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ARTICLES

Macroeconomic Simulation Results for India based on VEC/VAR Models

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" Bhootam hi Bhavyaahitam, Bhavyam Bhootey Pratishthitam." (Atharva Veda)

I

INTRODUCTION

With a population level of about 1055 millions and per capita income of Rs.10,965/- (1993-94 prices) in 2003, India is still only a developing economy. Agriculture, industry and services accounted for 24.08 per cent, 26.62 per cent and 49.30 per cent respectively, in the total gross domestic product (GDP) in the year 2002. The corresponding figures in the total investment (excluding errors of omission and commission) are 8.08 per cent, 45.26 per cent and 46.66 per cent. The Government vigorously pursues various economic policies to push up the economic growth with a hope to attain a status of 'developed country' at least by 2020. The major economic reforms have been initiated in 1991, which have led to improve the economic environment for growth. However it is still not clear how far the various policy instruments in the hands of the Government have been rightly used and how far it will be effective in future. Apart from the beneficial or non-beneficial effects of the Government policies, the economy may also experience shocks from external sources. A bad rainfall or a steep hike in oil prices alone may derail the growth momentum. In this context, it becomes important to know the real impacts of the policy instruments as well as the external shocks.

Several papers using vector error correction/vector auto regressive (VEC/VAR) models have dealt with Indian economic problems. Chitre (2005) for example, modified Blanchard and Quah (1989) model to suit the Indian situation and analysed non-agricultural GDP data to separate trend from the cyclical component. By making some appropriate assumptions supply shocks and demand shocks were distinguished. Impulse responses are obtained for different structural shocks. The structural shocks are obtained from the structural factorisation of the VAR model. The responses of the GDP to these shocks were compared to the actual cycles that were recorded and shown to be consistent. Dua *et al*. (2003) estimated univariate models as well as levels VAR, Bayesian VAR and VECM for different interest rate series in India. Ramachandran (2004) tested for the existence of a stable relationship between M3, output and prices by employing

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The authors are thankful to Mihir Rakshit, Dipankar Coondoo, T. Krishnakumar, Sanjoy Nath and Ellen Brock for sharing our concerns and discussions on various issues while this "Snakes and Ladders Game" of economic modeling work was going on. Shortcomings, sure to remain of course, are their monopoly.

conventional stability test, cointegration, ECM models and tested for structural break in a cointegrating vector. His analysis shows that there exists a fairly stable relationship between the three variables between the years 1952 to 2001. Identifying that growth in M3 could be a potential indicator of future price movements, his study however cautions against using it as an active monetary policy instrument to stabilise short run price fluctuation, as it might accentuate rather than moderate price fluctuation in the long run. Several other similar studies also exist using the VEC/VAR models. These studies however do not deal with structural aspects of the Indian economy nor provide any forecasts or simulation results under alternative policy decisions and counter factual economic environment.

In this paper, a macroeconomic simulation model has been developed for the Indian economy, based on three VEC/VAR component-models estimated separately. Hopefully, this model is useful in addressing some of the policy questions. In the next section scope of our models is spelt out. Later, three VEC models, long-run equilibrium relations and error correction mechanisms are presented. After diagnosing the estimated models, a reference run is presented. Then policy analysis is taken up. The last section presents concluding remarks.

II

SCOPE OF THE MODELS

This paper is mainly concerned with the production structure of the Indian economy.[1] Agriculture, industry and services (including public administration) sectors modeled separately form the three components. The three component models pooled together thus cover broadly the production structure of the entire economy thus enabling us to conduct a wide ranging policy analysis on the supply side. For each sector, a vector error correction (VEC) model has been estimated with the corresponding GDP, GCF (gross capital formation, i.e., investment) and prices PDFL (price deflators) as three endogenous variables. That means, the mutual dependence among these variables is characterised as a long-run equilibrium relation (LRE) with corresponding error correction existing. Each of the variables could also be influenced by some predetermined and exogenous variables such as rainfall (RF), real money supply (RM3), fuel price index (WPF), real bank rate (RBR), real budget deficit (RBD), corporate savings (PCSS) and real trade balance (RTB). These exogenous variables are mostly common for all the sectors. The predetermined variables will be mentioned later. The paper also takes into account if any permanent shift has occurred in the LREs due to the economic reforms initiated in the year 1991. Towards this a trend variable TR91 and shift variable L91 are also considered for incorporation into the LREs of the models. Henceforth we adopt the notation as follows:

$D(X_t) = (X_t - X_{t-1})$ and $D^2(X_t) = D(D(X_t)) = (X_t - X_{t-1}) - (X_{t-1} - X_{t-2})$

AGDP/IGDP/SGDP: GDP of agriculture/industry/services sectors,

AGCF/IGCF/SGCF: Investment in agriculture/industry/services sectors,

APDFL/IPDFL/SPDFL: Price deflators of agriculture/industry/services sectors,

TGDP/TGCF/TPD: GDP/investment/price deflator over all the sectors put together.

The GDPs and GCFs are at constant prices (base year, 1993-94). First, all the variables were tested for their order of integration. These test results for all the endogenous and exogenous variables are given in Table 1. The APDFL of the agricultural sector, IGDP, IGCF and IPDFL of the industrial sector, and SGDP and SPDFL of the services sector are I(2). Actually different unit root tests indicated different orders of integration! More on this follows later. The AGDP and AGCF of the agricultural sector and the SGCF of the services are I(1). Since only I(1) variables can be endogenous variables in a VEC model, the first differences of the I(2) variables (APDFL, IGDP, IGCF, IPDFL, SPDFL and SGDP) are included in the co-integrating equation along with AGDP, AGCF, SGCF, L91 and TR91 in the respective models. Among the exogenous variables, RF, RBR and RBD are I(0); RTB and PCSS are I(1); and RM3 and WPF are I(2). The data that we have are only for the years 1953 to 2003 (see Appendix). Setting up a large VEC model (instead of the three sub-models) with long lag structures is not possible with this data. For this reason the problem has been split into estimating 3 separate VEC models: one for agriculture, one for industry and one for services instead of estimating one big model with all the variables together. In general, an optimal lag structure is to be obtained before a VEC is estimated. The number of cointegrating vectors (CIV) is in principle dependent on the lag structure of the model [see Banerjee *et al*. (1993)]. For a given lag structure to determine the optimal number of cointegrating vectors in each sub-model, Johansen's trace test (JTT) and Saikkonen-Luetkepohl (2000) tests (SLT) have been used with the help of J-Multi software. The JTT requires a break point to be specified (specified as 1991 in our case) if there exists a shift in the cointegrating vector. Briefly, the results are as follows:

TABLE 1. UNIT ROOT TESTS

		SP		KPSS		Saikkonen and Luetkepohl		
(1)	ADF (2)	Rho test (3)	Tau test (4)	Level stationarity (5)	Trend stationarity (6)	Impulse (7)	Shift (8)	Exponential (9)
AGDP	I(1)	I(1)	I(1)	I(1)	I(1)	I(2)	I(2)	I(2)
AGCF	I(1)	I(1)	I(1)	I(1)	I(0)	I(1)	I(1)	I(1)
APDFL	I(2)	I(2)	I(2)	I(2)	I(1)	I(2)	I(2)	I(2)
IGDP	I(1)	I(1)	I(1)	I(2) / (1)	I(2) / (1)	I(2)	I(2)	I(2)
IGCF	I(1)	I(1)	I(1)	I(1)	I(1)	I(2)	I(2)	I(2)
IPDFL	I(2)	I(1)	I(1)	I(2)	I(1)	I(2)	I(2)	I(2)
SGDP	I(2)	I(2)	I(2)	I(2)	I(2)	I(2)	I(3)	I(2)
SGCF	I(1)	I(1)	I(1)	I(1)	I(1)	I(2)	I(2)	I(2)
SPDFL	I(2)	I(2)	I(2)	I(2)	I(2)	I(3)	I(3)	I(2)
RI	I(0)	I(0)	I(0)	I(0)	I(0)	I(1)	I(1)	I(1)
WPF	I(2)	I(1)	I(1)	I(2)	I(2)	I(2)	I(2)	I(2)
RM3	I(2)	I(2)	I(2)	I(2)	I(2)	I(3)	I(3)	I(2)
RBD	I(0)	I(0)	I(0)	I(0)	I(0)	I(1)	I(1)	I(1)
RBR	I(0)	I(0)	I(0)	I(0)	I(0)	I(1)	I(1)	I(1)
RTB	I(1)	I(1)	I(1)	I(1)	I(0)	I(2)	I(1)	I(2)
PCSS	I(1)	I(1)	I(1)	I(1)	I(1)	I(2)	I(2)	I(1)

Note: ADF denotes the Augmented Dickey Fuller test, SP the Schimidt-Philips test, KPSS the Kwiatkowski-Philips Schimidt and Shin test. SP has two test statistics: Tau statistic and Rho statistic. KPSS tests are under two assumptions of stationarity: levels stationarity and trend stationarity.

(a) Agriculture: JTT indicated that there exists one CIV between AGDP, AGCF and D(APDFL) with lag structure of 3 for a levels' VAR (i.e., VEC would have 2 lags). But, the SLT indicated non-existence of cointegration between these variables. When the model was estimated specifying one cointegrating vector, the results turned out quite satisfactory in terms of unit root test, residual auto correlations and stability. So, the JTT result was conformed to. The test results of LR statistics are as follows:

Johansen's Trace Test

r0	LR	pval	90%	95%	99%
0	61.25	0.0080	51.46	54.50	60.49
1	29.49	0.1641	31.54	34.10	39.25
2	10.18	0.4182	15.64	17.84	22.47

Saikkonen-Luetkepohl Test

r0	LR	pval	90%	95%	99%
0	17.26	0.5993	26.07	28.52	33.50
1	6.95	0.6687	13.88	15.76	19.71
2	1.25	0.7256	5.47	6.79	9.73

Included lags (levels): 3 and Trend and intercept included.

(b) Industry: JTT indicated that there exist two CIVs between D(IGDP) D(IGCF) and D(IPDFL) with lag structure of 2 for a levels' VAR (i.e., VEC would have 1 lag). SLT indicated that there exists one CIV with a lag structure of 2. The model was estimated in both ways. The one with two CIVs miserably failed in satisfying the residual autocorrelations and stability test. Besides, the loading coefficients (otherwise known as adjustment parameters) mostly turned out insignificant. On all these fronts, the model with only one CIV performed quite satisfactorily. Thus, the SLT was conformed to. The test results of LR statistics are as follows:

Johansen's Trace Test

r0	LR	pval	90%	95%	99%
0	69.19	0.0000	39.73	42.77	48.87
1	27.87	0.0257	23.32	25.73	30.67
2	3.72	0.7785	10.68	12.45	16.22

Saikkonen-Luetkepohl Test

r0	LR	pval	90%	95%	99%
0	44.32	0.0002	26.07	28.52	33.50
1	11.20	0.2406	13.88	15.76	19.71
2	2.13	0.5094	5.47	6.79	9.73

Included lags (levels): 2 and Trend and intercept included.

(c) Services: Both the JTT and SLT indicated that there exists one CIV between D(SGDP), SGCF and D(SPDFL) with a lag structure of 3 for a levels' VAR (i.e., VEC would have 2 lags). The test results of LR statistics are as follows:

Johansen's Trace Test

r0	LR	pval	90%	95%	99%
0	73.80	0.0001	51.46	54.50	60.49
1	32.43	0.0792	31.54	34.10	39.25
2	7.31	0.6994	15.64	17.84	22.47

Saikkonen-Luetkepohl Test

r0	LR	pval	90%	95%	99%
0	37.78	0.0021	26.07	28.52	33.50
1	11.67	0.2081	13.88	15.76	19.71
2	7.39	0.0361	5.47	6.79	9.73

Included lags (levels): 3 and Trend and intercept included.

III

METHODOLOGY

The general form of the VEC model we considered is as follows:

$$C_0\Delta Y_t = \mathbf{a}\,[\,\mathbf{b}'\ \boldsymbol{\eta}'\,]\begin{bmatrix} Y_{t-1} \\ T_{t-1} \end{bmatrix} + c_1\Delta Y_{t-1} + \ldots + c_p\Delta Y_{t-p} + d_0 X_t + \ldots + d_q X_{t-q} + \delta Z_t + u_t$$

where Y_t is the vector of endogenous variables, C_0 is an identity matrix, **a** the vector of adjustment parameters, **b** the vector of cointegrating parameters, c_i are the short-run parameters of the lagged endogenous variables, d_i the short-run parameters of the exogenous and predetermined variables, T_t and Z_t are deterministic variables (and/or constant) with associated coefficients η and δ respectively. u_t is the vector of error terms.

As stated earlier, while building up the VEC models, we also account for the significant effects if any of the 1991 reforms on the LRE.[2] Towards this a level variable (L91) and two trend variables (TR81 and TR91) are defined as follows:

$L91_t$ = 0 for $1953 \le t \le 1990$, and
= 1 for $t \ge 1991$;
$TR81_t$ = 0 for $1953 \le t \le 1980$, and
= (t-1980) for $t \ge 1981$;
$TR91_t$ = 0 for $1953 \le t \le 1990$, and
= (t-1990) for $t \ge 1991$;

where t represents year (time). $L91_t$ $TR81_t$ and $TR91_t$ figure in either T_t or Z_t in a model but not in both.

Now the specifics. In the equations below, l stands for lag structure (I=0,1,2) and the summation Σ is over l. a1, a2 and a3 are the adjustment parameters, b_1, b_2, η_1 and η_2 are the parameters in the CIV. $c1_{il}$, $c2_{il}$ and $c3_{il}$, are the short-run parameters associated with the lagged endogenous variables, and $d1_{il}$, $d2_{il}$ and $d3_{il}$ are the short-run parameters associated with the exogenous and predetermined variables.

In the first, agriculture model, AGDP, AGCF, D(APDFL), L91 and TR91 are the variables appearing in the co-integrating vector. D^2(IGDP) and D^2(IPDFL)are the predetermined variables (estimated in the industry sub-model). The postulated VEC model with a lag structure of 2 periods is as follows:

$$\begin{aligned} D(AGDP_t) = {} & a1[AGDP_{t-1} - b_1 AGCF_{t-1} - b_2 D(APDFL_{t-1}) - \eta_1 L91_{t-1} - \eta_2 TR91_{t-1}] \\ & + \Sigma\, c1_{1l}.D(AGDP)_{t-l} + \Sigma\, c1_{2l}.D(AGCF)_{t-l} + \Sigma\, c1_{3l}.D^2(APDFL)_{t-l} \\ & + d1_1.RI_t + d1_2.D(RTB)_t + \Sigma\, d1_{3l}.RBD_{t-l} + \Sigma\, d1_{4l}.D^2(WPF)_{t-l} \\ & + \Sigma\, d1_{5l}.D^2(IGDP)_{t-l} + \Sigma\, d1_{6l}.D^2(PDFL)_{t-l} + constant + u_{1t} \qquad ....(1) \end{aligned}$$

$$\begin{aligned} D(AGCF_t) = {} & a2[AGDP_{t-1} - b_1 AGCF_{t-1} - b_2 D(APDFL_{t-1}) - \eta_1 L91_{t-1} - \eta_2 TR91_{t-1}] \\ & + \Sigma\, c2_{1l}.D(AGDP)_{t-l} + \Sigma\, c2_{2l}.D(AGCF)_{t-l} + \Sigma\, c2_{3l}.D^2(APDFL)_{t-l} \\ & + d2_1.RI_t + d2_2.D(RTB)_t + \Sigma\, d2_{3l}.RBD_{t-l} + \Sigma\, d2_{4l}.D^2(WPF)_{t-l} \\ & + \Sigma\, d2_{5l}.D^2(IGDP)_{t-l} + \Sigma\, d2_{6l}.D^2(IPDFL)_{t-l} + constant + u_{2t} \qquad ....(2) \end{aligned}$$

$$
\begin{aligned}
D^2(APDFL_t) = {} & a3[AGDP_{t-1} - b_1AGCF_{t-1} - b_2D(APDFL_{t-1}) - \eta_1 L91_{t-1} - \eta_2TR91_{t-1}] \\
& + \Sigma\, c3_{1l}.D(AGDP)_{t-l} + \Sigma\, c3_{2l}.D(AGCF)_{t-l} + \Sigma\, c3_{3l}.D^2(APDFL)_{t-l} \\
& + d3_1.RI_t + d3_2.D(RTB)_t + \Sigma\, d3_{3l}.RBD_{t-l} + \Sigma\, d3_{4l}.D^2(WPF)_{t-l} \\
& + \Sigma\, d3_{5l}.D^2(IGDP)_{t-l} + \Sigma\, d3_{6l}.D^2(IPDFL)_{t-l} + constant + u_{3t} \qquad \text{....(3)}
\end{aligned}
$$

In the second, industry model, D(IGDP), D(IGCF), D(IPDFL) and TR91 are the variables appearing in the co-integrating vector. D(AGDP), D^2(APDFL) and D(AGCF) are the predetermined variables (estimated in the agriculture sub-model). The postulated VEC model with a lag structure of one period is as follows:

$$
\begin{aligned}
D^2(IGDP_t) = {} & a1[D(IGDP_{t-1}) - b_1\, D(IGCF_{t-1}) - b_2D(IPDFL_{t-1}) - \eta_1\, TR91_{t-1}] \\
& + \Sigma\, c1_{1l}.D^2(IGDP)_{t-l} + \Sigma\, c1_{2l}.D^2(IGCF)_{t-l} + \Sigma\, c1_{3l}.D^2(IPDFL)_{t-l} \\
& + \Sigma\, d1_{1l}.D^2(RM3)_{t-l} + \Sigma\, d1_{2l}.RBD_{t-l} + \Sigma\, d1_{3l}.RBR_{t-l} + d1_4.D(RTB_t) \\
& + \Sigma\, d1_{5l}.D^2(APDFL)_{t-l} + d1_6.D(PCSS)_t + \Sigma\, d1_{7l}.D^2(WPF)_{t-l} \\
& + \Sigma\, d1_{8l}.D(AGCF)_{t-l} + d1_9.D(AGDP)_t + \delta 1_1.L91_{t-1} + u_{1t} \qquad \text{....(4)}
\end{aligned}
$$

$$
\begin{aligned}
D^2(IGCF_t) = {} & a2[D(IGDP_{t-1}) - b_1\, D(IGCF_{t-1}) - b_2D(IPDFL_{t-1}) - \eta_1\, TR91_{t-1}] \\
& + \Sigma\, c2_{1l}.D^2(IGDP)_{t-l} + \Sigma\, c2_{2l}.D^2(IGCF)_{t-l} + \Sigma\, c2_{3l}.D^2(IPDFL)_{t-l} \\
& + \Sigma\, d2_{1l}.D^2(RM3)_{t-l} + \Sigma\, d2_{2l}.RBD_{t-l} + \Sigma\, d2_{3l}.RBR_{t-l} + d2_4.D(RTB_t) \\
& + \Sigma\, d2_{5l}.D^2(APDFL)_{t-l} + d2_6.D(PCSS)_t + \Sigma\, d2_{7l}.D^2(WPF)_{t-l} \\
& + \Sigma\, d2_{8l}.D(AGCF)_{t-l} + d2_9.D(AGDP)_t + \delta 2_1.L91_{t-1} + u_{2t} \qquad \text{....(5)}
\end{aligned}
$$

$$
\begin{aligned}
D^2(IPDFL_t) = {} & a3[D(IGDP_{t-1}) - b_1\, D(IGCF_{t-1}) - b_2D(IPDFL_{t-1}) - \eta_1\, TR91_{t-1}] \\
& + \Sigma\, c3_{1l}.D^2(IGDP)_{t-l} + \Sigma\, c3_{2l}.D^2(IGCF)_{t-l} + \Sigma\, c3_{3l}.D^2(IPDFL)_{t-l} \\
& + \Sigma\, d3_{1l}.D^2(RM3)_{t-l} + \Sigma\, d3_{2l}.RBD_{t-l} + \Sigma\, d3_{3l}.RBR_{t-l} + d3_4.D(RTB_t) \\
& + \Sigma\, d3_{5l}.D^2(APDFL)_{t-l} + d3_6.D(PCSS)_t + \Sigma\, d3_{7l}.D^2(WPF)_{t-l} \\
& + \Sigma\, d3_{8l}.D(AGCF)_{t-l} + d3_9.D(AGDP)_t + \delta 3_1.L91_{t-1} + u_{3t} \qquad \text{....(6)}
\end{aligned}
$$

In the third, services model, D(SGDP), SGCF and D(SPDFL) are the variables appearing in the co-integrating vector. D^2(NSGDP), D(AGCF), D^2(IGCF), D^2(APDFL) and D^2(IPDFL) are the predetermined variables (estimated in the sub-models of the industry and agriculture sectors). The postulated VEC model with a lag structure of two periods is as follows:

$$
\begin{aligned}
D^2(SGDP_t) = {} & a1[D(SGDP_{t-1}) - b_1SGCFt_{-t-1} - b_2D(SPDFL_{t-1})] \\
& + \Sigma\, c1_{1l}.D^2(SGDP)_{t-l} + \Sigma\, c1_{2l}.D(SGCF)_{t-l} + \Sigma\, c1_{3l}.D^2(SPDFL)_{t-l} \\
& + d1_1.RBD_t + d1_2.D(RTB_t) + \Sigma\, d1_{3l}.D^2(WPF)_{t-l} + d1_4.D^2(IPDFL)_t \\
& + \Sigma d1_{5l}.D(AGCF)_{t-l} + \Sigma d1_{6l}.D^2(APDFL)_{t-l} + d1_7.D^2(IGCF)_t + \\
& d1_8.D^2(NSGDP)_t + \Sigma d1_{9l}D^2(RM3)_{t-l} + \delta 1_1.TR81_t + constant + u_{1t} \qquad \text{....(7)}
\end{aligned}
$$

$$
\begin{aligned}
D(SGCF_t) = {} & a2[D(SGDP_{t-1}) - b_1SGCFt_{-t-1} - b_2D(SPDFL_{t-1})] \\
& + \Sigma\, c2_{1l}.D^2(SGDP)_{t-l} + \Sigma\, c2_{2l}.D(SGCF)_{t-l} + \Sigma\, c2_{3l}.D^2(SPDFL)_{t-l} \\
& + d2_1.RBD_t + d2_2.D(RTB_t) + \Sigma\, d2_{3l}.D^2(WPF)_{t-l} + d2_4.D^2(IPDFL)_t
\end{aligned}
$$

$$+ \Sigma\, d2_{5l}.D(AGCF)_{t-l}$$
$$+ \Sigma d2_{6l}.D^2(APDFL)_{t-l} + d2_7.D^2(IGCF)_t + d2_8.D2(NSGDP)_t$$
$$+ \Sigma d2_{9l}D^2(RM3)_{t-l}$$
$$+ \delta 2_1.TR81_t + \text{constant} + u_{2t} \qquad ....(8)$$

$$D^2(SPDFL_t) = a3[D(SGDP_{t-1}) - b_1SGCFt_{t-1} - b_2D(SPDFL_{t-1})]$$
$$+ \Sigma\, c3_{1l}.D^2(SGDP)_{t-l} + \Sigma\, c3_{2l}.D(SGCF)_{t-l} + \Sigma\, c3_{3l}.D^2(SPDFL)_{t-l}$$
$$+ d3_1.RBD_t+d3_2.D(RTB_t)+\Sigma\, d3_{3l}.D^2(WPF)_{t-l} +d3_4.D^2(IPDFL)_t$$
$$+ \Sigma\, d3_{5l}.D(AGCF)_{t-l} + \Sigma d3_{6l}.D^2(APDFL)_{t-l} + d3_7.D^2(IGCF)_t +$$
$$d3_8.D2(NSGDP)_t +$$
$$\Sigma d3_{9l}D^2(RM3)_{t-l} + \delta 3_1.TR81_t + \text{constant} + u_{3t} \qquad ....(9)$$

where $NSGDP_t = AGDP_t + IGDP_t$ = Non-services GDP is I(2).

The results of the estimations, using the J-Multi software, are presented in Table 2(A), 2(B) and 2(C). For the lags and the number of cointegrating rank, the stability of the estimated models has been checked and the residual auto-correlations checked. Table 3 reports these results. Since the stability conditions are met and residuals are free from auto-correlations, the estimated models are considered to be satisfactory and reliable for forecasting purposes.

Long-Run Relations

Before proceeding further, one issue may crop up. Pesaran and Smith (1998) discuss models where endogenous variables are cointegrated within themselves and are also jointly cointegrated with exogenous variables. However their methodology involves both theoretic conceptual and empirical complications. In most of the empirical applications of the VEC models, all exogenous variables, if any, appear only in the VAR part of the equations, and cointegrated relations of the exogenous variables with the endogenous variables are not considered. The same is adopted in this paper also. In our view this is not a serious shortcoming for the reason that the levels VAR in the case of Pesaran and Smith (1998) and in the case where the exogenous variables appear only in the VAR part of the VEC model would be the same except for a difference in the parameter restrictions implied.

The estimated LREs, where all the coefficients are significant for the three sectors are as follows:

Agriculture

$$AGDP_t = 3.5491*AGCF_t+1311004.3221*D(APDFL_t)-57159.176*L91_t$$
$$+ 9680.4531*TR91_t \qquad ....(10)$$

Industry

$$D(IGDP_t) = 0.5956*D(IGCF_t) + 158528.1993*D(IPDFL_t) + 2162.6334*TR91_t \qquad ....(11)$$

TABLE 2(A): AGRICULTURE: VEC MODEL ESTIMATION RESULTS

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
CIV_t	$AGDP_t$	$AGCF_t$	$D(APDFL_t)$	$L91_t$	$TR91_t$				
Coef	1.00	-3.5491	-1311004.3222	57159.176	-9680.4531				
t-statistics		-2.867	-4.557	2.414	-4.321				
$D(AGDP_t)$	$D(AGDP_{t-1})$	$D(AGDP_{t-2})$	$D(AGCF_{t-1})$	$D(AGCF_{t-2})$	$D^2(APDFL_{t-1})$	$D^2(APDFL_{t-2})$	CONST	CIV_{t-1}	RI_t
Coef	-0.26974132	-0.04231349	-1.85499217	1.8625565	-60958.035	-76240.6	-26239.3	-0.14037	421.246
t-statistics	-2.78	-0.443	-3.187	2.679	-1.397	-1.783	-3.781	-4.168	6.752
	$D^2(IGDP_{t-1})$	$D^2(IGDP_{t-2})$	$D^2(IPDFL_{t-1})$	$D^2(IPDFL_{t-1})$	$D^2(WPFL_{t-1})$	RBD_t	RBD_{t-1}	$D(RTB_t)$	
Coef	0.58282365	0.3232543	280431.0309	-81021.43	-296.17412	0.08193	0.213159	1.331705	
t-statistics	3.225	1.59	4.147	-1.223	-1.95	0.808	2.256	5.164	
$D(AGCF_t)$	$D(AGDP_{t-1})$	$D(AGDP_{t-2})$	$D(AGCF_{t-1})$	$D(AGCF_{t-2})$	$D^2(APDFL_{t-1})$	$D^2(APDFL_{t-2})$	CONST	CIV_{t-1}	RI_t
Coef	0.02693317	0.02492052	-0.43453958	0.1316199	6013.5384	23983.6	-1648.53	0.016809	10.58341
t-statistics	1.287	1.211	-3.461	0.878	0.639	2.6	-1.101	2.314	0.787
	$D^2(IGDP_{t-1})$	$D^2(IGDP_{t-2})$	$D^2(IPDFL_{t-1})$	$D^2(IPDFL_{t-1})$	$D^2(WPFL_{t-1})$	RBD_t	RBD_{t-1}	$D(RTB_t)$	
Coef	0.02268927	0.04576112	-43767.81284	-19539.53	-56.598567	-0.04606	-0.02197	-0.06392	
t-statistics	0.582	1.044	-3.001	-1.367	-1.728	-2.106	-1.078	-1.149	
$D^2(APDFL_t)$	$D(AGDP_{t-1})$	$D(AGDP_{t-2})$	$D(AGCF_{t-1})$	$D(AGCF_{t-2})$	$D^2(APDFL_{t-1})$	$D^2(APDFL_{t-2})$	CONST	CIV_{t-1}	RI_t
Coef	-8.90E-07	-1.38E-06	8.41E-06	-2.57E-06	-0.1091633	-0.17323	-0.03616	6.85E-07	-2.38E-04
t-statistics	-3.966	-6.228	6.228	-1.595	-1.079	-1.746	-2.246	8.767	-1.647
	$D^2(IGDP_{t-1})$	$D^2(IGDP_{t-2})$	$D^2(IPDFL_{t-1})$	$D^2(IPDFL_{t-1})$	$D^2(WPFL_{t-1})$	RBD_t	RBD_{t-1}	$D(RTB_t)$	
Coef	8.90E-07	7.70E-07	-6.11E-02	1.13E-01	0.0006919	5.42E-07	1.54E-06	-2.04E-06	
t-statistics	2.124	1.625	-0.39	0.732	1.964	2.307	7.023	-3.411	

No. of observations: 43; Degrees of freedom: 13; CIV=Cointegration Vector.

TABLE 2(B): INDUSTRY: VEC MODEL ESTIMATION RESULTS

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
CIV_t	$D(IGDP_t)$	$D(IGCF_t)$	$D(IPDFL_t)$	$TR91_t$			
Coef	1.00	-0.5956	-158528.1993	-2162.633447			
t-statistics		-8.726	-5.951	-7.003			
$D^2(IGDP_t)$	$D^2(IGDP_{t-1})$	$D^2(IGCF_{t-1})$	$D^2(IPDFL_{t-1})$	CIV_{t-1}	$L91_{t-1}$	$D^2(RM3_{t-1})$	RBD_{t-1}
Coef	-0.3430932	-0.014196	-51299.77487	-0.261792858	-5728.898751	0.2852772	-0.10015064
t-statistics	-2.414	-0.369	-1.069	-2.423	-2.402	4.58	-1.704
	RBR_{t-1}	$D(RTB_t)$	$D^2(APDFL_{t-1})$	$D(PCSS_t)$	$D^2(WPF_{t-1})$	$D(AGCF_{t-2})$	$D(AGDP_t)$
Coef	-243.49416	0.5616163	52607.38356	0.62623751	-284.2283159	1.04871465	0.169884
t-statistics	-1.52	3.051	1.722	3.349	-2.849	2.174	2.831
$D^2(IGCF_t)$	$D^2(IGDP_{t-1})$	$D^2(IGCF_{t-1})$	$D^2(IPDFL_{t-1})$	CIV_{t-1}	$L91_{t-1}$	$D^2(RM3_{t-1})$	RBD_{t-1}
Coef	-0.6806526	0.1675701	-158523.0322	2.033228807	30295.53555	0.4766692	0.35183588
t-statistics	-1.447	1.317	-0.998	5.684	3.837	2.31	-1.808
	RBR_{t-1}	$D(RTB_t)$	$D^2(APDFL_{t-1})$	$D(PCSS_t)$	$D^2(WPF_{t-1})$	$D(AGCF_{t-2})$	$D(AGDP_t)$
Coef	-1448.5718	-1.020974	38735.27567	2.35473474	-4.01293268	-0.4080111	0.20106673
t-statistics	-2.731	-1.675	0.383	3.804	-0.012	-0.255	1.012
$D^2(IPDFL_t)$	$D^2(IGDP_{t-1})$	$D^2(IGCF_{t-1})$	$D^2(IPDFL_{t-1})$	CIV_{t-1}	$L91_{t-1}$	$D^2(RM3_{t-1})$	RBD_{t-1}
Coef	-1.17E-06	5.20E-07	-0.54135675	9.57E-07	7.64E-03	3.76E-07	4.93E-07
t-statistics	-2.662	4.345	-3.643	2.862	1.034	1.951	2.711
	RBR_{t-1}	$D(RTB_t)$	$D^2(APDFL_{t-1})$	$D(PCSS_t)$	$D^2(WPF_{t-1})$	$D(AGCF_{t-2})$	$D(AGDP_t)$
Coef	-0.0003039	1.61E-07	0.2657765	8.28E-07	0.00060643	-7.00E-07	-1.33E-07
t-statistics	-0.613	0.282	2.811	1.431	1.964	-0.469	-0.718

No. of observations: 45; Degrees of freedom: 15; CIV=Cointegration Vector.

TABLE 2(C): SERVICES: VEC MODEL ESTIMATION RESULTS

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
CIV_t	$D(SGDP_t)$	$SGCF_t$	$D(SPDFL_t)$							
Coef	1.00	-0.51882	154343.4241							
t-statistics		-5.016	2.845							
$D^2(SGDP_t)$	$D^2(SGDP_{t-1})$	$D^2(SGDP_{t-2})$	$D(SGCF_{t-1})$	$D(SGCF_{t-2})$	$D^2(SPDFL_{t-1})$	$D^2(SPDFL_{t-2})$	CONST	CIV_{t-1}	$TR81_t$	$D^2(NSGDP_t)$
Coef	0.05225296	0.3295687	-0.12052572	-0.473420501	63180.74136	14443.62662	-4910.134469	-0.802637471	284.572596	-0.02391331
t-statistics	0.366	2.523	-1.314	-4.501	1.343	0.354	-5.257	-5.251	3.684	-1.078
	$D(AGCF_{t-1})$	$D^2(APDFL_{t-1})$	$D^2(IGCF_t)$	$D^2(IPDFL_t)$	$D^2(WPF_{t-1})$	$D^2(RM3_t)$	$D^2(RM3_{t-1})$	RBD_t	$D(RTB_t)$	
Coef	-0.234673563	-31025.80174	0.050830603	-86076.20182	-171.3222399	0.094095321	0.001548785	0.08328546	-0.4298084	
t-statistics	-0.809	-1.146	2.73	-2.18	-2.395	2.173	0.028	1.352	-4.53	
$D(SGCF_t)$	$D^2(SGDP_{t-1})$	$D^2(SGDP_{t-2})$	$D(SGCF_{t-1})$	$D(SGCF_{t-2})$	$D^2(SPDFL_{t-1})$	$D^2(SPDFL_{t-2})$	CONST	CIV_{t-1}	$TR81_t$	$D^2(NSGDP_t)$
Coef	-0.426186299	0.4565412	0.46369006	0.225080388	102796.7526	-39373.44324	4288.573112	0.628964159	-158.69164	0.134623121
t-statistics	-1.775	2.078	3.007	1.273	1.3	-0.573	2.731	2.447	-1.222	3.611
	$D(AGCF_{t-1})$	$D^2(APDFL_{t-1})$	$D^2(IGCF_t)$	$D^2(IPDFL_t)$	$D^2(WPF_{t-1})$	$D^2(RM3_t)$	$D^2(RM3_{t-1})$	RBD_t	$D(RTB_t)$	
Coef	-0.526267885	-107091.7177	0.146773953	213925.2649	-310.224552	0.283396743	0.039597944	0.01716262	-0.0875419	
t-statistics	-1.079	-2.353	4.688	3.223	-2.58	3.892	0.426	0.166	-0.549	
$D^2(SPDFL_t)$	$D^2(SGDP_{t-1})$	$D^2(SGDP_{t-2})$	$D(SGCF_{t-1})$	$D(SGCF_{t-2})$	$D^2(SPDFL_{t-1})$	$D^2(SPDFL_{t-2})$	CONST	CIV_{t-1}	$TR81_t$	$D^2(NSGDP_t)$
Coef	2.62E-06	1.12E-06	-1.20E-06	-1.18E-06	-0.16014168	-0.328939414	-0.005321636	-1.64E-06	0.00097932	1.31E-07
t-statistics	6.273	2.931	-4.457	-3.841	-1.164	-2.754	-1.949	-3.674	4.336	2.02
	$D(AGCF_{t-1})$	$D^2(APDFL_{t-1})$	$D^2(IGCF_t)$	$D^2(IPDFL_t)$	$D^2(WPF_{t-1})$	$D^2(RM3_t)$	$D^2(RM3_{t-1})$	RBD_t	$D(RTB_t)$	
Coef	-1.58E-06	-0.122544478	-6.60E-09	0.346059968	0.000967244	-1.07E-06	-7.15E-07	-3.57E-07	-7.96E-08	
t-statistics	-1.861	-1.549	-0.121	2.998	4.625	-8.463	-4.421	-1.979	-0.287	

No. of observations included: 45; Degrees of freedom: 15; CIV=Cointegration Vector.

TABLE 3. RESIDUAL AUTOCORRELATIONS AND VEC STABILITY

(1)	(2)	(3)	(4)	(5)
AGRICULTURE:	LM-Statistic	p-value	DF	Lags
	11.3804	0.2505	9	1
Roots of reverse characteristic polynomial : 1.0000, 1.1529, 1.1529, 1.3337, 1.3337, 1.6396, 1.6396, 2.4539, 1.0000				
INDUSTRY:	LM-Statistic	p-value	DF	Lags
	14.6302	0.1016	9	1
Roots of reverse characteristic polynomial : 1.6261, 1.6261, 2.3666, 11.7608, 1.0000, 1.0000				
SERVICES:	LM-Statistic	p-value	DF	lags
	9.0168	0.4357	9	1
Roots of reverse characteristic polynomial : 1.2509, 1.2509, 1.0692, 1.0692, 1.8211, 1.8211, 1.0000, 1.6627, 1.0000				

The LM-statistic is the Breush-Godfrey LM statistic to test for autocorrelation for a specified lag order (lags) and degrees of freedom (df).

Services

$$D(SGDP_t) = 0.51882*SGCF_t - 154343.4241*D(SPDFL_t) \qquad ….(12)$$

Table 4 presents the unit root tests of the residuals of the above LREs. The tests show that the residual vectors are all I(0). Thus, the equations (10), (11) and (12) indicate that the AGDP, AGCF and D(APDFL) are co-integrated in the agriculture; D(IGDP), D(IGCF) and D(IPDFL) in industry; and in the services sector D(SGDP), SGCF and D(SPDFL) are cointegrated. In agriculture and industry the respective GDPs have positive responses to prices and investments in the long-run. In the case of services, SGDP has positive relation to the rising SGCF but negative relation with prices. Within the cointegrating relations, the TR91 variable is significant both for agriculture and industry, but not for services. The L91 variable turned out significant only in agriculture

TABLE 4. STATIONARITY TEST FOR THE CIVS

	ADF	SP		KPSS	
		Rho-test	Tau-test	Level stationarity	Trend stationarity
(1)	(2)	(3)	(4)	(5)	(6)
AGCIV	I(0)	I(0)	I(0)	I(0)	I(0)
INCIV	I(0)	I(0)	I(0)	I(0)	I(0)
SERCIV	I(0)	I(0)	I(0)	I(0)	I(0)

AGCIV = AGDP - 3.5491*AGCF -1311004.322*D(APDFL) + 57159.17*L91 - 9680.45*TR91
INCIV = D(IGDP) -0.5956*D(IGCF) - 158528.1993*D(IPDFL) - 2162.6334*TR91
SRCIV = D(SGDP) - 0.51882*SGCF +154343.4241*D(SPDFL)

Note: ADF denotes the Augmented Dickey Fuller test, SP the Schimidt-Philips test, KPSS the Kwiatkowski Philips Schimidt and Shin test.
SP has two test statistics: Tau statistic and Rho statistic, while KPSS tests under two assumptions of stationarity: levels stationarity and trend stationarity.

(with a negative sign). The results imply that the reform effects on agricultural GDP were negative in the beginning and only later on turned out positive (57159.18/9680.45=5.90, i.e., 6 years approximately; thus positive from 1996-97 onwards. In agriculture and industry the significance of the TR91 variable indicates that the 1991 reforms caused a trend shift in the corresponding cointegrating relations. The L91 variable though turned out insignificant (hence dropped) in the industry's cointegrating relation, it is significant however with a lag (i.e., $L91_{t-1}$) in the VAR part of the industry model showing short-run negative effect on IGDP and positive effect on IGCF and insignificant effect on IPDFL. Neither TR91 nor L91 variable turned out significant within the cointegrating relation of the services sector. Services sector is however known to have been doing quite well because some of the reforms that the sector needed were initiated during the 1980s itself (TR81 variable in the VAR part shows positive significant effects on the SGDP and SPDFL). The 1991-reforms did not lead to any significant effect on the basic long-run relation that prevails between the GDP, investment and prices within the services sector.

It is possible to give the economic interpretation to the long-run cointegrated relations. However, this depends on which variable is normalised. For example consider the LREs of the agricultural and industrial sectors.

$$AGDP_t = 3.5491*AGCF_t + 1311004.3221*D(APDFL_t) - 57159.176*L91_t + 9680.4531*TR91_t \quad \text{….(13)}$$

$$D(IGDP_t)=0.5956*D(IGCF_t)+158528.1993*D(IPDFL_t)+2162.6334*TR91_t \quad \text{....(14)}$$

As the investments and/or prices go up the GDPs go up. Thus it could be treated as an aggregate supply response of the agricultural and industrial GDPs to the corresponding prices and investment. Now consider the services sector's LRE.

$$D(SGDP_t) = 0.51882*SGCF_t - 154343.4241*D(SPDFL_t) \quad \text{….(15)}$$

Here the SGDP is negatively related to the services prices and positively to the investment. Could this be supply or demand equation? For example, when this equation is normalised with respect to prices and the model is re-estimated, the following LRE is obtained:

$$D(SPDFL_t) = 0.00000336*SGCF_t - 0.00000648*D(SGDP_t) \quad \text{….(16)}$$

The parameter estimates of all the other variables (except for the adjustment parameter) are the same as with the former GDP-normalised model (i.e. equations 7 to 9) model. But now equation (16) can be interpreted as, prices would fall with increasing GDP. While modeling for forecasting purpose, how to treat different sectors – supply determined or demand determined? This is not an issue in computable general equilibrium models where both supplies and demands have to be modeled. However in macroeconometric models this may become an issue (see, Bhattacharya and Kar, 2004). In a way, VEC models can endogenise the issue and provide answers as the LREs presented above.

Error Corrections and Adjustments

The signs and p-values of the adjustment parameters (a1, a2 and a3) in the equations (1 to 9) of the three sectors are as follows [see Tables 2(A), 2(B) and 2(C)]:

	D(AGDP)	D(AGCF)	D^2(APDFL)
Agriculture:	- ve & Significant(0.00)	+ve & Significant(0.021)	+ve & Significant(0.00)
	D^2(IGDP)	D^2(IGCF)	D^2(IPDFL)
Industry:	-ve & Significant(0.015)	+ve & Significant(0.00)	+ve & Significant(0.004)
	D^2(SGDP)	D(SGCF)	D^2(SPDFL)
Services:	-ve & Significant(0.00)	+ve & Significant(0.014)	-ve & Significant(0.00)

This constitutes an important result. The error correction mechanisms work as follows. The GDPs, investments and prices together react to any deviations from the long-run equilibrium path and adjust themselves to return to the equilibrium path. In the case of services, for example, when either the SGDP and/or SPDFL rise too high relative to the SGCF the disturbed long-run equilibrium path gets restored by a fall in the D^2(SGDP) and/or D^2(SPDFL) and a rise in the D(SGCF). Note that the adjustment parameters are all significant, and negative for D^2(SGDP) and D^2(SPDFL) but positive for D(SGCF). In the case of agriculture, any positive deviations from the equilibrium path cause the D(AGDP) to fall and the D(AGCF) and D^2(APDFL) to rise. All the adjustment parameters are significant, and negative for the D(AGDP) and positive for the D(AGCF) and D^2(APDFL). The situation is exactly similar in the case of industry also. Recall, earlier we stated that actually different unit root tests indicated different orders of integration. So when the industry model was estimated treating IGDP and IGCF as I(1) not only the signs of the cointegrating parameters were wrong, but also some of the adjustment coefficients turned out insignificant. Under the circumstances, one way out could have been the Bounds Testing Approach suggested by Pesaran *et al*. (2001) which tests for existence of level relationships between the variables when the orders of integration are not known whether they are I(0) or I(1). Here in our case they are certainly not I(0). The uncertainty is, are they I(1) or I(2)? Only when they were treated as I(2) as in equations 4, 5 and 6, the results turned out satisfactory and also the signs of all the adjustment parameters turned out sensible. This demonstrates that misidentification of the order of integration could lead to wrong signs of the adjustment parameters.

In this regard, in VEC models two more possibilities of misspecification exist. One: the variables treated as endogenous may not really all be endogenous. Econometric theory offers some tests for weak, strong and super exogeneity etc. See Ericsson (1992), Ericsson, Hendry and Mizon (1998). Generally, whenever an adjustment parameter turns out insignificant, the corresponding endogenous variable is considered to be weakly exogenous. However, before drawing such conclusions, it is better to recheck whether the orders of integration of the variables are correctly identified or not. If they are not, estimates of the adjustment parameters may misbehave leading to wrong conclusions about the endogeneity. In our models all the adjustment parameters are not only significant but also are of the expected sign. Two: the variables treated as exogenous may not really all be exogenous, some of them could actually be endogenous. We discuss this possibility later.

Short-run Responses to the Exogenous and Pre-determined Variables: Some important exogenous variables have already been mentioned earlier. In addition, some more variables have been considered to account for inter-sectoral influences. These variables appearing as predetermined variables in one model are endogenous in another model. For example, IGDP and IPDFL from the industry are quite important for agriculture. Thus, they are the additional predetermined variables in the agriculture sub-model but endogenous in the industry model. Similarly non-services GDP (AGDP+IGDP) is predetermined in the services model, while AGDP and IGDP are endogenous in the agriculture and industry models. The basic results of the sectoral VEC models are as follows.

Agriculture: The estimation results are given in Table 2(A). This model has rainfall (RI), industrial GDP (IGDP), industrial prices (IPDFL), fuel prices (WPF), real budget deficit (RBD - nominal budget deficit/price deflator) and real trade balance (RTB – nominal trade balance/price deflator; this indicates net exports, thus mostly negative) as the predetermined/exogenous variables. The IGDP and IPDFL account for the influence of the industry sector on the agriculture. These two are endogenous variables in the industry model, but are predetermined here. AGDP is positively influenced by rainfall, IGDP, IPDFL, RBD and RTB. It is negatively influenced by fuel prices. Apart from its own past lags, the fuel prices, IPDFL and RBD have negative significant influence on AGCF. Agricultural prices alone positively influence the AGCF. APDFL is positively influenced by investment (AGCF), industrial output (IGDP), RBD, and fuel prices (WPF) and negatively by agricultural GDP (AGDP), rainfall and trade balance (RTB). The following table summarises the signs of the explanatory variables in each of the equations.

	AGRICULTURE		
	D(AGDP)	D(AGCF)	D^2(APDFL)
D($AGDP_{t-1}$)	-	+	-
D($AGDP_{t-2}$)	-	+	-
D($AGCF_{t-1}$)	-	-	+
D($AGCF_{t-2}$)	+	+	-
D^2($APDFL_{t-1}$)	-	+	-
D^2($APDFL_{t-2}$)	-	+	-
Constant	-	-	-
CIV_{t-1}	-	+	+
RI_t	+	+	-
D^2($IGDP_{t-1}$)	+	+	+
D^2($IGDP_{t-2}$)	+	+	+
D^2($IPDFL_{t-1}$)	+	-	-
D^2($IPDFL_{t-2}$)	-	-	+
D^2($WPFL_{t-1}$)	-	-	+
RBD_t	+	-	+
RBD_{t-1}	+	-	+
D(RTB_t)	+	-	-

Industry: The estimation results are given in Table 2(B). This model has fuel prices (WPF), real money supply (RM3 – nominal money supply/price deflator), agricultural GDP, investment and prices (AGDP, AGCF and APDFL), real bank rate (RBR– nominal bank rate minus percentage rise in the GDP price deflator), real budget deficit (RBD - nominal budget deficit/price deflator), real trade balance (RTB) and private corporate savings (PCSS) as the predetermined/exogenous variables. AGCF AGDP and APDFL, which are endogenous in the agriculture model, are predetermined variables here. IGDP is positively influenced by money supply (RM3), corporate savings (PCSS), trade balance (RTB), AGDP, AGCF and APDFL. The fuel price (WPF) and RBD have negative relation with the IGDP. IGCF is positively related to the RM3 and PCSS, negatively with RBD, RBR, and RTB. Industrial prices (IPDFL) are positively related to RM3, RBD, APDFL and WPF. The following table summarises the signs of the explanatory variables in each of the equations.

		INDUSTRY	
	D^2(IGDP)	D^2(IGCF)	D^2(IPDFL)
$D^2(IGDP_{t-1})$	–	–	–
$D^2(IGCF_{t-1})$	–	+	+
$D^2(IPDFL_{t-1})$	–	–	–
CIV_{t-1}	–	+	+
$L91_{t-1}$	–	+	+
$D^2(RM3_{t-1})$	+	+	+
RBD_{t-1}	–	–	+
RBR_{t-1}	–	–	–
$D(RTB_t)$	+	–	+
$D^2(APDFL_{t-1})$	+	+	+
$D(PCSS_t)$	+	+	+
$D^2(WPF_{t-1})$	–	–	+
$D(AGCF_{t-2})$	+	–	–
$D(AGDP_t)$	+	+	–

Services: The estimation results are in Table 2(C). This model has non-services GDP (NONSGDP=AGDP+IGDP), investments and prices of agriculture and industry (AGCF, IGCF, APDFL, and IPDFL), fuel prices (WPF), real money supply (RM3), real budget deficit (RBD) and real trade balance (RTB) as the predetermined/ exogenous variables. The AGDP and IGDP are endogenous in the agriculture and industry models, but their sum is a predetermined variable here. IGCF and RM3 have positive influence on SGDP. Negative influences are by IPDFL, fuel price (WPF) and trade balance (RTB). Positive influences on SGCF are by non-services' GDP, IGCF, IPDFL, and RM3; and negative influences are by WPF and APDFL. Positive influences on services' prices (SPDFL) are by NSGDP, WPF and IPDFL; and negative influences are by RBD, AGCF and RM3. The following table summarises the signs of the explanatory variables in each of the equations.

		SERVICES	
	D^2(SGDP)	D(SGCF)	D^2(SPDFL)
$D^2(SGDP_{t-1})$	+	–	+
$D^2(SGDP_{t-2})$	+	+	+
$D(SGCF_{t-1})$	–	+	–
$D(SGCF_{t-2})$	–	+	–
$D^2(SPDFL_{t-1})$	+	+	–
$D^2(SPDFL_{t-2})$	+	–	–

Constant	–	+	–
CIV_{t-1}	–	+	–
$TR81_t$	+	–	+
$D^2(NONSGDP_t)$	–	+	+
$D(AGCF_{t-1})$	–	–	–
$D(APDFL_{t-1})$	–	–	–
$D^2(IGCF_t)$	+	+	–
$D^2(IPDFL_t)$	–	+	+
$D^2(WPF_{t-1})$	–	–	+
$D^2(RM3_t)$	+	+	–
$D^2(RM3_{t-1})$	+	+	–
RBD_t	+	+	–
$D(RTB_t)$	–	–	–

Diagnostics: We believe that most of the estimated coefficients in the above models are as they ought to be. With respect to short-run responses to the exogenous variables, in general one may not be able to expect the signs of the coefficients one way, or the other. Though, of course, one does not expect agricultural drought when the rainfall is good! Similarly one may not expect a fall in prices or a rise in investment when fuel prices rise. Even in this case, if rising fuel prices lead to substantial fall in real incomes, demand may fall too and hence a fall in prices may result but only over time. To sum it up, it is generally difficult to expect any particular signs for the short-run parameters. Canova and Pina (1999) attribute wrong and unexpected signs of short-run coefficients to mis-specification in VAR models. Valadkhani (2004) discusses the various arduous tasks in building macroeconometric models and say the VAR approach is difficult to implement when there are more than five variables due to over-parameterisation and resultant multicollinearity. The multicollinearity problem often could lead to unexpected and wrong signs. Therefore, in the above models multicollinearity was seen to be as low as possible. In fact the variance inflation factors (vif) of the explanatory variables are all less than 10 in each of the three models presented above.

The estimated residuals of the models are free from first-order autocorrelation. Table 3 shows the results of the Breush-Godfrey LM test, useful for testing low order autocorrelations (see Luetkepohl and Kratzig, 2004). According to Stock and Watson (2001), “Small VARs like our three-variables system have become a benchmark against which new forecasting systems are judged. But while useful as a benchmark, small VARs of two or three variables are often unstable and thus poor predictors of the future.” This paper too estimates only small VECs/VARs. Thus it is important that the stability issue is taken up seriously since the estimated coefficients will be used later for policy simulation results. For inference purposes, the estimated models must satisfy stability conditions. For stable VAR models, all the eigen values of the companion matrix should be strictly less than one; or equivalently all the roots of the reverse characteristic polynomial (RCP) should be strictly greater than one.[3] For stable VEC models with K endogenous variables and r co-integrating equations the companion matrix should have exactly (K-r) unit eigen values with the remaining eigen values being strictly (significantly) less than one. Equivalently, the RCP should have exactly (K-r) unit roots and the remaining roots strictly greater than one. This condition if satisfied indicates that the number of co-integrating equations in the VEC has been correctly specified. Table 3 shows these details. For each of the models, there are K=3 endogenous variables and r=1 CIV. The stability results show that (K-r)=2 unit roots with all the others being strictly greater than one. Thus the estimated models are all stable. Therefore the policy responses generated by using these models can be treated as reliable.

In general, policy analysis in the case of VEC/VAR models is done through impulse response functions (IRF). The IRF procedure rests on analyzing the impact of an innovation in one of the endogenous (but not exogenous) variables on the other endogenous variables – usually done through the Vector Moving Average (VMA) representation. However, IRF analysis does not indicate, how that initial innovation in one of the endogenous variables evolved in the first place. In principle, this innovation could occur either through any of the exogenous variables included in the model or through some unknown way. Not concerned with this aspect, the IRF analysis does not capture the impact of a change in any particular exogenous variable. Besides, there are different kinds of IRFs. Simple IRFs, Orthogonalised IRFs, Structural IRFs, Cumulative IRFs, IRFs adjusted/unadjusted for degrees of freedom and so on. For some of these IRFs the specified order of endogenous variables also matters. Another class, the Generalised IRFs, avoids the problem of ordering. In general, the analyses based on different IRFs may not necessarily yield similar policy results. See Hendry and Clements (2003) and Hendry and Mizon (2001) for a discussion on the difficulties with impulse responses analyses particularly in the context of structural breaks.

Here our interest is not only in assessing the impacts on some endogenous variables due to innovations in some other endogenous variables, but also assessing the impacts due to changes in exogenous variables. Our interest is to analyse, for example, the impact of a drastic change in the fuel prices or money supply or budget deficit, etc. or the impact of inadequate rainfall and so on, on GDPs, GCFs and price levels. Towards this, a simulation model has been developed based on the above estimated VEC models. The simulation model involves pooling the above VEC models in a particular sequence. For each time period, simulate first the agriculture model with already known values of the predetermined variables and pre-specified levels of the exogenous variables. Collect the forecast values of the AGDP, AGCF and APDFL. Then simulate the industry model using the forecasts of the agriculture model as predetermined variables along with other pre-specified exogenous variables. This gives the forecasts of the IGDP, IGCF and IPDFL. Now simulate the services model using the forecasts of the agriculture and industry models as predetermined variables along with other pre-specified exogenous variables. This gives the forecasts of the SGDP, SGCF and SPDFL. Now moving on to the next period simulation where the current period forecasts of the GDPs, GCFs and PDFLs of the three sectors would be used as one-period lagged (hence predetermined) values. Since for each period, only the forecast values (and not actual data) of the previous periods are used, this is dynamic simulation.

Dynamic Simulation within the Sample Period: Recall that the data period for the models is 1953 to 2003. While simulating the model, static simulations have been restricted to the period upto 1994. From 1995 to 2003 dynamic simulations have been made using actual data only for the exogenous variables, but not for the predetermined and endogenous variables for which the forecasts already made have been used. If the model generated forecasts of the endogenous variables for the period 1995-2003 (9 years) could come close to the actual data, the model could be treated as reliable for forecasting for the future (2004-2011)[4] (see Table 6). The dynamic forecasting performance of the models for 1995 to 2003 can be assessed by the following details.

NUMBER OF CASES WITH PER CENT DEVIATIONS OF THE FORECASTS FROM ACTUAL DATA

	AGDP	AGCF	APDFL	IGDP	IGCF	IPDFL	SGDP	SGCF	SPDFL	Total
≤ 3.0%	8	3	9	3	1	6	9	2	7	48
3% - 6%	1	3	0	6	2	3	0	2	1	18
6% - 10%	0	2	0	0	6	0	0	3	1	12
≥ 10%	0	1	0	0	0	0	0	2	0	3

There are nine endogenous variables, each forecasted for nine years period; i.e., total 81 different forecasts could be compared with the corresponding actual data. The above table shows that 59 per cent (48 out of 81) forecasts come out within 3 per cent accuracy, 81 per cent forecasts fall within 6 per cent deviation, and 97 per cent forecasts fall within 10 per cent deviation. The two forecasts corresponding to the SGCF that fell beyond 10 per cent deviation correspond to the years 1998 and 1999. Actually the years 1997 to 1999 seem to be really outliers for both IGCF and SGCF, where a rising trend suddenly changed direction in both cases. The actual data (Rs.crores[5]) for the IGCF, SGCF and AGCF may be noted:

	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
IGCF:	90735	117734	172568	145520	148666	139182	142754	124298	114608	133226
SGCF:	75149	95360	94300	84785	89591	87045	102988	110977	118164	115732
AFCF:	15249	16785	17689	18326	18294	17470	20024	19578	20458	21867

The ups and downs in the SGCF data are almost similar to the IGCF data. In general, in India the investment data particularly in the mid 1990s show drastic ups and downs causing much difficulty in modeling. Despite these hurdles, the static (1958 to 1994) and the dynamic (1995 to 2003) simulation results look quite satisfactory. The forecasts for GDP/GCF/PDFL are quite close to the actual data for all the three sectors. Next, forecasting for future is taken up.

Reference Run: To quantify any policy impacts, first a reference run (Ref_Run) is to be arrived at. Since this involves certain specifications for the exogenous variables for the period 2003–2011, the figures under the Ref_Run are not the conventional forecasts of the economy in the usual sense. They are only benchmarks for the policy runs to be compared with. Based on the past data of the exogenous variables for the period 1990 to 2003 (See Table 5), specifications for the reference run have been arrived at as follows:

Rainfall: Year 2003 would have actual rainfall and all the other years would have normal rainfall.

TABLE 5 A: DATA

Year (1)	GDP (2)	AGDP (3)	IGDP (4)	SGDP (5)	AGCF (6)	IGCF (7)	SGCF (8)	APDFL (9)	IPDFL (10)	SPDFL (11)
1952	144571	82278	21850	40443	4262	6531	9325	0.0682	0.0697	0.0751
1953	148487	84873	21932	41682	4100	4915	8091	0.0644	0.0657	0.0752
1954	157545	91409	23217	42919	3903	4607	8605	0.0659	0.0680	0.0775
1955	164187	94096	25100	44991	3992	5995	11270	0.0544	0.0662	0.0771
1956	168244	93283	27657	47304	4934	8349	12395	0.0532	0.0643	0.0776
1957	177969	98354	29992	49623	4849	12568	14413	0.0641	0.0699	0.0810
1958	175343	93936	29904	51503	5081	11992	16877	0.0658	0.0731	0.0841
1959	189026	103401	31920	53705	4820	7823	15952	0.0693	0.0744	0.0868
1960	192922	102360	34125	56437	3965	11784	16241	0.0703	0.0778	0.0895
1961	206882	109254	37834	59794	5258	15323	18509	0.0694	0.0834	0.0930
1962	212920	109346	40503	63071	5115	13918	18428	0.0718	0.0850	0.0935
1963	217197	107171	43306	66720	5625	16425	21089	0.0748	0.0878	0.0983
1964	228037	109678	47574	70785	6129	17487	21384	0.0860	0.0911	0.1021
1965	245546	119795	50808	74943	6559	19232	22756	0.0962	0.0952	0.1090
1966	236355	106567	52741	77047	7230	21708	22888	0.1079	0.1000	0.1158
1967	238996	105051	54499	79446	7216	25505	20201	0.1273	0.1081	0.1256
1968	259412	120673	56178	82561	7830	23166	20517	0.1387	0.1154	0.1355
1969	265829	120482	58999	86348	8450	21134	18762	0.1432	0.1194	0.1387
1970	282701	128226	63622	90853	8919	25264	20108	0.1471	0.1265	0.1424
1971	296909	137320	64258	95331	8587	25301	21412	0.1417	0.1357	0.1491
1972	299447	134742	65982	98723	9147	25779	23834	0.1475	0.1458	0.1578
1973	298073	127980	68418	101675	10077	25715	27382	0.1708	0.1551	0.1682
1974	311427	137197	69154	105076	10314	29272	27109	0.2099	0.1780	0.1869
1975	315199	135107	70295	109797	9567	35097	24694	0.2336	0.2195	0.2223
1976	344749	152522	74960	117267	11223	39099	25504	0.2051	0.2261	0.2355
1977	347887	143709	81505	122673	14165	34705	26526	0.2223	0.2361	0.2467
1978	373982	158132	87105	128745	13068	38517	27359	0.2392	0.2495	0.2595
1979	392917	161773	93714	137430	17979	46912	30686	0.2403	0.2605	0.2657
1980	372373	141107	90830	140436	17358	44451	31400	0.2851	0.3025	0.2928
1981	401128	159293	95082	146753	14233	37419	40534	0.3176	0.3354	0.3250
1982	425072	167723	102647	154702	14079	68959	42821	0.3391	0.3754	0.3661
1983	438079	166577	106418	165084	14529	61311	38621	0.3655	0.4109	0.3932
1984	471742	182498	115002	174242	14725	51652	39204	0.3985	0.4448	0.4290
1985	492077	185186	121641	185250	14948	67442	45673	0.4228	0.4792	0.4649
1986	513990	186570	127472	199948	14132	81463	49182	0.4510	0.5167	0.4978
1987	536257	185363	136224	214670	13708	79853	49972	0.4885	0.5428	0.5300
1988	556778	182899	145253	228626	14294	61823	46157	0.5509	0.5804	0.5727
1989	615098	211184	158649	245265	14762	82524	61005	0.5867	0.6347	0.6275
1990	656332	214315	175053	266964	13424	80849	65239	0.6387	0.6896	0.6758
1991	692871	223114	188601	281156	16416	81289	68372	0.7160	0.7488	0.7468
1992	701863	219660	187560	294643	14965	91728	66170	0.8455	0.8286	0.8416
1993	737791	232386	194994	310411	16141	92688	69419	0.8962	0.9228	0.9182
1994	781345	241967	205162	334216	15249	90735	75149	1.0000	1.0000	1.0000
1995	838031	254090	226051	357890	16785	117734	95360	1.0971	1.0995	1.0890
1996	899563	251892	252359	395312	17689	172568	94300	1.2033	1.1958	1.1849
1997	970083	276091	270218	423774	18326	145520	84785	1.3134	1.2625	1.2738
1998	1016594	269383	281788	465423	18294	148666	89591	1.4366	1.3433	1.3420
1999	1082748	286094	292347	504307	17470	139182	87045	1.5467	1.4488	1.4517
2000	1148368	286983	306336	555049	20024	144272	102988	1.6097	1.4872	1.5211
2001	1198592	286666	326391	585535	19578	124298	110977	1.6342	1.5512	1.5853
2002	1267833	305263	337480	625090	20458	114608	118164	1.7097	1.5909	1.6512
2003	1318321	289386	359216	669719	21867	133226	115732	1.7620	1.6662	1.7038

All the GDPs and GCFs are in Rs.crores at 1993-94 prices. PDFLs are sectoral GDP price deflators. 1952=>1951-52 and so on.

TABLE 5B: DATA

Year (1)	Rainfall (2)	RTB (3)	RTB/ GDP(t-1) (4)	RBD (5)	RBD/ RBD(t-1) (6)	RBR (7)	PCSS (8)	PCSS/ NAGDP(t-1) (9)
1952	87.47	-2985		57		NA	1939	
1953	85.39	-1376		533		7.40	952	0.0153
1954	107.53	-591	-0.00398	519	0.9749	0.92	1304	0.0205
1955	100.57	-993	-0.00630	1602	3.0852	13.47	1897	0.0287
1956	130.22	-2666	-0.01624	2472	1.5434	4.37	2175	0.0310
1957	149.27	-4054	-0.02410	3452	1.3965	-9.29	2227	0.0297
1958	81.91	-5538	-0.03112	6864	1.9883	0.28	1680	0.0211
1959	110.02	-4405	-0.02512	2395	0.3490	0.21	1869	0.0230
1960	115.50	-4154	-0.02198	2420	1.0104	1.18	2403	0.0281
1961	110.25	-6092	-0.03158	-1180	-0.4877	2.03	3571	0.0394
1962	121.01	-5338	-0.02580	1783	-1.5110	1.52	3973	0.0407
1963	96.68	-5272	-0.02476	1418	0.7953	-0.53	4079	0.0394
1964	94.03	-4670	-0.02150	1575	1.1104	-4.32	4295	0.0390
1965	100.42	-5333	-0.02339	1341	0.8514	-3.05	3904	0.0330
1966	71.76	-5548	-0.02259	3395	2.5318	-2.77	3740	0.0297
1967	81.85	-7527	-0.03185	1512	0.4454	-6.57	3475	0.0268
1968	104.25	-6100	-0.02552	2187	1.4462	-2.39	3092	0.0231
1969	85.17	-4038	-0.01557	2389	1.0927	2.12	3222	0.0232
1970	107.04	-1199	-0.00451	106	0.0445	1.67	3902	0.0268
1971	107.54	-694	-0.00245	2935	27.5874	4.25	4716	0.0305
1972	102.53	-1442	-0.00486	5215	1.7769	0.56	5123	0.0321
1973	79.66	625	0.00209	5142	0.9858	-4.48	4866	0.0295
1974	113.97	-2215	-0.00743	2578	0.5015	-10.81	5578	0.0328
1975	86.47	-5254	-0.01687	3316	1.2859	-7.11	6484	0.0372
1976	112.36	-5560	-0.01764	1591	0.4799	11.89	4920	0.0273
1977	104.71	290	0.00084	572	0.3596	2.54	5053	0.0263
1978	105.84	-2462	-0.00708	4087	7.1423	2.84	5693	0.0279
1979	107.26	-4271	-0.01142	2484	0.6078	6.82	6534	0.0303
1980	82.59	-9325	-0.02373	9085	3.6573	-6.05	8240	0.0356
1981	106.12	-17990	-0.04831	10631	1.1702	-2.05	7207	0.0312
1982	98.28	-16220	-0.04043	7042	0.6624	-0.23	7156	0.0296
1983	84.20	-14187	-0.03338	6070	0.8620	1.82	7701	0.0299
1984	109.43	-14392	-0.03285	5071	0.8353	1.19	7728	0.0285
1985	87.03	-11910	-0.02525	11280	2.2245	2.51	8927	0.0309
1986	103.38	-18049	-0.03668	7083	0.6280	2.72	11176	0.0364
1987	91.29	-14731	-0.02866	17634	2.4895	3.12	10284	0.0314
1988	87.51	-11576	-0.02159	9698	0.5500	0.62	10452	0.0298
1989	109.81	-13008	-0.02336	8291	0.8550	1.58	13791	0.0369
1990	95.26	-11493	-0.01868	15903	1.9180	1.54	17749	0.0439
1991	99.51	-12933	-0.01970	15575	0.9794	-0.50	20563	0.0465
1992	94.78	-4526	-0.00653	8437	0.5417	-1.81	24191	0.0515
1993	96.01	-10615	-0.01512	13743	1.6289	3.28	21883	0.0454
1994	105.08	-3429	-0.00465	12477	0.9079	2.41	29866	0.0591
1995	117.27	-6668	-0.00853	-2097	-0.1681	2.57	32221	0.0597
1996	102.44	-13684	-0.01633	21214	-10.1151	2.97	49067	0.0840
1997	106.50	-15682	-0.01743	10221	0.4818	4.56	47658	0.0736
1998	112.93	-17606	-0.01815	45835	4.4845	3.83	46426	0.0669
1999	115.48	-26138	-0.02571	-809	-0.0177	0.06	44056	0.0590
2000	103.01	-36783	-0.03397	-10718	13.2488	4.06	54966	0.0690
2001	89.49	-16974	-0.01478	1990	-0.1857	3.51	54256	0.0630
2002	97.90	-21939	-0.01830	4964	2.4949	2.62	48007	0.0526
2003	81.84	-24654	-0.01945	3317	0.6682	2.79	55116	0.0573
MAX			-0.00465		13.2490	4.56		0.0840
MIN			-0.03397		-10.1150	-1.81		0.0440
MEDIAN			-0.01779		0.7880	2.71		0.0590

1952=>1951-52 and so on. MAX, MIN, MEDIAN denote the maximum, minimum and the median values between 1990 to 2003.

RTB, RBD and PCSS are in Rs. crores at 1993-94 prices. RBR is percentage.

TABLE 5C: DATA

Year	WPF	WPF/WPF(t-1)	RM3	RM3/RM3(t-1)
(1)	(2)	(3)	(4)	(5)
1952	NA		30378	
1953	5.7198		31375	1.0328
1954	5.6201	0.9826	31725	1.0112
1955	5.5984	0.9961	38104	1.2010
1956	5.0328	0.8990	43430	1.1398
1957	5.6762	1.1278	41097	0.9463
1958	6.1294	1.0798	43698	1.0633
1959	6.2288	1.0162	46255	1.0585
1960	6.3842	1.0250	49735	1.0752
1961	6.4557	1.0112	50309	1.0115
1962	6.9001	1.0688	52549	1.0445
1963	7.0399	1.0203	53815	1.0241
1964	8.7358	1.2409	54709	1.0166
1965	8.7668	1.0036	55025	1.0058
1966	7.9366	0.9053	56432	1.0256
1967	8.4429	1.0638	55714	0.9873
1968	8.6721	1.0271	56250	1.0096
1969	8.8646	1.0222	60878	1.0823
1970	9.1281	1.0297	68368	1.1230
1971	9.3136	1.0203	77196	1.1291
1972	10.0684	1.0810	84331	1.0924
1973	10.2786	1.0209	90281	1.0706
1974	12.4931	1.2155	90344	1.0007
1975	18.0239	1.4427	86309	0.9553
1976	19.3050	1.0711	102199	1.1841
1977	20.1189	1.0422	118636	1.1608
1978	20.1747	1.0028	132371	1.1158
1979	20.7669	1.0294	157910	1.1929
1980	24.5676	1.1830	161602	1.0234
1981	34.0628	1.3865	171865	1.0635
1982	43.3332	1.2722	175423	1.0207
1983	44.6251	1.0298	189120	1.0781
1984	46.4850	1.0417	205495	1.0866
1985	46.5821	1.0021	227435	1.1068
1986	51.2182	1.0995	245915	1.0813
1987	52.8720	1.0323	272951	1.1099
1988	53.8410	1.0183	289452	1.0605
1989	54.6538	1.0151	314452	1.0864
1990	54.8775	1.0041	346058	1.1005
1991	70.2241	1.2797	360471	1.0416
1992	81.6713	1.1630	377746	1.0479
1993	91.9795	1.1262	398930	1.0561
1994	100.0000	1.0872	431084	1.0806
1995	108.1697	1.0817	482131	1.1184
1996	108.1645	1.0000	502212	1.0417
1997	124.5241	1.1512	542955	1.0811
1998	144.6225	1.1614	600628	1.1062
1999	167.6212	1.026	664611	1.1065
2000	207.1375	1.1312	732738	1.1025
2001	224.5036	1.2357	827124	1.1288
2002	240.1156	1.0838	908514	1.0984
2003		1.0695	1007543	1.1090
MAX		1.2797		1.1288
MIN		1.0000		1.0416
MEDIAN		1.1067		1.0995

MAX, MIN, MEDIAN denote the maximum, minimum and the median value between 1990 to 2003. RM3 is in Rs. crores at 1993-94 prices.

WPF is fuel price index. 1952=> 1951-52 and so on.

Fuel Price Index (WPF): Between the years 1990 and 1991, the fuel price rose nearly by 28 per cent; and between 1995 and 1996, it fell down marginally. The median value of year-to-year growth rates was more than 10 per cent. However, for the reference run, year 2003 would have the actual price, and in the later years the same price would continue. This of course is quite an optimistic assumption.

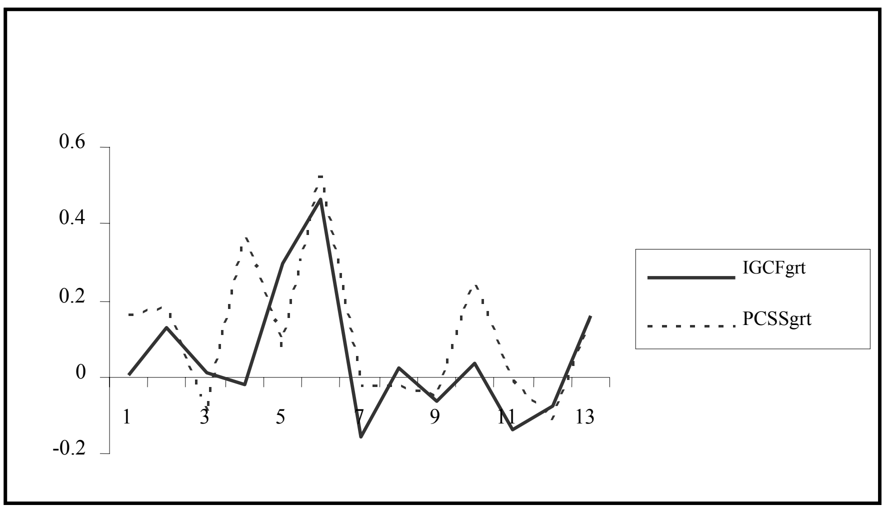
Real Money Supply (RM3): [$RM3_t/GDP_t$] which was about 52 per cent in 1991 rose gradually to 76 per cent in the year 2003. This movement indicates that [$RM3_t/GDP_t$] is very likely to go up in the future periods too. RM3 grew by 4.1 per cent between 1990 and 1991 (minimum observed) and 12.9 per cent (maximum) between 2000 and 2001. For the period 1997 to 2003, annual growth rate has been mostly around 10 per cent. However, the reference run specification for RM3 is kept at 8 per cent growth a year for the period 2003 to 2011.

Real Bank Rate (RBR): The pre-reforms period was a regime of administered interest rates. From 1993 onwards, they are mostly market determined. This paper considers the bank rate as a surrogate for the interest rate structure (call money rate, treasury-bill rate and commercial paper rate etc.). Real bank rate is defined as nominal bank rate minus inflation [$100.0*(TPD_t-TPD_{t-1})/TPD_{t-1}$; where TPD: GDP deflator.]. The RBR was negative in 1991 and 1992. The maximum was 4.56 per cent in 1997, while the median value was 2.71 per cent. The specified RBR in the reference run is 2.78 per cent for 2003 (actual value) and 0 per cent for all the later years up to 2011 – that is, nominal bank rate is equal to inflation.

Real Budget Deficit (RBD): Since data on fiscal deficit are not available for all the years, 1951 to 2003, RBD was used as a surrogate variable in this paper. Real budget deficit is defined as nominal budget deficit divided by the GDP deflator [$TGDP_{\text{current prices}}$ / $TGDP_{\text{1993-94 prices}}$]. RBD was, though negative in some years, generally positive. [RBD_t/GDP_t] was at maximum at 4.5 per cent in 1998, while the median value was 1.12 per cent. Either in this ratio or in the annual growth rate, the RBD data however do not show any regular pattern. In the reference run RBD is specified to grow at 5 per cent every year from 2004 onwards.

Real Trade Balance (RTB): It is nominal trade balance (exports-imports) divided by the GDP deflator. The trade balance as a proportion of the GDP has no regular pattern, though the imports have always been more than the exports. Thus trade balance has always been negative. We assume a one-period lag between trade levels and the GDP. Year 2000 recorded the largest negative [RTB_t/GDP_{t-1}] at -3.4 per cent, and in 1994 the least at -0.5 per cent. Years 2003 and 2004 values (-1.9 per cent) are close to the median value (-1.7 per cent). In the reference run, the specified value for [RTB_t/GDP_{t-1}] is –1.0 per cent for the years 2005 to 2011.

Private Corporate Savings (PCSS): There are some minor problems involved in bringing PCSS into our modelling framework. First, it appears only in the industry model. While PCSS has no direct bearing in explaining the agricultural performance in India, one may perhaps argue that it may explain at least a part of the services sector performance. However, when the PCSS variable with or without lags was introduced into the services model, the estimation results did not turn out satisfactory (either wrong signs or insignificant coefficients resulted and hence dropped). Second, as already stated above the industrial investment in India particularly during the 1990s has abrupt ups and downs instead of a smooth trend. When the annual growth rates of IGCF were plotted against those of PCSS, the ups and downs almost matched. (See Figure 1.) Therefore PCSS was brought into the industry model. Third, one may argue that there could be an endogeneity problem between PCSS and IGDP. That is, a part of the PCSS could have come from IGDP itself. For this reason, we estimated auto-regressive distributed lag (ARDL) models between PCSS and IGDP. The results (not reported here) indicated that $PCSS_t$ depends on its own past lags and $IGDP_{t-1}$ (not $IGDP_t$). Based on this, one may conclude that the above mentioned endogeneity problem is not serious. Table 5 shows that the ratio ($PCSS_t$/Non-agricultural GDP_{t-1}) varied between 4.4 per cent and 8.4 per cent during the 1990s. The data show a clear rising trend over time with a median value of 5.9 per cent for the period 1990-2003. In the reference run, the ratio was rather conservatively specified to be at 6 per cent for the years 2005 to 2011.



IGCFgrt and PCSSgrt are the annual growth rates from 1990-91 to 2002-03.

Figure.1 IGCF and PCSS

Thus, our reference run specifications, more or less, conform to a kind of "business as usual" except for the two quite optimistic assumptions that there would not be any hike in fuel prices and a normal rainfall would prevail in all the years, 2005 to 2011.

Now, one may ask, are the variables specified as exogenous really exogenous? From a general equilibrium point of view, everything depends on everything else, and hence all the variables are endogenous (even rainfall could depend on climate changes and industrialisation!). However VEC models with a large number of endogenous variables and long lag structures would only leave few degrees of freedom. The data problems do not allow us to treat all these variables also as endogenous. Besides, the variables such as money supply, budget deficit, bank rate, fuel price, etc., are indeed policy instruments in the hands of the Government. Hence they are treated as exogenous only.

The reference run simulation results are reported in Table 6. The forecasts made upto 2011 yield the following cumulative annual growth rates (C.A.G.R) for the periods 2003-2011. These growth rates have been worked out using the actual data for the year 2003 and forecast values for the year 2011.

COMPOUND ANNUAL GROWTH RATES : 2003 TO 2011(*PER CENT*)

	GDP	GCF	PDFL
Agriculture	2.92	3.38	2.39
Industry	8.60	12.90	2.79
Services	7.23	5.69	5.88
Total	6.79	9.51	4.40

The total GDP is the sum of the sectoral (agriculture + industry + services) GDPs obtained from the respective models. The total GCF is merely the sum of the sectoral GCFs. This does not include the component of adjustments made for the errors of omissions and commissions. The total price index (TPDFL=TPD) is the weighted sum of the sectoral prices, the weights being the shares of the different sectors in the total GDP.

The reference run subject to normal rainfall, no fuel price hike, etc., indicates that overall the Indian economy can grow at about 6.8 per cent rate. This constitutes agricultural growth at 2.9 per cent, services growth at 7.2 per cent and industry growth faster than the former two at 8.6 per cent rate. Services prices grow faster than industry and agriculture prices. However, industrial investment grows faster than agricultural and services investments. In a way it seems, agriculture may continue to get low priority in terms of investment and thus unable to show impressive growth performance. Juxtaposing these forecasts along with the C.A.G.R's of the actual data of the previous periods, the following comparative picture emerges between the past and the future.

COMPOUND ANNUAL GROWTH RATES : (*PER CENT*)

C.A.G.R.	GDP	AGDP	IGDP	SGDP	GCF	AGCF	IGCF	SGCF	PDFL	APDFL	IPDFL	SPDFL
1951-1960	3.53	2.62	5.68	4.08	7.10	0.48	11.21	6.87	1.39	0.54	1.90	2.41
1960-1970	3.89	2.28	6.43	4.88	5.43	8.44	7.92	2.16	6.20	7.66	4.99	4.75
1970-1980	2.79	0.96	3.62	4.45	5.55	6.89	5.81	4.56	7.56	6.84	9.11	7.47
1980-1990	5.83	4.27	6.78	6.63	5.52	-2.54	6.16	7.59	8.61	8.40	8.59	8.72
1990-2003	5.51	2.34	5.69	7.33	4.16	3.82	3.92	4.51	7.49	8.12	7.02	7.37
2003-2011 Forecasts*	6.79	2.92	8.60	7.23	9.51	3.38	12.90	5.69	4.40	8.23	7.09	7.48

*: 2003-2011 forecasts assume normal rainfall and no hike in fuel prices. GCF = AGCF+IGCF+SGCF does not include the component of adjustments for errors of omissions and commissions.

IV

POLICY SIMULATIONS

A dozen alternative policy/counterfactual scenarios are postulated within the scope of the above estimated VECMs. This basically involves changing the exogenous specifications of the reference run. A change in policy specification is effected from the year 2005 and the economic impacts for the period 2005-2011 are simulated. We draw attention to two aspects in this connection. Generally policy related FAQs are like – how much the output is affected when money supply changes, how much the investment is affected when bank rate changes, and so on. Though the simulation results would seem to present answers to such questions, the results may not be interpreted as a cause and effect

TABLE 6: ACTUAL DATA AND REFERENCE RUN FORECASTS [CAGR: COMPOUND ANNUAL GROWTH RATE BETWEEN 2003(ACTUAL) AND 2011(FORECAST)

Sector: Year (1)	Total TGDP (Forecast) (2)	Total TGDP (Actual) (3)	Total TGCF (Forecast) (4)	Total TGCF (Actual) (5)	Total TPD (Forecast) (6)	Total TPD (Actual) (7)	Services SGDP (Forecast) (8)	Services SGDP (Actual) (9)	Services SGCF (Forecast) (10)	Services SGCF (Actual) (11)	Services SPDFL (Forecast) (12)	Services SPDFL (Actual) (13)
1995	835309	838031	216087	229879	1.0919	1.0943	359232	357890	88822	95360	1.0884	1.0890
1996	887164	899563	271117	284557	1.1920	1.1931	393112	395312	92425	94300	1.1940	1.1849
1997	951952	970083	254429	248631	1.2829	1.2819	423181	423774	91723	84785	1.2865	1.2738
1998	1003542	1016594	271197	256551	1.3704	1.3675	460122	465423	99588	89591	1.3570	1.3420
1999	1067098	1082748	263073	243697	1.4729	1.4760	497841	504307	100164	87045	1.4545	1.4517
2000	1126347	1148368	289742	267284	1.5474	1.5342	547092	555049	112938	102988	1.5353	1.5211
2001	1196661	1198592	266243	254853	1.6184	1.5877	583049	585535	116600	110977	1.6229	1.5853
2002	1250667	1267833	265041	253230	1.7063	1.6492	627839	625090	120011	118164	1.7194	1.6512
2003	1306198	1318321	263911	270825	1.7880	1.7063	672381	669719	120364	115732	1.8093	1.7038
2004	1406627		274671		1.8584		729371		127410		1.9000	
2005	1513025		284462		1.9459		780442		132501		2.0221	
2006	1611235		326108		2.0237		838522		147680		2.1312	
2007	1702252		361852		2.1014		894321		152571		2.2324	
2008	1825477		385983		2.1664		956194		155856		2.3278	
2009	1942330		440271		2.2506		1023496		159789		2.4474	
2010	2078991		494995		2.3347		1094735		168873		2.5740	
2011	2229950		560336		2.4075		1170504		180191		2.6914	
CAGR (per cent)	6.79		9.51		4.40		7.23		5.69		5.88	

Sector: Year (1)	Industry IGDP (Forecast) (14)	Industry IGDP (Actual) (15)	Industry IGCF (Forecast) (16)	Industry IGCF (Actual) (17)	Industry IPDFL (Forecast) (18)	Industry IPDFL (Actual) (19)	Agriculture AGDP (Forecast) (20)	Agriculture AGDP (Actual) (21)	Agriculture AGCF (Forecast) (22)	Agriculture AGCF (Actual) (23)	Agriculture APDFL (Forecast) (24)	Agriculture APDFL (Actual) (25)
1995	220087	226051	110619	117734	1.1012	1.0995	255990	254090	16646	16785	1.0889	1.0971
1996	241560	252359	161013	172568	1.1954	1.1958	252492	251892	17679	17689	1.1855	1.2033
1997	258117	270218	144967	145520	1.2644	1.2625	270655	276091	17740	18326	1.2948	1.3134
1998	271997	281788	154359	148666	1.3485	1.3433	271424	269383	17250	18294	1.4150	1.4366
1999	281211	292347	145567	139182	1.4544	1.4488	288045	286094	17343	17470	1.5228	1.5467
2000	296499	306336	157893	144272	1.5282	1.4872	282755	286983	18911	20024	1.5910	1.6097
2001	319370	326391	132032	124298	1.6018	1.5512	294242	286666	17611	19578	1.6277	1.6342
2002	327865	337480	125967	114608	1.6636	1.5909	294964	305263	19064	20458	1.7261	1.7097
2003	347046	359216	123836	133226	1.7507	1.6662	286771	289386	19711	21867	1.7832	1.7620
2004	373002		127209		1.7979		304253		20053		1.8331	
2005	411654		130107		1.8501		320930		21854		1.8834	
2006	441993		154713		1.8886		330720		23714		1.9316	
2007	481794		183930		1.9468		326138		25351		1.9704	
2008	526793		205492		1.9742		342490		24635		2.0116	
2009	576021		253091		2.0150		342813		27391		2.0590	
2010	631130		299036		2.0511		353126		27086		2.0999	
2011	695017		351606		2.0761		364429		28540		2.1281	
CAGR (per cent)	8.60		12.90		2.79		2.92		3.38		2.39	

relations. As Nachane (2004) points out and indeed as per Sim's VAR methodology and the notion of Granger causality, such results are at the most statistical correlations or leading indicators. Second, in reality there can be a lot more to policy making than the broad level at which we talk in this paper. For example, a policy that influences the corporate savings may itself involve several sub-policies with regard to several taxes and subsidies, which are not dealt with here. With this caution we now present a set of policy runs.

Rainfall

Run1: Rainfall is below normal for three consecutive years 2005, 2006 and 2007 and then returns to normalcy. The rainfall index falls down to 85, 90, 95 respectively in these years before returning to 100 (normalcy) in 2008 onwards. This is a lower rainfall situation (LRS).

Run2: Rainfall is above normal for three consecutive years 2005, 2006 and 2007 and then returns to normalcy. The rainfall index rises to 115, 110, 105, respectively in these years before returning to 100 (normalcy) in 2008 onwards. This is a higher rainfall situation (HRS).

Fuel Price

Run3: From 2005 onwards, the fuel price, WPF, goes up by 10 per cent compared to the previous year level. It is a multi-period shock. A 10 per cent raise every year amounts to nearly doubling the fuel price in 7 years. $(1.10)^7 = 1.95$.

Run4: In 2005, WPF rises by 18 per cent compared to the year 2004 level, and then every alternate year the price rises by the same percentage. This specification too amounts to nearly doubling the fuel price in 7 years (4 times increase every alternate year). $(1.18)^4 = 1.94$. Basically this run is same as Run3 as far as price rise is concerned, but the way the fuel price goes up over time is different here.

Money Supply:

Run5: RM3 grows at 10 per cent every year from 2005 onwards instead of the reference run level of 8 per cent. This is of higher money supply (HRM3).

Budget Deficit:

Run6: In the reference run, RBD was specified to grow at 5 per cent every year over the previous year's value. In Run6, the growth rate is specified to be 0 per cent from 2005 onwards (i.e., budget deficit remains the same for all years). This postulates lower budget deficits compared to reference run (LRBD).

Bank Rate:

Run7: In the reference run, RBR was specified at a level of 2.78 per cent for year 2003 and 0 per cent for all later years. Against this specification, in Run7, from 2005 onwards the real bank rate is -2.5 per cent; i.e., the nominal bank rate is 2.5 per cent below the inflation (LRBR).

Private Corporate Savings:

Run8: In the reference run, these savings as a proportion of the previous year non-agricultural GDP were specified to be 0.06. In Run8, this proportion was kept fixed at 0.055 for all these years. This scenario postulates lower corporate savings compared to the reference run (LPCS).

Trade Balance:

Run9: When [RTB_t/GDP_{t-1}] is less (more) negative, exports are going up (down) relative to imports, so we have higher (lower) net exports. In the reference run, RTB was specified to be at -1.0 per cent of the previous year GDP, for all years. In Run9 the RTB is specified to be -0.4 per cent of the previous year GDP. That is, exports are going up relative to imports (HEXP).

Run10: In Run10 RTB is specified to be -1.7 per cent of the previous year GDP, meaning that imports are rising relative to exports (HIMP).

Adverse Rainfall, Lower Money Supply, Lower Budget Deficit and Fuel Price Hike:

Run11: A combination of bad rainfall (Run1), lower money supply (6 per cent growth rate), lower budget deficit (Run6) and 10 per cent fuel price rise every year (Run3). Other specifications are as in the reference run.

More Exports, Lower Money Supply, Lower Budget Deficit and Fuel Price Hike:

Run12: A combination of more exports relative to imports (Run9), lower money supply (6 per cent growth rate), lower budget deficit (Run6) and 10 per cent fuel price rise every year (Run3). Other specifications are as in the reference run.

Policy simulation results for the years 2003 to 2011 are reported in Tables 7A to 7C. The results reported are the sectoral GDP, GCF and PDFL levels for the reference run and the percentage deviations (impacts) from the reference run levels for each policy variant. A discussion of the results below is in terms of these policy impacts on the reference run levels. Whenever an impact occurs only for one year, this is referred to as 'transitory effect'; and when it is for several years, it is referred to as 'continuous' or 'permanent' effect'. Below is a summary of the impacts on the endogenous variables due to different scenarios compared to the reference run levels.

DIRECTION OF THE IMPACTS ON THE REFERENCE RUN LEVELS (FROM TABLES 7A TO 7C)

	AGDP	AGCF	APDFL	IGDP	IGCF	IPDFL	SGDP	SGCF	SPDFL
Run1: (Lower Rainfall)	↓	↓	↑↓	↓	↓	↑	↓	↓↑	↑
Run2: (Higher Rainfall)	↑	↑	↓↑	↑	↑	↓	↑	↑↓	↓
Run3: (10 per cent FP Rise)	↓	↓	↑	↓	↓	↑	↓	↓	↑
Run4: (18 per cent FP Rise)	↓	↓	↓	↑	↓	↑	↓	↓	↑
Run5: (Higher RM3)	↑	↑	↑	↑	↑	↑	↑	↑	↓
Run6: (Lower RBD)	↓	↑	↓	↓↑	↑	↓	↓	↓	↑
Run7: (Lower RBR)	↑	↑	↑	↑	↑	↑	↑	↑	↑
Run8: (Lower PCSS)	↓	↓	↓	↓	↓	↓	↓	↓	↓
Run9: (More Exports)	↑	↑	↓	↑	↑	↓↑	↓	↑↓	↑
Run10: (More Imports)	↓	↓	↑	↓	↓	↑↓	↑	↓↑	↓
Run11:	↓	↓	↑↓	↓	↓	↑	↓	↓	↑
Run12:	↑↓	↓	↓	↓	↓	↑	↓	↓	↑

(↑ : Rising / ↓ : Decreasing/↨: Mixed / ↔ : No change / ↑ ↓ : Rises and then falls).

Run11: Lower rainfall, higher fuel price, lower money supply and lower budget deficit.

Run12: Higher fuel price, lower money supply and lower budget deficit and higher exports.

TABLE 7 A. PER CENT DIFFERENCES BETWEEN REFVAL AND THE POLICY RUNS

Year (1)	REFVal (2)	Run1 (3)	Run2 (4)	Run3 (5)	Run4 (6)	REFVal (7)	Run1 (8)	Run2 (9)	Run3 (10)	Run4 (11)
TGDP an d SGDP:										
2003	1306198.	.0000	.0000	.0000	.0000	672381.	.0000	.0000	.0000	.0000
2004	1406627.	.0000	.0000	.0000	.0000	729371.	.0000	.0000	.0000	.0000
2005	1513025.	-.4859	.4860	.0000	.0000	780442.	.0051	-.0051	.0000	.0000
2006	1611235.	-.6107	.6108	-1.2492	-2.2485	838522.	-.0661	.0661	-.6103	-1.0986
2007	1702252.	-.6361	.6361	-1.3619	-.1103	894321.	-.0360	.0360	-1.2822	-1.1749
2008	1825477.	-.6797	.6798	-2.4320	-4.2049	956194.	-.0999	.0999	-1.4451	-1.3636
2009	1942330.	-.6823	.6823	-3.5209	-1.9260	1023496.	-.0840	.0840	-2.3881	-2.8368
2010	2078991.	-.8033	.8034	-3.5823	-4.2918	1094735.	-.0919	.0920	-2.7220	-1.8843
2011	2229950.	-.8058	.8059	-4.9627	-4.2996	1170504.	-.0935	.0935	-3.5152	-4.2134
IGDP and AGDP:										
2003	347046.	.0000	.0000	.0000	.0000	286771.	.0000	.0000	.0000	.0000
2004	373002.	.0000	.0000	.0000	.0000	304253.	.0000	.0000	.0000	.0000
2005	411654.	-.2608	.2608	.0000	.0000	320930.	-1.9689	1.9689	.0000	.0000
2006	441993.	-.3867	.3867	-1.8012	-3.2422	330720.	-2.2909	2.2909	-2.1311	-3.8361
2007	481794.	-.6077	.6077	-2.2095	-.7052	326138.	-2.3236	2.3237	-.3283	3.6881
2008	526793.	-.7983	.7983	-4.1281	-6.6395	342490.	-2.1163	2.1163	-2.5784	-8.3931
2009	576021.	-1.0092	1.0092	-5.3208	-2.7984	342813.	-1.9193	1.9194	-3.8788	2.2587
2010	631130.	-1.2373	1.2374	-6.3480	-8.3505	353126.	-2.2331	2.2331	-1.3065	-4.5015
2011	695017.	-1.3748	1.3748	-7.8229	-5.4042	364429.	-2.0086	2.0086	-4.1575	-2.4697
TGCF and SGCF:										
2003	263911.	.0000	.0000	.0000	.0000	120364.	.0000	.0000	.0000	.0000
2004	274671.	.0000	.0000	.0000	.0000	127410.	.0000	.0000	.0000	.0000
2005	284462.	-.8546	.8546	.0000	.0000	132501.	-.7561	.7561	.0000	.0000
2006	326108.	-1.4663	1.4663	-2.8202	-5.0764	147680.	-.5344	.5344	-4.2913	-7.7243
2007	361852.	-1.8374	1.8374	-7.6899	-8.8094	152571.	-.1865	.1865	-3.7644	1.4484
2008	385983.	-1.9690	1.9691	-12.7771	-13.7856	155856.	.0989	-.0987	-8.5183	-16.6730
2009	440271.	-2.4513	2.4513	-14.2455	-12.0063	159789.	.3475	-.3474	-8.0248	3.6385
2010	494995.	-2.7886	2.7887	-18.5037	-20.9034	168873.	.0423	-.0422	-6.8215	-15.4019
2011	560336.	-3.0290	3.0291	-20.0127	-14.7896	180191.	.2675	-.2675	-8.6264	.9380
IGCF and AGCF:										
2003	123836.	.0000	.0000	.0000	.0000	19711.	.0000	.0000	.0000	.0000
2004	127209.	.0000	.0000	.0000	.0000	20053.	.0000	.0000	.0000	.0000
2005	130107.	-.9765	.9764	.0000	.0000	21854.	-.7264	.7264	.0000	.0000
2006	154713.	-2.2021	2.2021	-.9777	-1.7599	23714.	-2.4695	2.4696	-5.6797	-10.2234
2007	183930.	-3.0197	3.0197	-10.7805	-17.7764	25351.	-3.1949	3.1949	-8.8921	-5.4861
2008	205492.	-3.3186	3.3186	-16.6036	-12.3445	24635.	-3.7940	3.7940	-7.8022	-7.5386
2009	253091.	-4.0839	4.0839	-18.6989	-22.2098	27391.	-3.6936	3.6935	-9.3862	-8.9927
2010	299036.	-4.3088	4.3088	-25.5776	-24.7142	27086.	-3.6556	3.6556	-13.2415	-13.1312
2011	351606.	-4.6512	4.6513	-26.7064	-23.8644	28540.	-3.8576	3.8576	-9.4366	-2.2877
TPD and SPD:										
2003	1.7880	.0000	.0000	.0000	.0000	1.8093	.0000	.0000	.0000	.0000
2004	1.8584	.0000	.0000	.0000	.0000	1.9000	.0000	.0000	.0000	.0000
2005	1.9459	.0463	-.0514	.0000	.0000	2.0221	-.0346	.0346	.0000	.0000
2006	2.0237	.1137	-.1137	1.0921	1.9667	2.1312	.0047	-.0047	1.2387	2.2288
2007	2.1014	.1713	-.1761	1.4467	.4949	2.2324	.0358	-.0358	1.8993	1.0796
2008	2.1664	.2123	-.2077	1.7679	2.5942	2.3278	.0773	-.0730	2.2124	2.7880
2009	2.2506	.1555	-.1555	2.7815	2.1328	2.4474	.0409	-.0409	3.3219	2.9705
2010	2.3347	.1670	-.1670	3.1139	3.1781	2.5740	.0505	-.0505	3.8617	3.6675
2011	2.4075	.1952	-.1911	3.7217	3.0654	2.6914	.0966	-.1003	4.3063	3.6338
IPD and APD:										
2003	1.7507	.0000	.0000	.0000	.0000	1.7832	.0000	.0000	.0000	.0000
2004	1.7979	.0000	.0000	.0000	.0000	1.8331	.0000	.0000	.0000	. 0000
2005	1.8501	.0432	-.0486	.0000	.0000	1.8834	.1911	-.1911	.0000	. 0000

(Contd.)

TABLE 7A (*Concld.*)

Year (1)	REFVal (2)	Run1 (3)	Run2 (4)	Run3 (5)	Run4 (6)	REFVal (7)	Run1 (8)	Run2 (9)	Run3 (10)	Run4 (11)
2006	1.8886	.1324	-.1324	.8154	1.4667	1.9316	.2692	-.2640	.8542	1.5376
2007	1.9468	.1336	-.1336	1.3509	.8630	1.9704	.4314	-.4365	.1472	-1.3855
2008	1.9742	.2482	-.2482	1.3170	1.3930	2.0116	.3331	-.3380	.4574	2.2768
2009	2.0150	.2134	-.2184	2.4268	2.7990	2.0590	.1214	-.1214	.6654	-1.2628
2010	2.0511	.2243	-.2291	2.5303	1.4139	2.0999	-.0095	.0048	.5191	2.2239
2011	2.0761	.2505	-.2553	3.2031	4.0171	2.1281	-.1692	.1692	.7612	-1.0855

Run1: LRF, Run2: HRF, Run3:10 per cent WPF rise, Run 4:18 per cent WPF rise in alternate years.

TABLE 7 B. PER CENT DIFFERENCES BETWEEN REFVAL AND THE POLICY RUNS

Year (1)	REFVal (2)	Run5 (3)	Run6 (4)	Run7 (5)	Run8 (6)	REFVal (7)	Run5 (8)	Run6 (9)	Run7 (10)	Run8 (11)
					TGDP and SGDP:					
2003	1306198.	.0000	.0000	.0000	.0000	672381.	. 0000	.0000	.0000	.0000
2004	1406627.	.0000	.0000	.0000	.0000	729371.	.0000	.0000	.0000	.0000
2005	1513025.	.1367	-.0020	.0000	-.2403	780442.	.2651	-.0019	.0000	-.0236
2006	1611235.	.7608	-.0089	.0443	-.7291	838522.	.7098	-.0048	.0124	-.1142
2007	1702252.	1.7837	-.0201	.1754	-.8747	894321.	1.3112	-.0098	.0387	-.1089
2008	1825477.	2.4270	-.0316	.3238	-1.1234	956194.	2.0618	-.0173	.0640	-.2334
2009	1942330.	3.4217	-.0430	.4926	-1.5095	1023496.	2.9405	-.0277	.1087	-.3413
2010	2078991.	4.3928	-.0547	.7235	-1.7204	1094735.	3.7865	-.0411	.1690	-.4260
2011	2229950.	5.3549	-.0653	.9581	-1.9687	1170504.	4.6776	-.0578	.2364	-.4727
					IGDP and AGDP:					
2003	347046.	.0000	.0000	0000	.0000	286771.	.0000	0000	.0000	.0000
2004	373002.	.0000	.0000	.0000	.0000	304253.	.0000	.0000	.0000	.0000
2005	411654.	.0000	-.0006	.0000	-.8385	320930.	. 0000	-.0045	.0000	.0000
2006	441993.	1.4329	-.0014	.1377	-1.7075	330720.	-.0083	-.0296	.0000	-.9806
2007	481794.	2.6456	.0003	.4320	-2.4332	326138.	1.8060	-.0786	.1712	-.6724
2008	526793.	3.9503	.0081	.8171	-3.0803	342490.	1.1038	-.1326	.2900	-.5986
2009	576021.	5.2947	.0242	1.2639	-3.8187	342813.	1.7110	-.2013	.3425	-1.1176
2010	631130.	6.7885	.0477	1.7833	-4.3963	353126.	1.9909	-.2802	.5486	-.9510
2011	695017.	8.1778	.0804	2.3196	-4.9544	364429.	2.1469	-.3675	.6792	-1.0799
					TGCF and SGCF:					
2003	263911.	.0000	.0000	.0000	.0000	120364.	.0000	.0000	0000	.0000
2004	274671.	.0000	.0000	.0000	.0000	127410.	.0000	.0000	.0000	.0000
2005	284462.	2.1903	.0000	.0000	-5.7389	132501.	4.7024	-.0040	.0000	-2.5253
2006	326108.	6.0721	.0103	1.3485	-5.9779	147680.	6.1025	-.0154	.5255	-1.6978
2007	361852.	7.8770	.0412	2.4749	-7.4560	152571.	6.0519	-.0347	.7935	-1.1125
2008	385983.	12.1161	.1007	3.7860	-9.2904	155856.	7.5340	-.0552	.8842	-.9904
2009	440271.	14.2492	.1836	5.0399	-9.9947	159789.	8.5298	-.0829	.9549	-.8440
2010	494995.	17.4282	.2951	6.2267	-11.6137	168873.	10.3159	-.1166	.9637	-1.7606
2011	560336.	20.5471	.4284	7.4560	-12.5260	180191.	12.0809	-.1536	1.1325	-2.0998
					IGCF and AGCF:					
2003	123836.	.0000	.0000	.0000	.0000	19711.	.0000	.0000	.0000	.0000
2004	127209.	.0000	.0000	.0000	.0000	20053.	.0000	.0000	.0000	.0000
2005	130107.	.0000	-.0022	.0000	-9.9756	21854.	.0000	.0368	.0000	.0000
2006	154713.	6.9729	.0202	2.3407	-11.0567	23714.	.0056	.1060	.0000	.5023
2007	183930.	10.5947	.0804	4.2211	-13.5722	25351.	-.8573	.2141	-.0749	-1.2582
2008	205492.	16.8068	.1864	6.4185	-16.5499	24635.	1.9775	.3722	.1863	-1.2461
2009	253091.	19.3356	.3150	8.1084	-16.7560	27391.	.6173	.5245	.5171	-.9031
2010	299036.	22.8547	.4840	9.7036	-18.0950	27086.	1.8605	.7765	.6535	-1.4890
2011	351606.	26.4125	.6791	11.2241	-18.7693	28540.	1.7383	1.0153	.9580	-1.4362

(Contd.)

TABLE 7B (*Concld.*)

Year (1)	REFVal (2)	Run5 (3)	Run6 (4)	Run7 (5)	Run8 (6)	REFVal (7)	Run5 (8)	Run6 (9)	Run7 (10)	Run8 (11)
					TPD and SPD:					
2003	1.7880	.0000	.0000	.0000	.0000	1.8093	.0000	.0000	.0000	.0000
2004	1.8584	.0000	.0000	.0000	.0000	1.9000	.0000	.0000	.0000	.0000
2005	1.9459	-.6218	.0000	.0000	-.1079	2.0221	-1.1671	.0050	.0000	-.0940
2006	2.0237	-1.2749	.0000	.0148	-.0840	2.1312	-2.5244	.0094	.0141	-.0516
2007	2.1014	-1.8131	-.0048	.0238	-.0428	2.2324	-3.5343	.0179	.0224	.0314
2008	2.1664	-2.1464	-.0092	.0092	-.1015	2.3278	-4.3775	.0301	.0000	-.0515
2009	2.2506	-2.6571	-.0222	.0000	-.1511	2.4474	-5.3281	.0449	-.0041	-.2084
2010	2.3347	-3.1739	-.0343	-.0043	-.1885	2.5740	-6.3403	.0622	.0272	-.2875
2011	2.4075	-3.7425	-.0540	-.0166	-.1661	2.6914	-7.5351	.0855	.0557	-.2824
					IPD and APD:					
2003	1.7507	.0000	.0000	.0000	.0000	1.7832	.0000	.0000	.0000	.0000
2004	1.7979	.0000	.0000	.0000	.0000	1.8331	.0000	.0000	.0000	.0000
2005	1.8501	.0000	.0000	.0000	-.2486	1.8834	.0000	-.0053	.0000	.0000
2006	1.8886	.4448	-.0053	.0424	-.2489	1.9316	.0052	-.0207	.0000	-.1450
2007	1.9468	.5291	-.0205	.0719	-.2517	1.9704	.2690	-.0558	.0254	-.2893
2008	1.9742	.9776	-.0456	.0608	-.3546	2.0116	.4673	-.0994	.0795	-.3380
2009	2.0150	1.2804	-.0844	.0645	-.3424	2.0590	.5537	-.1554	.1506	-.4080
2010	2.0511	1.6333	-.1414	.0488	-.3852	2.0999	.7762	-.2381	.2191	-.5238
2011	2.0761	2.1242	-.2216	.0096	-.4720	2.1281	1.1278	-.3383	.3007	-.5874

Run5:HRM3, Run6:LRBD, Run7:LRBR, Run8:LPCS

TABLE 7 C. PER CENT DIFFERENCES BETWEEN REFVAL AND THE POLICY RUNS

Year (1)	REFVal (2)	Run9 (3)	Run10 (4)	Run11 (5)	Run12 (6)	REFVal (7)	Run9 (8)	Run10 (9)	Run11 (10)	Run12 (11)
					TGDP and SGDP:					
2003	1306198.	.0000	.0000	.0000	.0000	672381.	.0000	.0000	.0000	.0000
2004	1406627.	.0000	.0000	.0000	.0000	729371.	.0000	.0000	.0000	.0000
2005	1513025.	.8937	-1.0426	-.6247	.7549	780442.	-.5595	.6528	-.2618	-.8264
2006	1611235.	.8806	-1.0069	-2.6244	-1.1344	838522.	-.3959	.4493	-1.3812	-1.7102
2007	1702252.	.4890	-.5512	-3.7678	-2.6611	894321.	-.7510	.8677	-2.6028	-3.3068
2008	1825477.	1.2884	-1.5019	-5.4703	-3.5293	956194.	-.6778	.7797	-3.5389	-4.1023
2009	1942330.	.9471	-1.0660	-7.4769	-5.8831	1023496.	-.6932	.7865	-5.2790	-5.8596
2010	2078991.	1.1716	-1.3418	-8.5162	-6.6048	1094735.	-.9442	1.0912	-6.3715	-7.1846
2011	2229950.	1.5536	-1.7927	-10.7117	-8.4194	1170504.	-.9521	1.0816	-7.9347	-8.7463
					IGDP and AGDP:					
2003	347046.	.0000	.0000	.0000	.0000	286771.	.0000	.0000	.0000	.0000
2004	373002.	.0000	.0000	.0000	.0000	304253.	.0000	.0000	.0000	.0000
2005	411654.	1.6153	-1.8845	-.2614	1.6147	320930.	3.5021	-4.0858	-1.9733	3.4977
2006	441993.	1.7309	-1.9828	-3.6222	-1.5069	330720.	2.9809	-3.3950	-4.4434	.8233
2007	481794.	2.3106	-2.6587	-5.4098	-2.5236	326138.	1.1982	-1.3284	-4.5369	-1.0935
2008	526793.	3.2258	-3.7290	-8.7209	-4.7477	342490.	3.7976	-4.4461	-5.8626	-.0552
2009	576021.	3.4478	-3.9377	-11.3128	-6.9441	342813.	1.6428	-1.7715	-7.5939	-4.1706
2010	631130.	4.0489	-4.6532	-13.8545	-8.7091	353126.	2.5887	- 2.9663	-5.6242	-1.0467
2011	695017.	4.6205	-5.2970	-16.5945	-10.7762	364429.	3.7524	-4.3417	-8.4119	-2.8747
					TGCF and SGCF:					
2003	263911.	.0000	.0000	.0000	.0000	120364.	.0000	.0000	.0000	.0000
2004	274671.	.0000	.0000	.0000	.0000	127410.	.0000	.0000	.0000	.0000
2005	284462.	-2.1758	2.5384	-3.0450	-4.3662	132501.	.5337	-.6228	-5.4625	-4.1726
2006	326108.	.9990	1.2116	10.2719	7.8037	147680.	.5989	.6870	10.7749	-9.6424
2007	361852.	2.2917	-2.6498	-17.0711	-12.9066	152571.	-1.5958	1.8753	-9.6280	-11.0481
2008	385983.	1.1665	-1.2902	-26.1760	-23.0408	155856.	-1.5256	1.7358	-15.3467	-16.9870
2009	440271.	3.5775	-4.1983	-29.7936	-23.7859	159789.	-2.4897	2.8756	-15.3118	-18.1308

(Contd.)

TABLE 7C (*Concld.*)

Year (1)	REFVal (2)	Run9 (3)	Run10 (4)	Run11 (5)	Run12 (6)	REFVal (7)	Run9 (8)	Run10 (9)	Run11 (10)	Run12 (11)
2010	494995.	4.8872	-5.6110	-37.0051	-29.3551	168873.	-.3093	.3314	-15.9079	-16.2297
2011	560336.	4.6974	-5.3661	-41.2146	-33.5983	180191.	-.7841	.8864	-18.9114	-19.8875
				IGCF and AGCF:						
2003	123836.	.0000	.0000	.0000	.0000	19711.	.0000	.0000	.0000	.0000
2004	127209.	.0000	.0000	.0000	.0000	20053.	.0000	.0000	.0000	.0000
2005	130107.	-4.8860	5.7002	-.9787	-4.8881	21854.	-2.4687	2.8801	-.6896	-2.4318
2006	154713.	1.1372	- 1.4266	-10.1325	-6.7871	23714.	2.5896	-3.0765	-8.0488	-2.9863
2007	183930.	5.5694	-6.4706	-24.0800	-15.4180	25351.	1.9071	-2.1637	-11.0155	-5.8714
2008	205492.	3.4011	-3.8103	-35.9407	-29.2062	24635.	-.4410	.5860	-13.2365	-9.9113
2009	253091.	7.3594	-8.6004	-40.7396	-29.3419	27391.	4.0271	-4.7909	-13.1348	-5.4381
2010	299036.	8.1878	-9.4006	-50.6482	-38.2100	27086.	.8469	-.8216	-17.9157	-13.4283
2011	351606.	7.7442	-8.8399	-54.8631	-42.6700	28540.	1.7703	-2.0460	-13.8807	-8.4021
				TPD and SPD:						
2003	1.7880	.0000	.0000	.0000	.0000	1.8093	.0000	.0000	.0000	.0000
2004	1.8584	.0000	.0000	.0000	.0000	1.9000	.0000	.0000	.0000	.0000
2005	1.9459	-.2107	.2261	.6681	.4008	2.0221	.0841	.0940	1.1374	1.2512
2006	2.0237	-.4101	.4694	2.4806	1.9222	2.1312	-.1502	.1783	3.7350	3.5755
2007	2.1014	-.0190	.0095	3.3977	3.1550	2.2324	.1613	-.1881	5.3485	5.4695
2008	2.1664	-.0969	.1108	4.0482	3.6420	2.3278	.2792	-.3179	6.4181	6.6200
2009	2.2506	.2222	-.2622	5.4652	5.4208	2.4474	.5475	-.6292	8.2863	8.7930
2010	2.3347	.4540	-.5311	6.2363	6.3477	2.5740	.8003	-.9285	9.6581	10.4040
2011	2.4075	.2824	-.3074	7.3686	7.1983	2.6914	.6614	.7543	11.1206	11.6668
				IPD and APD:						
2003	1.7507	.0000	.0000	.0000	.0000	1.7832	.0000	.0000	.0000	.0000
2004	1.7979	.0000	.0000	.0000	.0000	1.8331	.0000	.0000	.0000	.0000
2005	1.8501	-.0108	.0054	.0432	-.0108	.0432	-.9132	1.0672	.1858	.9186
2006	1.8886	-.2859	.3389	.4977	.0794	1.9316	.9267	1.0613	1.0924	.0932
2007	1.9468	.4674	-.5496	.9554	1.2893	1.9704	-.7917	.8932	.2538	-.9490
2008	1.9742	.2685	-.3039	.5876	.6078	2.0116	-.9445	1.0887	.2386	-1.0091
2009	2.0150	.5211	-.6055	1.3548	1.6576	2.0590	-.4128	.4517	.1068	-.3837
2010	2.0511	1.0385	-1.2140	1.1165	1.9258	2.0999	-.2905	.3191	-.4476	-.6572
2011	2.0761	.9585	-1.0886	1.3150	2.0038	2.1281	-.2678	.3007	-.7847	-.8176

Run9: HEXP, Run10:HIMP, Run11:LRF+HWPF+LRM3+LRBD, Run12:HWPF+LRM3+LRBD+HEXP.

First we take up the rainfall impacts on the economy. Obviously, the impact on the agriculture is more prominent. Three years' shortfall in rainfall (Run1) has permanent and mostly increasing downward effect on all the GDPs and GCFs. The fall down in AGDP is nearly 2.0 per cent in the first low rainfall year compared to the reference level. Though the rainfall returns to normal levels after three years, the negative impacts of the low rainfall years would continue to persist prominently in agriculture even later years.[6] This feature is even worse in the case of AGCF, where the persistent negative impacts would grow over time. Initially the AGCF fell down by more than 0.7 per cent but subsequently the fall down was nearly 4.0 per cent. Thus bad rainfall and the consequent lower agricultural incomes would have serious negative impacts on agricultural investment. The prices would increase only marginally perhaps because of the governmental interventions (not modeled here). Though rainfall does not figure in the industry, it also experiences strong indirect impacts via agriculture, particularly in the case of IGCF. However the indirect impacts on services sector are only marginal. The results under higher rainfall (Run2) are exactly opposite.

Next the fuel price hike. Run3 where the fuel price rises every year by 10 per cent shows that all (agriculture, industry and services) the GDPs and GCFs suffer from negative impacts compared to the reference run. The fall across the sectoral GDPs ranges between 0.61 per cent (services) to 2.13 per cent (agriculture) in the very beginning. Besides, these negative impacts generally rise over time – going up to 3.5 per cent for services, 4.16 per cent for agriculture and 7.8 per cent for industry by 2011. Investments suffer even more. Generally, the industry suffers the most followed by agriculture and then services. With regard to prices, again here, the agricultural prices may not go up as much as the services and industry prices. But between the latter two, the services prices go up more than the industry prices. Thus in the face of fuel price hike, while the agriculture and industry suffer severely in terms GDPs and investment, the services gain in terms of prices more than the former two sectors.

In Run4 also, fuel prices would be nearly doubled up between 2005 and 2011. However, the fuel prices go up only in alternate years. This specification shows up some difference between the results under Run3 and Run4. In our models, the rise in fuel price affects the endogenous variables with a one period lag. Thus when the fuel price is specified to rise by 18 per cent in 2005, 2007 and 2009, the effects in 2006, 2008 and 2010 turn out to be more negative compared to the Run3 results. However, for the year 2011 the negative impacts in the case of AGDP and AGCF and IGDP and IGCF are less under Run4 than the negative impacts under Run3. But, in the case of services, SGDP (though not SGCF) loses more under Run4 compared to Run3. Thus the results imply that, in general though international fuel-prices go up at frequent intervals, it is better not to pass on those hikes to the domestic economy so soon. In other words, government should act as a spike-buster or shock-absorber and strive to maintain fuel price stability at least over a 'reasonable' time period. Possibly, the strain/loss in terms of subsidies if any could be made up by the gains in the GCF and GDP!

In Run5, where real money supply is more than that in the reference run, all sectoral GDPs and GCFs gain. Industry gains the most, followed by services and agriculture. A 2 per cent hike in the growth rate of RM3 could lead to 8.2 per cent more in IGDP, 4.7 per cent in SGDP and 2.1 per cent in AGDP by year 2011 than the reference run levels. With regard to prices, while industrial and agriculture prices rise, the services prices fall. Since the services sector has the largest share in the total GDP, the overall prices too showed a negative impact.[7] Recall the cointegrating relations of the three sectors and the adjustment parameters. While in agriculture and industry GDPs are positively related to the prices, in services however the relationship is negative (i.e. higher the supply, lower the prices). To keep up the long-run equilibrium between the GDPs, investments and prices, the adjustments are such that prices would fall in services and go up in industry and agriculture whenever the corresponding GDPs and GCFs would go up. This is the error correction mechanism.

In Run6, where real budget deficit is lower than that in the reference run, the impacts turned out rather marginal. Lower budget deficit would lead to more investment in industry and agriculture but no so for services. In services, both investment and GDP would fall and hence prices go up. In agriculture while the GDP and prices would fall, equilibrium would be restored by rising investment. On the whole the results are hardly different from the reference run. Possibly, the budget deficit could not really be a surrogate for fiscal deficit.

In Run7, where the real bank rate is negative, -2.5 per cent (i.e., nominal bank rate which actually is the policy instrument is lower than the inflation rate) the initial impacts turn out rather marginally positive on all the GDPs. However over the time, the impacts on IGDP and AGDP grow to higher levels. In 2011, the IGDP (AGDP) in Run7 is 2.32 per cent (0.68 per cent) higher than the reference run level. The direction of the impacts is the same in the case of investments also; however the impacts are substantially higher than on the GDPs. In 2011, the IGCF (AGCF) in Run7 is 11.22 per cent (0.95 per cent) higher than the reference run level. To this extent, our results are in line with Jha (2002)'s views. However, the impacts on prices seem to be marginal but positive. Nachane (1988) as well as Bhanumurty and Agarwal (2004) argue that interest rates and expected inflation do not move together in India. Our results indicate that lowering the real bank rate could lead to higher level of economic activity and marginally higher prices. In other words, raising nominal bank rates in the face of inflationary pressures may actually lead to relieving from such pressures. This phenomenon is consistent with the results of Clarida *et al*. (2000) for U.S.A.

In Run8, the private corporate savings (PCSS) are lower than in the reference run. The results are analogous to the lower rainfall run. In the case of rainfall, though agriculture is the directly affected sector, indirect impacts on industry are also substantial. In the case of PCSS, though the industry is directly affected, indirect impacts on both agriculture and services are also substantial. In general lower corporate savings rate at 5.5 per cent (instead of 6 per cent) of the non-agricultural GDP leads to negative impacts on all GDPs, GCFs and even prices. The impacts on IGDP are nearly –1 per cent in 2005 which keeps increasing to nearly –5 per cent in 2011. The corresponding figures are nearly -0.02 per cent and -0.5 per cent for services. For agriculture the impact is around – 1 per cent all the years. The adverse impacts on investments in all the sectors are even higher, again industry suffering the most – nearly 10 per cent less in 2005 and 19 per cent in 2011. Thus in general lower income levels lead also to lower prices. It is a recession on all fronts. The results point out to the importance of devising different corporate tax policies, which affect the savings and private investment. Note that we have modeled only sectoral totals of investment, and did not distinguish between the public and private investments. When corporate taxes are raised, it would lead to lower corporate savings and lower private investment. Generally one expects that Government would raise tax resources in order to finance its various activities including raising the public investment. If the increased tax resources really led to increase in public investment compensating for the loss of private investment, then the level of total investment would nearly be the same, except that the composition between public and private components would be different. Then, the impact on total investment would have been insignificant! But this is not the case indicated by our results. The government revenues tend to be aimed at directing resources away from productive activities to unproductive consumption subsidies.

In Run9 and Run10, real trade balance (exports-imports) is less negative in the former (exports grow faster than imports) and more negative in the latter (imports grow faster than exports). In Indian exports manufactured goods accounted for more than 75 per cent and agricultural products for about 12 per cent in 2003. In imports while petroleum and related products accounted for about 26 per cent, capital goods (including transport machinery among others) for 14 per cent, non-POL items (computer software, electronic goods, and a host of trade and non-trade related other goods) for 42 per cent. The agricultural related items have a larger share in the exports than in imports, where as it is reverse in the case of services related items.

Share of Imports – 2003	Per cent	Share of Exports – 2003	Per cent
Petroleum crude and products imports	26.32	Agricultural and allied products export	11.80
Food and related items imports	4.36	Ores and minerals export	3.71
Textile yarn fabrics, made-up articles imports	1.61	Manufactured goods export	75.96
Chemicals and related products imports	7.99	Petroleum and crude products export	5.59
Capital goods imports	13.99	Other commodities export	2.95
Other non-POL items imports	42.41		
Other commodities imports	3.33		

Source: Business Beacon, CMIE Database.

Our model unfortunately does not distinguish between agricultural and non-agricultural exports and imports separately. Such distinction would involve computing commodity-wise separate price deflators for exports and imports, and aggregation. In this model, the trade balance at current prices has been deflated using only the GDP price deflator. This could in principle cause some distortion in the results, which has to be kept in mind while interpreting the results. In Run9 higher exports would lead to higher industrial investment (with one period lag though) and GDP. In the case of agriculture too, the GDP and investment (though not in all years) go up. The positive impacts on industry are more than those on agriculture. In 2011, the IGDP (AGDP) is 4.62 per cent (3.75 per cent) higher in Run9 compared to the reference run level. Generally the impact on services seems to be negative for both GDP and GCF with the latter having more impact. With regard to prices the story is different: first, the impacts, often less than 1 per cent compared to the reference run, are not as prominent as on GDPs and GCFs. Next, higher exports would lead to higher prices in industry and services but to lower prices in agriculture. The results under Run10 where imports go up relative to exports are opposite. These results indicate three different situations. One, on all fronts (GDP, GCF and prices) industry gains with higher exports, and loses with higher imports. Recall that the short-run parameter of RTB variable is positively significant only for the IGDP in the industry model. RTB has no direct effect on IGCF and IPDFL. Therefore the direction of the movements in the IGCF and IPDFL are a result mainly of the corresponding adjustment parameters. Here any rise in GDP must be accompanied by a rise in the corresponding GCF and prices as per these parameters. Two, gains or losses are only in GDP and GCF but not in prices. This is the case with services where also the short-run parameter of the

RTB is significant only for SGDP. Hence SGCF and SPDFL adjust according to the movements in SGDP. Therefore when with higher imports (exports) services sector gains (loses) in GDP and GCF, consequently it loses (gains) in prices – that is the LRE of this sector. Three, in agriculture model, the short-run parameters of the RTB are significant for both AGDP (positive) and APDFL (negative). This means, trade liberalisation and more exports actually lead to lower agricultural prices though GDP would go up. Now, AGCF has to adjust according to the movements in AGDP and APDFL. With higher exports when prices fall and the GDP goes up, investment has to rise to restore the equilibrium. This feature can be understood in a different way also. Actually, when exports go up, the rise in GDP more than compensates for the fall in prices as far as the agricultural incomes are concerned. Whereas when imports go up, the rise in prices do not compensate for the fall in GDP. The table below presents the AGDP, APDFL and their product (AGDPxAPDFL=Income). The income levels are higher in the exports oriented RUN9 where prices are lower than in the imports oriented Run10. But prices in both Run9 and Run10 anyway keep increasing over time. It then amounts to that the supply response of agriculture to changes in prices turns out to be higher when exports go up.

	AGDP			APDFL			Agricultural incomes		
Year (1)	Reference (2)	Run9 (3)	Run10 (4)	Reference (5)	Run9 (6)	Run10 (7)	Reference (8)	Run9 (9)	Run10 (10)
2003	286771	286771	286771	1.7832	1.7832	1.7832	511369	511369	511369
2004	304253	304253	304253	1.8331	1.8331	1.8331	557726	557726	557726
2005	320930	332169	307817	1.8834	1.8662	1.9035	604439	619893	585930
2006	330720	340578	319492	1.9316	1.9137	1.9521	638819	651765	623680
2007	326138	330045	321805	1.9704	1.9548	1.9880	642621	645173	639748
2008	342490	355497	327263	2.0116	1.9926	2.0335	688954	708363	665489
2009	342813	348445	336740	2.0590	2.0505	2.0683	705852	714486	696480
2010	353126	362267	342651	2.0999	2.0938	2.1066	741528	758514	721828
2011	364429	378104	348607	2.1281	2.1224	2.1345	775542	802489	744101

Run11 presents an adverse scenario where rainfall is bad continuously for three years as in Run1, fuel prices are rising at 10 per cent a year, money supply grows only at 6 per cent a year and real budget deficit does not go up as in Run6. All the sectors turn out casualties. Initially in the year 2005, agriculture suffers the most with a negative impact of 2 per cent which goes up to more than 8 per cent by 2011. The industry and services however over time become more affected with negative impacts by 2011 going up to 17 per cent and 8 per cent, respectively, compared to the reference levels. The negative impacts on investment levels are even higher than on the GDPs. The prices of course rise, with the maximum impact being on the services sector. The lower GDPs in the services sector are associated with higher prices – as can be anyway expected from the corresponding LRE itself. But the contribution of the short-run effects of the adverse situation is distinctly noticeable in the case of industry and agriculture. Here actually lower GCFs and GDPs should have been associated with lower prices. Besides, lower money supply and lower budget deficit should also have contained prices. But the effects of bad rainfall, and higher fuel prices dominated and the net result turned out a rise in prices. In such a scenario how far exports (if feasible) help the economy? Run12 attempts to answer this issue. The adverse impacts still continue, however with substantially reduced (increased) levels of the impacts both on industry and agriculture (services). But the overall impact on the total economy due to higher exports even in adverse situations is quite helpful.

V

CONCLUSIONS

We have attempted to analyse some important questions using the above simple models. Let us look into what kind of questions can and cannot be answered with the way these models have been estimated. For example, impulse-response function analysis (IRFA) for our models can provide answers to questions such as “what may happen to agricultural GDP (AGDP) and prices (APDFL) if agricultural investment (AGCF) experiences a shock (negative or positive)?” But, it is not possible to ask, “what may happen to industrial GDP and services prices (SPDFL) when AGCF experiences the shock?” This is so because AGCF, IGDP and SPDFL do not figure in the same VEC model as endogenous variables; they appear in different models. Given the data limitations it is not possible to bring all the variables into one model, and it is not possible to conduct IRFA across the models. We overcome this difficulty by developing a simulation model which uses the small VEC models in sequence. Given the way the above simulation model works, now one may ask even more precise questions: “How does the AGCF in the first place experience a shock – is it because the rainfall is low/high, or because fuel price has gone up, or bank rate has gone up, or because of the adverse trade balance?” Knowing this, then the simulations would work out the impact on the AGCF first, and on the IGDP and SPDFL later.

In a similar way, if one wants to analyse, what is the trade-off between output and inflation, first the source of inflation must be known – high fuel prices, inappropriate levels of money supply, bank rate and budget deficit, low rainfall, low levels of production in the past periods, etc. Inflation affects not only the output levels but along the way also affects several other variables including investments. Different exogenous variables all of which may be affecting inflation could have different impacts on investments and prices and consequently on output. Thus, targeting inflation requires first the knowledge of the source of inflation.[8] One is looking for total, not a partial, elasticity in this context. The ultimate responses in the endogenous variables presented in this paper due to changes in the exogenous policy specifications are not partial responses. For example when the results say that, if fuel prices rise by 10 per cent a year the impact on the IGDP would be -2.21 per cent in 2007 compared to the reference run, the figure does not imply that the other endogenous variables did not change at the same time. The fuel price rise could for example lead to a fall in the AGDP also, which in turn could affect the IGDP. The figure thus denotes all such direct and indirect impacts on the IGDP.

The exogenous variables have all been treated as purely exogenous here. For example, it was assumed in the above policy runs that when the fuel prices rise, budget deficit specification, etc., would still be the same to reflect upon the reality that the assumption may be relaxed. That is, interdependence among the exogenous variables can in principle be accounted for, though this has not been attempted here. Finally, savings and foreign direct investment do not explicitly appear in the above models. These have been subsumed under gross capital investments. With these limitations as well as advantages, the dozen policy scenarios studied here reveal different growth patterns over time for each sector. These patterns have been summarised in the following Table.

COMPOUND ANNUAL GROWTH RATE BETWEEN 2003 (ACTUAL) AND 2011 (FORECAST)

(*per cent*)

Policy Runs	AGDP	AGCF	APDFL	IGDP	IGCF	IPDFL	SGDP	SGCF	SPDFL	TGDP	TGCF	TPDFL
Reference Run	2.92	3.38	2.39	8.60	12.90	2.79	7.23	5.69	5.88	6.79	9.51	4.40
Run1 LRF	2.66	2.88	2.37	8.41	12.23	2.82	7.22	5.73	5.89	6.68	9.09	4.42
Run2: HRF	3.18	3.88	2.41	8.79	13.54	2.75	7.24	5.65	5.87	6.90	9.92	4.37
Run3: WPF 10 per cent	2.38	2.11	2.48	7.50	8.60	3.19	6.75	4.51	6.44	6.11	6.50	4.87
Run4: WPF 18 per cent	2.60	3.09	2.25	7.85	9.11	3.29	6.65	5.81	6.36	6.21	7.34	4.79
Run5: HRM3	3.20	3.61	2.53	9.67	16.25	3.06	7.84	7.21	4.85	7.49	12.10	3.90
Run6: LRBD	2.88	3.52	2.34	8.61	12.99	2.76	7.22	5.67	5.89	6.78	9.57	4.39
Run7: LRBR	3.01	3.51	2.43	8.91	14.41	2.79	7.26	5.84	5.89	6.92	10.50	4.39
Run8: LPCS	2.78	3.20	2.31	7.91	10.00	2.73	7.16	5.41	5.84	6.53	7.70	4.38
Run9: HEXP	3.40	3.61	2.35	9.21	13.95	2.91	7.10	5.59	5.97	7.00	10.14	4.43
Run10: HIMP	2.35	3.12	2.43	7.86	11.60	2.65	7.37	5.81	5.78	6.55	8.76	4.36
Run11: LRF, HWPF LRM3,LRBD	1.80	1.47	2.29	6.16	2.21	2.95	6.13	2.96	7.29	5.29	2.48	5.33
Run12: HWPF,LRM3, LRBD,HEXP	2.55	2.26	2.28	7.06	5.31	3.04	6.01	2.80	7.35	5.62	4.05	5.31
MINIMUM	1.80,	1.47,	2.25,	6.16,	2.21,	2.65,	6.01,	2.80,	4.85,	5.29,	2.48,	3.90,
	2.35	2.11	2.28	7.06	5.31	2.73	6.13	2.96	5.78	5.62	4.05	4.36
MAXIMUM	3.40,	3.88,	2.53,	9.67,	16.25,	3.29,	7.84,	7.21,	7.35,	7.49,	12.10,	5.33,
	3.20	3.61	2.48	9.21	14.41	3.19	7.26	5.84	7.29	7.00	10.50	5.31

L: Low, H: High.

Though the directions are comparable across the different runs, it is inappropriate to compare these results with regard to the magnitudes of the growth rates presented below – because these magnitudes depend on the levels of the exogenous variables that we specified. For example, the lower growth rate of 7 per cent under the Run9, compared to the 7.49 per cent growth rate under the Run5, could be increased with a different specification of the real trade balance with even higher level of export performance!

In this light, let us consider one issue: The reference run showed a growth rate of 6.8 per cent between 2003 and 2011, whereas the run with 10 per cent hike in fuel price showed only 6.1 per cent; i.e., a fall of 0.7 per cent. How to make up this loss of 0.7 per cent? The results show that a rise in money supply or corporate savings or exports, or lowering bank rate could increase the GDP growth rate. Then an appropriate combination of all these policies could possibly be worked out that can exactly counter the adverse effect of the fuel price hike.

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APPENDIX

Data and variables considered: The variables considered are Agricultural GDP, GCF, price deflator (APDFL), Industrial GDP, GCF, price deflator (IPDFL), Services GDP, price deflator (SPDFL), Rainfall Index (RI), Fuel prices (WPF), Real money supply (RM3), Real bank rate (RBR), Real budget deficit (RBD) and Real trade balance (RTB). All the data are at constant prices (base year 1993-94). The data on AGDP, AGCF, IGDP, IGCF, SGDP, and SGCF have been collected from Business Beacon (BB), CMIE data-base for the years 1952-53 to 2002-03, which is referred to as 1953-2003. The data on the other variables were computed using procedures as described now. Data on nominal money supply was collected from BB for the years 1971-2003 and for the years 1953-1970 from H. L. Chandhok's and the Policy Group's 'Indian data base-The Economy'. Using the data on nominal money supply, real money supply was computed by dividing nominal money supply by total GDP price deflator PDFL (PDFL=[(TGDP $_{\text{current prices}}$ /TGDP $_{\text{1993-94 prices}}$)]. Similarly for real budget deficit, data on nominal budget deficit were collected from H. L. Chandhok's and the Policy Group's data base for the year 1953-89 and from the Economic Surveys of India for the years 1989-2003. Real budget deficit was computed by dividing nominal budget deficit by the price deflator PDFL. For real trade balance, data on nominal trade balance was collected from BB, CMIE data base, from the years 1953-2003 and real trade balance computed by dividing nominal trade balance by the price deflator PDFL. The real bank rate was constructed as nominal annual bank rate minus inflation rate. The data on nominal annual bank rate was obtained from the Reserve Bank of India data documents. In case of the years when there was more than one bank rate prevailed over the year, the average of all the bank rates was taken as the annual bank rate for that year. The inflation rate was computed as the percentage change in the price deflator PDFL, i.e., inflation rate= ($PDFL_t - PDFL_{t-1}$)/ $PDFL_{t-1}$. The sectoral price deflators APDFL, IPDFL, and SPDFL were constructed respectively as the ratio of the corresponding sectoral GDPs at current and constant prices, i.e., APDFL = (AGDP $_{\text{current prices}}$ /AGDP $_{\text{1993-94 prices}}$) and similarly for IPDFL and SPDFL. In the case of fuel prices (WPF), a fuel price index was constructed using the whole sale prices of three major components of fuel i.e. petrol, high speed diesel oil and low speed diesel oil. The data on whole sale prices was collected from H. L. Chandhok's and the Policy Group's 'Indian data base-The Economy' for the year 1953-89 and from BB, CMIE data base for 1983-2003. The data from 1953-89 was using 1970-71 as the base year. And the data from 1983-2003 was using 1993-94 as the base year. Hence as a first step, WPF was constructed for the first set of data (1953-89) as the weighted average of petrol, high speed diesel oil and low speed diesel oil, the weights being the same as specified in the construction of the index numbers of wholesale prices. Similar procedure was repeated for the second set of data (1983-2003). As the two sets had different base years, in order to make them compatible to one base year i.e. 1993-94 the first data set was proportionally spliced with the second data set. Similarly in the case of the rainfall index (RI), data for actual rainfall was collected from BB, CMIE data base, for the year 1971-2003. The Rainfall index was computed using this data by dividing the series by the arithmetic average of the series from 1971 to 2003. Data for another similarly constructed rainfall index was taken from the AGRIM model (Narayana *et al*., 1991) for the years 1953-1970. Again the splicing technique was used to make the two series of the indexes compatible with each other.

NOTES

1. The consumption aspect will be taken up elsewhere.
2. There is a lot of literature dealing with incorporation of deterministic trends into CIVs. See Luetkepohl and Kratzig (2004), Hungnes (2004), Philips and Catherine (2000), Hendry and Mizon (2001) etc.
3. Consider a VAR(p) model, $Y_t = c + A_1 Y_{t-1} + A_2 Y_{t-2} + \ldots\ldots + A_p Y_{t-p} + u_t$. The reverse characteristic polynomial is defined as,

$$\det (I_k - A_1 Z_1 - A_2 Z_2 - \ldots\ldots\ldots\ldots - A_p Z_p)$$

The companion matrix is given by

$$A = \begin{pmatrix} A_1 & A_2 & \ldots\ldots\ldots & A_{p-1} & A_p \\ I_k & 0 & \ldots\ldots\ldots & 0 & 0 \\ 0 & I_k & \ldots\ldots\ldots & 0 & 0 \\ \ldots & \ldots & \ldots\ldots\ldots & \ldots & \ldots \\ \ldots & \ldots & \ldots\ldots\ldots & \ldots & \ldots \\ 0 & 0 & \ldots\ldots\ldots & I_k & 0 \end{pmatrix}$$

Thus the matrix A is of the order kp x kp, where k=number of endogenous variables and p=number of lags. In the case of VEC (p-1) model, the coefficients of the corresponding levels VAR(p) model is first computed. Using the coefficients of the VAR(p) the companion matrix is computed. For further details refer to Luetkepohl (1991) and Gregory (1993).

4. Some studies follow a different procedure. They generally omit 3 to 4 years' data towards the end of the sample while estimating the models; and then forecasts made for the omitted period are compared for their closeness with the actual data. This procedure is fine if only there are not any major structural breaks in the omitted period and enough data are available. We have not omitted any observations during estimation since already severe data shortage problems exist, and there would not have been enough degrees of freedom if some data are to be omitted.

5. A crore = 10 millions = 100 lakhs.

6. In a scenario in which rainfall is below normal only for one year (90 per cent in 2005) and returns to normalcy (100 per cent) from 2006 onwards, the impact turned out to be that AGDP is 1.32 per cent less than the reference run level in 2005, and the impact gradually reduced to -0.6 per cent by 2011.

7. This result is somewhat contrary to Ramachandran (2004).

8. See Kannan (1999), Vasudevan(2002) etc.

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