jha for bringing out such a book. However, from a reader's point of view, presentation of some exercises (analytical or otherwise) would have made the text much more useful. Perhaps a little more attention to the problems of the developing countries in the field of public economics could have been provided. Besides, as the strength of the book lies in its vast coverage, one suspects that in some cases a number of topics had been accommodated

within the span of a chapter without sufficient organic wholeness. Despite these limitations, the book is likely to be valued as an important text on public economics for years to come.

Partha Ray*

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2. See for example, Arnott, R and J. Stiglitz (1986): "Moral Hazard and Optimal Commodity Taxation", *Journal of Public Economics*, 29: 1-24.

3. As for example, Laffont, Jean-Jacques (1989): *Fundamentals of Public Economics*, Cambridge: MIT Press.

* Shri Partha Ray is Assistant Adviser in the Department of Economic Analysis and Policy.

Collective Bargaining : Perspectives and Practices, B.R. Patil,
Universities Press (India) Ltd., 1993, pp. 539 Price Rs. 250.

In recent years, bargaining policies and bargaining practices have
been at the forefront of decision-making. This has been due, in
large part, to the fact that a systematic and incisive analysis of
bargaining is an important pre-requisite to an understanding of
markets in general, and labour markets, in particular. Labour mar-
kets are quick to react to economic cycles. For example, during
upswings, labour markets respond through an increase in the wage
rate and/or employment level, which would tend to recede when
the economy nears the downturn. Central to the working of the
labour market is an understanding of the processes by which the
variables of concern (wages, employment, hours of work etc.) are
determined in the market. Although some literature on these issues
in the Indian context have been extant for some time, the analyses
were of piece-meal and incomplete nature. The present book at-
tempts to fill this void by looking into the bargaining aspect of
labour market functioning. Titled "Collective Bargaining: Perspec-
tives and Practices", the book goes beyond the normal textbook
requirements and provides us with a systematic analysis of collec-
tive bargaining by knitting together the various facets of collective
bargaining: theory, evidence and practice. In all, there are twenty-
two chapters in the book and the organization of the chapters fol-
lows a pattern starting with a general perspective of the theory,
practices and principles, followed by an examination of the various
issues pertaining to collective bargaining in India and ending with a
case study.

Chapter 1 delves into the definitional aspects of collective bar-
gaining from the economic viewpoint, the sociologists viewpoint,
the managerial viewpoint, the International Labour Organisation
(ILO) definition etc. to mention a few. A common thread running
through these definitions is an attempt by the parties to arrive at
an amicable solution to the potential tension that exists among the
sides. However, as the author observes, many of these definitions

"...fail to consider other important aspects or features of collective bargaining as a method of industrial jurisprudence and government, as a method of management, and as a social institution" (pp.14). The following three chapters deal with the basic tenets of collective bargaining, the process involved and the alternative approaches to bargaining. The various objectives of collective bargaining, the underlying procedures and principles, the associated environment influencing the bargaining practices and the scope and subject matters are discussed. Thereafter, the author examines the process of collective bargaining, its different phases and the alternative bargaining approaches.

Chapters 5 through 7 take up the issue of the nature and pattern of collective agreements and the extant arbitration mechanisms. The author lucidly discusses the various bargaining patterns, including conjunctive bargaining (wherein the parties agree to provide certain requisite services to recognize certain sets of authority and to accept certain responsibilities), distributive bargaining (which is concerned with determination of wages, hours and working conditions), integrative bargaining (where the parties attempt to increase the size of the joint gain), co-operative bargaining, productivity bargaining (concerned with achieving higher efficiency, a reduction/minimization in unit labour costs and higher earnings).

Chapter 8 describes the diverse collective bargaining practices as evidenced in the developed economies. The author traces the bargaining patterns in the U.K., the home of collective bargaining, which, in its initial phase, centred around productivity bargaining, but after the passage of the Employment Protection Act (1975) has shifted to plant-level bargaining "...with considerable expansion in the range of issues negotiated" (pp.200). Bargaining practices in the U.S., on the other hand, has certain salient features, including, among others, (i) a decisive preference in favour of plant-or enterprise-level negotiations, (ii) a bargaining structure determined primarily by union preferences, and (iii) greater willingness of some employers to operate during a strike by hiring strike replacements. Surprisingly, however, "... a very small fraction of all agreements, i.e., 0.16 per cent, cover about 20 per cent of the workers em-

ployed under the negotiated terms" (pp.201). The author thereafter discusses bargaining practices in Japan, Australia and in Scandinavian economies like Sweden (which has a two-tier bargaining structure: conducted first at the national-level and thereafter at the plant level encompassing local issues).

The second part of the book starts by tracing the evolution of the industrial relations environment in India encompassing the Trade Union Act, 1926, the Industrial Employment (Standing Orders) Act, 1946 (subsequently amended in 1982) and the Industrial Disputes Act, 1947 (Chapters 9 and 11). In Chapter 10, the development of collective bargaining in Indian industries is described in detail. The author notes that the period starting post 1977 can be described as an era of collective bargaining. Chapter 12 examines the practices of collective bargaining in public sector industries. Of special interest to the financial sector is the section describing the bargaining process in the banking industry. Collective bargaining practices in the banking sector was initiated in the mid-sixties and the first bipartite settlement between the Indian Banks Association (IBA) and the Exchange Banks Association (EBA) representing the Indian and the exchange banks on the one hand, and the employees, represented by All-India Bank Employees' Association (AIBEA) and the All-India Bank Employees' Federation (AIBEF) on the other, was signed on October 19, 1966. The author then goes on to trace the various pay agreements in the banking industry. The next three chapters discuss the duration and subject matters of collective agreement, the issues structural and attitudinal, besieging collective bargaining in India and the conciliation and arbitration mechanisms. In the author's own words "...conciliation, does not operate as a voluntary process...it is quasi compulsory in nature" (pp. 381).

Finally, in part III of the book, the author undertakes a detailed and comprehensive study of the practices, principles and methodology of collective bargaining of several industries in the Coimbatore region in South India. The last chapter (chapter 22) brings out the conclusions.

In general, the individual chapters of the book are elaborate and the author has attempted to analyze the issues in great detail.

Some of the points in this context deserve a mention. The author has provided an extensive discussion of the collective bargaining principles. Central to the process of bargaining is the concept of bargaining power. What determines the bargaining power of the parties in the course of negotiations? What happens in the presence of multiple unionism? How are the bargaining strengths of the sides affected in the presence of strategic stocks (inventories and/or strike funds)? How is the bargaining process affected if a third party/parties negotiate(s) on behalf on one/both (of) the sides? Discussion on several of these crucial issues, either from a general perspective or from the Indian standpoint, are worthwhile but seem to be missing in the book under review.

Informational constraints play a critical role in the bargaining process. As the author aptly observes " ...influencing the other party's estimate of the true value of a specific issue, may be accomplished by a selective withholding (bold in original) of information" (pp.133). Earlier advances in theoretical research showed that, in a world of asymmetric information, parties often resort to disputes to gain information about the true state. For instance, in the face of incomplete information about the true value of the firm's profits, a union might often resort to strikes to screen the more profitable firm from the less profitable ones. Recent advances in bargaining theory however, observe that disputes in the process of bargaining can occur even in the presence of complete information(!). Such disputes have been shown to be rational outcomes emerging from the bargaining process.

The author is somewhat silent of the basic theory of non-cooperative bargaining wherein the sides alternate offers till an agreement is reached. The "take-it-or-leave-it" argument as described by the author is a variant of this approach where only one side has the entire bargaining power. A little more attention on the interrelationships and interconnections among the various theories would have been useful. Data reveal that in recent times, in the developed countries and specially in the U.S. and the Netherlands, there has been a gradual shift away from standard forms of industrial disputes (strikes, lockouts etc.) and towards holdouts (where the pro-

duction takes place under the terms of the previous contract while the new contract is negotiated upon). Why are such forms of disputes preferred vis-à-vis traditional modes? What are the cost advantages/disadvantages accruing as a result? One would have expected more on some of these problem solving issues in the book for its completeness.

East and South-East Asia have been at the centre-stage of economic policy discussion in recent times. How far conducive was the collective bargaining relations in facilitating growth in these economies? The book is illustrative on the experiences of several developed countries, understandably due to the primacy of labour market issues in these countries. Some discussion in the book on the growth phenomenon in the emerging economies in the context of labour market issues would have been useful for a better understanding of the policy problems in these countries. Recent researches have revealed that East Asian economies had succeeded in creating a highly disciplined, motivated and flexible work environment. These include, among others, the support of at least 30 · workers (or 20 per cent of the employees) to form an union, approval by a majority (2/3 in Malaysia) of union members by a secret ballot for a legal strike, free or highly subsidized retraining facilities in cases of retrenchment (Singapore and Malaysia) as well as retrenchment compensation. A discussion of the relative flexibility/inflexibility of the labour policies in India as compared to South-East/East Asia would have given a direction to policy makers to understand the intricacies involved and the remedial measures that can be undertaken. Overall however, the book makes a significant contribution to our understanding of the process of collective bargaining and would be read widely by those interested in the process of industrial relations.

Saibal Ghosh*

* Shri Saibal Ghosh is Research Officer in the Department of Economic Analysis and Policy of the Bank.

Estimating and Interpreting the YIELD CURVE, Nicola
Anderson, Francis Breedon, Mark Deacon, Andrew Derry and
Gareth Murphy (Series in Financial Economics and
Quantitative Analysis) John Wiley and Sons, Chichester,
England, 1996, pp. XIII + 221.

For credible monetary policy, central banks generally place em-
phasis on a wide range of economic indicators. In this context in-
formation derived from asset prices on market expectations of
future inflation and interest rates have assumed critical significance
with the elevation of market expectations to the status of primary
indicator for liquidity management. Following sterling's dramatic exit
from the European Exchange Rate Mechanism in September 1992,
the Bank of England reviewed its underlying analytical framework
for monetary management. One of the crucial aspects that has re-
ceived pointed attention in this context is the analysis and modeling
of the term structure of interest rates and comparisons of nominal
and index-linked government debt prices that can be used to ex-
tract information on market expectations of future movements in
inflation. The Bank of England used to estimate yield curves to
price new issues of government debt and to value loans to public
corporations and local authorities which is now the general practice
of many pro-market oriented Central Banks. But the shift of policy
focus to a multi-indicator approach, anchoring mainly on informa-
tion based on asset prices, has led the Bank to explore the best
possible way of estimating and analysing the term structure of in-
terest rate. The Bank has undertaken a review of theoretical and
empirical literature on the term structure of interest rates. With this
objective in view, the book has been brought out authored by five
of the then members of the Bank's Quantitative Financial Econom-
ics group. The book provides a competent account of what could
interest the policy makers, practitioners and academicians alike in
issues relating to term structure of interest rates. In fact, in the
authors' own admission the book could be an unique contribution,
since there is no single publication which successfully combines
theoretical techniques and empirical issues in pricing securities

whilst never loosing sight of their use in the 'real-world' applications.

The book is primarily concerned with the relationship between market interest rates and the valuation of debt instruments. Different forms of debt are distinguished primarily by the creditworthiness of the borrower. The governments are deemed to be the borrowers least likely to default on their debt repayments, implying that the cost of borrowing funds in the country will never be lower than that faced by the government. For this reason, the interest rates charged to government are of particular importance for the market related yield curve.

The volume under review could either be read from cover to cover, or used for reference on chapter by chapter basis. It has nine chapters blending relevant theory and empirical analysis in an exemplary way. Chapter 1 (The term structure of interest rates) presents the basic tools required for the economic analysis of bond markets. It introduces the term structure of interest rates and places its important role in the valuation of debt instruments. Bond arithmetic techniques cover the bond price equation, accrued interest and continuous compounding, measuring the return on a bond, interest rate risk and immunization, convexity of price-yield function, the implied forward rate curve, spot (or Zero coupon) yield curve, par yield curve, forward yield curves, etc. This chapter suggests that the expectations theory of the yield curve, i.e., implied forward interest rate representing the market expectations of future short-term rates is of fundamental importance to both market practitioners and to the authorities monitoring market interest rates. The intuition behind this theory is that, in a deterministic world, expected rates of return on different investment strategies are equalized only when all forward rates equal expected short-term interest rates. The pure expectations theory states that the observed market forward curve provides the best forecast of future interest rates.

In Chapter 2 the book discusses two distinct approaches to modeling the term structure of interest rates: first, measuring the

term structure using statistical techniques and second, using asset pricing models based on equilibrium or arbitrage arguments. This chapter briefly introduces some of the problems associated with the best known approaches to yield curve estimation and argues that the choice of a particular model depends on the purpose to which it is to be put. For example, for macro economic analysis while a parsimonious model may be the preferred option, a highly flexible non-parametric approach may have greater appeal for pricing. What is outstanding in the book is its rigorous presentation of various models, giving a critical assessment of the econometric techniques used for estimating discount functions. For the readers who are interested in mathematical proofs of the models, the appendices to this chapter provide step-wise solution of some of the more complicated discount functions with proper referencing. This can be viewed as the core chapter of the book as it develops the theoretical foundations that underlay the term structure models.

Chapter 3 (comparing yield curve models) provides a study of comparative approach to evaluating the performance of alternative estimation methods measuring the term structure of interest rates, both in theory and in practice. The authors note that there is a trade-off between smoothness and the goodness of fit of yield curve estimates because of idiosyncrasies influencing the market price of a bond. Taxation rules, the existence of derivative markets, the classification of certain bonds as 'benchmarks', ex-dividend effects etc. might influence the market behaviour. These factors also need to be taken into account when choosing a method of estimating yield curve for a particular market.

Discussing the arbitrage opportunities in the market, the book shows that normally security-pricing proceeds with the assumption of 'no-arbitrage equilibrium'. Arbitrage arises in the case of mispricing which allows an investor to make a riskless profit. The relationship between no-arbitrage and risk-neutral pricing is discussed in Chapter 4 (Equilibrium term structure models). Some examples of equilibrium models, in which the market prices of risk are explicitly incorporated into the model are presented in this chapter. The role of no-arbitrage equilibrium was seen to be central

to the development of term structure models. It establishes the validity of risk-neutral pricing methods which often leads to particularly tractable methods of pricing interest rate contingent claims.

The pure models of term structure of interest rates ignore several real world complications involving the pricing of bonds. As the authors allude to in this book had bond price been only determined by the term structure, it would have been possible to determine exactly the price of every bond in the market. Bond markets are, however, driven by a number of other factors which influence their relative valuation. The most important of these factors is the tax regime. Different tax regimes have different impacts on bond prices. Different investors may value the same bond differentially because investor specific tax rules provide different cashflows net of tax. There could also be bond-specific tax rules, which differentiate between the yields from two bonds although they may have similar gross cashflows. The authors pose an interesting question as to whether tax effects can be treated as 'noise' in the bond pricing models. Such a course could assume that the 'noises' are evenly distributed, which of course is not a reasonable assumption to make. Tax regulations do affect pricing and a statistically fitted curve with the assumption of symmetrical distribution of noise can introduce bias to the estimated term structure. The authors in chapter 5 review various models that take explicit recognition of tax regimes and make comparisons to show the best preferred model.

Chapter 6 introduces bonds with embedded options to show why such instruments cannot readily be thought of in the same way as conventional bonds for valuation and estimation of yield curve. This chapter provides a description of the techniques for valuing such bonds using the appropriate theoretical framework. In their simplest form bonds with embedded options have two distinct components - a straight bond component and an option component. Hence different perceptions regarding yields and interest rate volatility can be consistent with the same price. These bonds are very common among corporate debt issues as they provide the advantage of trading yield levels against views on volatility. The authors discuss two most common embedded options viz., callable and con-

vertible bonds and go into pricing issues with considerable depth. The book provides an authoritative account of the index-linked bonds, given the Bank of England's pioneering position in this regard. Using index-linked bond prices, it is possible to estimate the term structure of real interest rates. The estimation of such a curve provides the 'real' counterpart to the nominal curves. In particular, it enables the derivation of a real forward rate curve. In practice, however, there are two factors which complicate such estimation: there is the lag in indexation and, in most markets, there are typically far fewer indexed linked bonds than conventional ones. Chapter 7 (Index-linked debt) presents a very useful discussion on the concept and related issues regarding index-linked or indexed bonds. The authors provide perhaps the most articulated and competent account of how index-linked bonds work in practice in several countries and how such bonds are useful in extracting information about the market's expected inflation.

The book devotes a full chapter (Chapter 8) to the expectation hypothesis and its role in setting term premia in the market. The expectations hypothesis is based on the general proposition that expectations about future interest rates affect the current level of long rates. Theoretical aspects regarding the expectations hypothesis (the unbiased expectations hypothesis, the local expectations hypothesis, and the return to maturity hypothesis) are discussed. This chapter gives a detailed theoretical account of expectations hypothesis and practical issues in modeling yield curve using the theory as basis. An interesting aspect of this chapter is that it provides the reader with a detailed technical knowledge of how to develop the expectation theory into an estimable specification for conducting empirical analysis.

In the last chapter the authors turn to the empirical evidences on the success or otherwise of market expectations as predictors of future economic variables. In practice, this means testing whether term premia are constant or time variant. As the authors own account reveal, "the evidence ..... produces the surprising conclusion that for most countries the expectation theory with a constant term premium cannot be rejected". This is a significant conclusion as far

as its policy implications are concerned, since this not only validates the simple yield curve models but also makes a strong case for basing policies on market expectations as mirrored in bond prices. The authors note that the only exception to a stable term premia is the US bond market, which makes the interpretation of yield curve difficult in that country. While the yield curve seems to be over-reacting to future short rates in the US, providing the basis for easy rule to market participants to make excess profits, in the authors' view "it is possible that these excess profits are simply fair compensation for risk. Such easy trading rules, however, do not appear to exist in other markets".

Whilst any views expressed in this book are those of the authors and not necessarily those of the Bank of England, it is to be recognised that the Bank of England has done a commendable service by supporting and encouraging the publication of this book. It remains probably the most useful source on its subject, and that is a great deal to be thankful for. Given the exhaustive set of issues discussed with incisive analysis and terse presentations, the book is an extremely valuable contribution to the literature on interest rate. This makes the book a worthy piece for possession.

<div align="right">T.K. Chakrabarty*</div>

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* Dr. T.K. Chakrabarty is Director in the Department of Economic Analysis and Policy of the Bank.

Trade and Innovation : Theory and Evidence, Katharine
Wakelin, Edward Elgar Publishing, Inc. U.K., 1997 Pp 191,
Price £ 45.

Katharine Wakelin's book under review provides both macro-economic and micro-economic level study of the role of innovations in trade flows from an empirical perspective. The Schumpeterian approach to international trade theory viewed technology diffusion process as being at least partly non-codified and largely firm specific, making the transfer of technology both a costly and complex process. Countries may have a technological advantage in some sectors, giving a base for competitive advantage. The level of advantage depends on the degree of codifiability and transferability of the relevant information. This approach to technology is effective in explaining technological differences between countries and in particular technological differences between sectors in different countries.

The importance of a country's history and institutions in developing her technological profile has led to a number of studies on national systems of innovations. Such studies have highlighted the diverse technological strengths and weaknesses of different economies. Underlying this aggregate view of the technological strengths of sectors and countries are the firms which produce innovations. There are very few studies even in the Schumpeterian approach on the role of innovation in trade performance at the firm level. The book therefore is important in contributing to an understanding of the role of technology in detemining trade flows between countries at a similar level of economic development and sectoral and firm level performance between countries and also within the same country.

The book is based on the author's Ph.D. work. It is divided into four main parts. The first part consisting of three chapters, gives a critical overview of the developments in the treatment ac-

corded to technology in trade theories. The classical comparative cost theory, despite its evolution over the years to Heckscher-Ohlin-Samuelson (H-O-S) theorem remained essentially a two-good two-country model. It considered capital and labour as the determinants of comparative advantage on the assumption of identical technological inputs across countries. The subsequent refinements of it following the Leontief paradox covered more than two factors of production. Leontief in his study testing factor proportions theory for the US, found that the US, thought to be the most capital rich country, was exporting, paradoxically enough, more labour intensive goods than it was importing. This led to a theoretical search for an alternative explanation for trade patterns. Labour was divided into skilled labour (human capital) and unskilled labour. Finer definitions of factors particularly of technology and human capital were used in empirical studies resulting in the neo-factor endowment approach to trade. The neo-factor endowment approach however, was also found to be suffering from certain weaknesses. Technology, knowledge and capital were often treated as static endowments. The implicit dynamic nature of technology, and capital as well as the accumulation and diffusion over time of technology, and capital were left out under the neo factor endowment approach. In a neo-Schumpeterian approach, on the other hand, a more detailed treatment of technology and its dynamic implications is given. The neo-Schumpeterian approach viewed innovation as a micro-economic process (which explained how a country could maintain a cumulative advantage in the production of technology) and combined cost differences with absolute advantages in technology. This approach in effect while considering technology gap as the most important factor causing trade flows, stressed at the same time the importance of cost advantages in an explanation of trade patterns. Countries with a high technological advantage produce technology - intensive goods, and will export new products.

The author has surveyed the existing empirical literature on the subject including as recent as Musket's 1994 work on the US and the U.K. trade flows. The literature is classified according to three main characteristics: (i) the use of dynamic or static model of trade, (ii) consideration of the relationship across sectors for one

country or across countries for each sector, and (iii) the choice of innovation proxy.

It is found that the relative technological performance was an important factor in OECD's trade. Patents were found to be significantly related to trade performance in machinery and high technology sectors. In general, it was found that innovations and investment variables showed significant long term effects. Many NICS improved their market share through-imitations rather than innovations. The dynamic model studies also confirm the importance of non-price factors, such as quality and innovation in trade flows of developed countries.

As regards the choice of proxy used for measuring technical capabilities, studies have shown that patents taken out domestically were not found appropriate. Institutional differences between countries could make comparing domestic patent counts impossible. Use of foreign patents taken out in the U.S., the largest international market, is made in all studies for the patent proxies. Both patent and R & D expenditure captured different aspects of innovations and were found varying systematically over sectors. The role of patents in protecting property rights comes out as an important factor influencing the sector's propensity to take out patent. Variations in use of both patent and R & D expenditure data singly or in combination are used in many studies. Openness and size of the economy, the relative market share in the U.S., labour productivity, combined technology index, etc. are used in the literature. In fact, foreign patents and R & D expenditure are the most commonly used proxies for innovation. Given the nature of innovation which is a risky process and because of the drawback of using R & D expenditure, output measures of innovations have been generally preferred. This chapter gives detailed account of the various proxies used in measuring technical capability of a country and its impact on trade flows in a critical way pointing to the efforts made in the literature to arrive at a competent index that would take all relevant aspects into account. Readers will find useful the tabular presentation of the classification of innovation proxies used by scholars in the literature.

Part II is devoted to the case studies of bilateral trade between

France, West Germany, the Netherlands and the U.K., with an extension of bilateral trade of all the six countries with West Germany. The sample countries were heterogeneous, both in terms of their aggregate innovation levels (shown by patenting and R & D expenditure) and also in terms of the R & D intensity of their bilateral exports. In this part, Chapter 4 concentrates on trade among the four European countries. The focus here is on assessing the impact of differences in innovations on bilateral trade. This analysis is further extended to trade of these four countries with rest of the European countries. The major objective is to assess the extent of technology gap between these four advanced countries. This testing is done both on a bilateral basis for each pair of countries and multilaterally within Europe. The relationship for each sector across the bilateral trade flows has also been considered.

Particular attention is given to why and how the relationship varies according to the sectors and countries involved. For this purpose, the author has made use of simple correlations between bilateral differences in innovations proxied by patents and bilateral trade performance. This, she admits, reduces the explanatory power of the relationship. Nonetheless it helps in isolating sectors and countries. The results have shown that even for similar and economically integrated countries, differences in innovations exert dominating influence and differences in innovations remain-sector, specific the areas of strength being based on individual innovation patterns, institutions and economic structure. The variations in attitude to innovations shown by the European countries, the author says, implies a lack of real convergence between them. Positive and significant relationship was generally found in the very high and medium high technology sectors. By implication it means that the European Commission has focused on the convergence of monetary variables rather than on the convergence of real variables, including the level of innovations and that differences in innovation importantly determine intra-European trade.

In Chapter 5, the same relationship is considered for bilateral trade using more comprehensive specifications, like relative R & D intensity, and actual counts of innovations, R & D expenditures, and patents taken out in the U.S. The countries sample choosen

are also large. In the case of U.K., actual counts of innovations are used as explanatory variable. The author has used the ratio of innovations produced and used in each sector and classified the sectors into net users and net producers of innovations. The relationship between innovation and trade performance is considered separately for each group of sectors. The sectoral model-result showed the importance of innovation in influencing trade flows, where as skill had little importance except in computer and pharmaceuticals when taken along with innovation. The national systems of innovation in different countries led to specialization of some countries in such sectors where rates of technological changes were rapid and required innovation rates were high. As information is costly and can be partly appropriated by the innovator, innovation could remain country specific and could provide comparative advantage to countries and also to sectors amongst the countries.

The third part of the book is more disaggregate and Chapter 6, analyzes the impact of innovation on the export performance at a firm level for a group of U.K. firms. Based on a survey of the innovations in the U.K., the innovation history of each firm is used to characterize it as an innovator or non-innovator. Further, the firms' propensity to export and size are considered. The hypotheses that innovation gives a firm a specific competitive advantage, improves its performance on foreign markets, leads to greater export and increases the probability of a firm to export are tested with an empirical model set up to take account of determinants of export behaviour, including firm specific characteristics and also the characteristics of the sector in which the firm is located. The firm-specific characteristics appeared to be a more important determinant of exports for innovating firms than for non-innovating firms. For non-innovating firms, on the other hand, sector specific characteristics appeared to be more important. Non innovating firms' export behaviour is largely influenced by domestic market size. This influence does not extend to innovating firms where capital intensity was found to be an important determining factor. The results showed that innovation at micro-economic level is a fundamental characteristic that alter the nature of the firm and its performance. The policy implication are that promoting innovation at the level of

the firm can considerably improve export performance and the general level of innovation at the sectoral level can improve the trade performance of non-innovating firms. In terms of labour market, skills appear to be a much more important determinant of export behaviour at the firm level than low wages. Improvement of skill should be a major objective of government policy rather than that of keeping down wage levels to improve competitiveness.

By way of conclusion and implications it can be said that international competitiveness is determined by a country's knowledge-base built up both through the process of learning and through innovation. Innovation gives a specific advantage to a firm and because of its cumulative nature technological development can remain firm-specific overtime. Innovations help both the sectors which produce them and which subsequently use them. Part of the benefits would remain localized within sectors and the country. Domestic market size and export performance vary according to the innovating characteristic of the firm. Technology does not get diffused automatically. In majority of cases there is domestic spill-over between sectors. Technology gap survives even with increased trade and integration and globalization of production. Innovations affect not just the high technology industries' trade performance but also a key determinant of trade flows of a number of medium technology industries in particular those in the machinery sector. Innovations are more important in improving competitiveness in a great number of sectors than labour cost, although the latter plays a role in some sectors, often considered as desirable by governments.

The book is a well written and valuable contribution to the trade literature. It is presented in a non-technical fashion, and can be accessed by reader who are not well versed with mathematical presentation. The style, the depth and the analytical vigour in which the book has dealt with various issues relating to innovation and trade, make it a useful reference book for those interested in the economics of technology and trade.

M.P. Gaikwad*

* Shri M.P. Gaikwad is Director in the Department of Economic Analysis and Policy.

Exchange Rate Determination and Control, Giorgio
Radaelli, Routledge Publication, London, 1995 pp. 117,
Price £ 42.50.

Choice of an appropriate exchange rate regime, identifying the
right level for the exchange rate, and designing an effective inter-
vention strategy constitute three critical areas of research in the
sphere of exchange rate management by the central banks. With
globalisation of trade and finance, exposure to currency risk has
magnified considerably and unexpected exchange rate volatility is
often found to be unrelated to developments in domestic economic
fundamentals. Conduct of exchange rate policy in many developing
countries has increasingly become a complex and a challenging
task particularly in the context of the surges in private capital
flows and liberalisation of cross border capital movements. Coordi-
nation of monetary policies at regional/global level, sterilised foreign
exchange market interventions, and (re)introduction of exchange and
capital controls have generally been resorted to, singly as well as
in concert, by national authorities to contain exchange rate volatil-
ity. As each of these instruments has limitations the right approach
to contain volatility still remains an ambiguous issue. While high-
lighting this aspect in his book Radaelli suggests some empirically
well tested measures which could serve as useful guide to policy
by drawing on the experience of the ERM and the G3 countries.

In Chapter 1 Radaelli identifies the factors which contributed to
the stability of the currencies of the ERM in relation to non-ERM
currencies and explicates the importance of monetary policy conver-
gence in relation to capital controls and sterilised interventions in
ensuring ERM stability. The relative stability of the ERM currencies
could partly be due to high degree of convergence among national
monetary policies evident in terms of the high correlation between
monetary variables such as monetary aggregates, interest rates and
domestic inflation. Evidence of high monetary convergence is also
found among several non-ERM economies but their currencies do
not exhibit the same degree of exchange rate stability. This sug-

gests that exchange rate stability cannot be unambiguously ascribed to the pursuance of convergent monetary policy which has associated costs in the form of loss of monetary policy independence as also welfare loss arising due to capital controls. According to Radaelli, in the process of overemphasising the role of policy coordination and capital controls the efficacy of intervention operations have been largely underestimated. What contributes to undermining the importance of intervention is the perception that intervention amounts would at best constitute only a marginal proportion of the exchange market turnover or the existing stock of assets in any currency and hence may fail to affect the behaviour of the exchange rate. The ERM mechanism, however, provided for unlimited intervention at the compulsory intervention rates (i.e. near around the bands) and the mutual loan facility under the Very Short Term Financing Facility (VSTFF) ensured each central bank access to the currency of another central bank. This *symmetrical* intervention channel, in a sense, contributed to monetary convergence since such interventions involved opposite effects on the monetary base of the participating ERM nations. ERM countries, however, often resorted to *asymmetric* interventions affecting the monetary base of the intervening country only. Radaelli found that less than 15 per cent of the total ERM interventions were actually at the compulsory intervention rates indicating that a large part of the ERM interventions were actually of asymmetric nature. According to Radaelli the ERM crisis that started in September 1992 was not due to the failure of capital controls and ineffectiveness of intervention operations, but was the result of a supply shock emanating form unification of Germany that warranted a realignment of bands. Furthermore, the relative stability of the ERM currencies in the pre crisis period was ensured largely through interventions and not through capital controls alone. Radallei therefore argues that complete removal of capital controls from countries like Ireland, Portugal and Spain may not endanger the stability of the ERM.

Persistence with capital controls may not help in ensuring exchange rate stability and such controls may actually turn ineffective in the long run. He cites the experience of France and Italy to show how removal of capital controls in these economies did not

destabilise the ERM during the nineties. Empirically, effectiveness of controls is generally studied by estimating the degree of deviation from the parity suggested by the law of one price. This, however, enables one to capture the price effect and not the quantity effect. According to Radaelli, while exchange controls gave rise to a large discrepancy between onshore and offshore interest rates in the ERM countries the yield differentials arising on account of capital controls have been generally low and relatively stable. For example, the differentials between the Euro-DM and German domestic interest rates were never above fifty basis points and whatever small differential existed it was largely due to the reserve requirement (a form of capital control) applicable to domestic banks. On the other hand in the case of France and Italy which retained exchange controls on the underlying capital transactions, the differentials between the onshore and the off-shore rates exceeded 20 percentage points on several occasions.

Countries generally retain capital controls so as (a) to ensure that domestic savings contribute to domestic capital formation, (b) to enhance the degree of monetary policy independence, and (c) to fight speculative attacks particularly in an adjustable exchange rate system like the ERM. The empirical exercise undertaken by Radaelli in this book, however, shows that in both France and Italy capital controls proved ineffective in achieving these objectives. In France capital controls existed since 1939 but such controls were tightened severely only in the early eighties. The measures included compulsory surrender of export earnings within two weeks, permission for foreign direct investment only if financed 100 per cent by foreign currency loans, monitoring the positions of banks vis-à-vis individual non-residents, preventing banks from providing francs to non-residents through any contract that would spiral speculation, and subjecting capital outflows for the purchase of real estate to state authorisation. Italy also tightened controls during the seventies and eighties amidst severe external payments imbalances which included the requirement that foreign assets and liabilities of the banks must be balanced on a daily basis, a compulsory non-interest bearing deposit with the central bank amounting to 50 per cent of incremental investment abroad and taxes on foreign exchange pur-

chases. In both France and Italy, prior to early eighties, capital controls helped the authorities to some extent in strengthening the external balance and reserve position. But during the eighties, particularly since 1986, controls proved mostly ineffective in stabilising the exchange rate. External sector developments in these two countries in the aftermath of capital account liberalisation in the late eighties vindicates the findings of Radaelli that removal of restrictions on capital transactions can bring down pressures on currencies and help them to realise a more stable exchange rate system. It needs to be noted however that capital controls can work as a powerful short-term anti-speculative device when used effectively during periods of acute exchange market pressures.

In Chapter 3 Radaelli deals with the theoretical explanations for the movement of the US dollar vis-à-vis the DM and the Japanese yen. After briefly reviewing the theoretical exchange rate models such as the monetary model (fixed price, flex price and sticky price), the balance of payments model and the portfolio balance model he elucidates how the portfolio model has gained precedence over the monetary approach in the more recent decades. With the collapse of the Bretton Woods system the influence of capital account transactions on the exchange rate has gradually increased and one often finds large cross border capital movements which are quite unrelated to real trade transactions. As a result the asset market approach to exchange rate has emerged as an important transmission channel that could provide reasonably acceptable explanations for movement of exchange rate over a particular time horizon. In justification of the portfolio approach, Radaelli carries out empirical exercises to explain the long run behaviour of the DM/US dollar and the yen/US dollar rate over the first quarter of 1973 to the last quarter of 1991. Both the OLS and co-integration techniques are used to establish the presence of a long run equilibrium relationship between the exchange rates and several identifiable fundamental determinants of the exchange rate underlying a standard portfolio balance model. For the DM/US dollar rate the empirical findings validate the assest approach to exchange rate determination with rates of return and private financial wealth emerging as the dominant determinants. The empirically estimated equilibrium sug-

gests that by the last quarter of 1991 the US dollar was undervalued by about 8 per cent against the DM, a result also borne out by the PPP rule. Furthermore, the influence of the wealth effect on the exchange rate was seen to be declining during the eighties with corresponding increase in the influence of interest rates. Empirical results also showed the rising degree of substitutability between the US and the German financial assets. In a VAR framework the impulse response function indicated that the German monetary policy was to some extent influenced by the US policies whereas the US monetary policies were largely a function of domestic developments. A more or less similar finding was reported in respect of the Yen/US dollar rates. The long run asset market equilibrium showed that the US dollar was about 14 per cent undervalued against the yen and this also turned out to be consistent with the PPP rule as in the case of the DM/US dollar rate. A majority of the empirical analyses conducted to test the relevance of the standard theoretical exchange rate models has yielded two important findings : (a) no exchange rate theory provides a complete explanation for the behaviour of exchange rates, and (b) random walk models generally outperform the models based on theories. Radaelli had proved in 1988 in one of his research papers that some of the structural exchange rate models could outperform the random-walk models. In this book he has reiterated this point and shows that the long run behaviour of the exchange rates could be reasonably explained through the asset market behaviour although not to the fullest extent. The validity of the asset market approach also vindicates the view that exchange market interventions are potentially effective.

According to Radaelli unsterilised interventions in general are known to affect exchange rates by altering the relative supplies of money and interest rates. Effectiveness of sterilised interventions, however, depend on the efficacy of the portfolio balance channel. Sterilised interventions alter the relative levels of assets denominated in different currencies which are generally imperfect substitutes. Another channel for influencing the exchange rate through interventions is the signaling mechanism, which the central banks can use to influence market perceptions. The effectiveness of portfolio bal-

ance models discussed in the book has raised two crucial but related questions. The first one relates to the direction of causation, i.e. whether exchange rate movements influence asset preferences and thereby alter the relative asset levels or exchange rates themselves are a result of shifts in relative position of asset levels. The second is the extent to which portfolio balance channel is actually used by the central banks in their exchange market operations. Radaelli addresses these two issues in Chapter 4 by using central bank balance sheet data as proxy for sterilised interventions. Causality tests undertaken by the author showed no strong evidence that interventions systematically affected the exchange rate of three major currencies, i.e. US dollar, the DM and the yen. As regards the two ERM currencies some evidence of successful intervention is available only in the case of the Italian lira. According to Radaelli these contradictory results on the effectiveness of intervention obtained from the empirical exercises conducted in Chapter 3 and 4 could be ascribed to the nature of the exchange rate data used in the two sets of analyses.

It is essential to recognise that monetary policy coordination at the global level has a significant implication for the exchange rate stability. Exchange rate developments mirror the asymmetric supplies of different national monies in relation to their demand. Towards the late sixties and the early seventies the Phillips curve analysis gained ascendancy which prompted many national authorities to move in the direction of greater exchange rate flexibility. A flexible exchange rate apparently promised monetary independence in terms of the freedom to choose any point on the Phillips curve. As a result in the post Bretton Woods period the external constraint to money supply turned out to be less binding and pursuance of asymmetric monetary policies contributed to greater exchange rate volatility. In recent years there has been a surge in empirical literature indicating that the trade-off suggested in the Phillips curve approach may not necessarily hold. From the standpoint of ensuring exchange rate stability, therefore, national authorities must attach greater importance to monetary policy coordination. The policy responses of many countries amidst severe currency crises reveal the crucial importance of symmetrical monetary policies for ensuring ex-

change rate stability. During   periods of excessive volatility, exchange market interventions are generally supplemented by a tight monetary policy to stem speculative pressures and align domestic monetary conditions with international developments. Intervention is, thus a short term measure while for long-term stability of the exchange rates, some degree of international monetary coordination appears crucial. In Radaelli's analysis of ERM stability, however, intervention operations turn out to be more effective than monetary policy coordination. For interventions to be successful, a necessary precondition is to have an idea on the rate at which the exchange rate must be stabilised. A rate that equilibrates demand and supply and necessitates intervention support from the central bank only at the margin for a short period of time could be the ideal equilibrium level. Radaelli, however, does not mention how the ERM parities were decided and to what extent the selection of appropriate parities actually contributed to stability. Intervention operations around an equilibrium rate could be successful whereas any level of intervention may prove ineffective if the rate that is to be stabilised is a severely misaligned one. Radaelli also does not explain why removal of capital controls in France and Italy did not destabilise the ERM system. To reap the benefits of an open capital account what becomes crucial for an economy is to ensure a sound macroeconomic framework, a strong and resilient financial system and adequate safeguard measures to deal with sudden and unexpected policy failures. In the last decade or so, in their attempt to achieve a common currency for the EU members, the ERM countries have been pursuing policies to achieve the convergence criteria and their emphasis on attainment of convergence of certain key fundamental macro-economic variables can be considered as preconditions for an open capital account. During the eighties, on the other hand, the macroeconomic indicators of the ERM members were divergent and as a result, retention of capital controls helped the system to sustain stability. Furthermore, Radaelli highlights the asymmetric nature of the intervention operations undertaken by the Japanese and the German authorities but does not suggest what could be an appropriate intervention strategy, particularly when exchange rate is assigned the dual objective of ensuring price stability and preventing deterioration in external competitiveness. The

Japanese authorities generally intervene when the US dollar depreciates, i.e. external competitiveness consideration predominates the exchange rate policy. The German authorities, on the other hand, intervene when the US dollar appreciates so as to contain the danger of imported inflation.

In the conduct of exchange rate policy the overwhelming importance of capital account developments is getting wider recognition now. The asset market view and the portfolio balance channel are accordingly finding greater acceptability at the policy level which was hitherto led by the standard monetarist approach. There is, however, no transparent and definite procedure that could guide the authorities in effectively using the portfolio balance channel of intervention at the policy level. Radaelli throws some useful light on the policy dilemma confronting central banks of the ERM countries in this book and offers several forceful arguments in explaining the ERM stability. This book should be read by academics as well as by those who closely and carefully monitor the activities of the central bank for designing their own strategies in a market economy.

Sitikantha Pattanaik*

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* Shri Sitikantha Pattanaik is Assistant Adviser in the Department of Economic Analysis and Policy of the Bank.