CHAPTER - 8
CAUSAL RELATIONSHIP BETWEEN RUPEE/NEPALESE RUPEE EXCHANGE RATE AND RELATIVE PRICE LEVEL-A STUDY WITH VECTOR AUTOREGRESSIVE MODEL

8.1 Introduction:

'Cointegration' study in Chapter 6 has confirmed the existence of long-run relation between exchange rate(e_t) and relative price level(p_t) over the sub-period 1993:2-2006:1. The study with the estimated *Vector Error Correction Model* (VECM) in Chapter 7 has established the *stability* of such long run relationship between e_t and p_t. It is, therefore, pertinent to examine if the estimated relationship between e_t and p_t or a variant of it could be effectively used for forecasting the future values of the variables concerned.

Granger and Newbold (1977) hold that any *stable* long-run relationship can be effectively used as a forecasting equation provided such relationship entails '*Causality*' of any sort running from any of the variables to another. If e_t, in *Granger's Sense*, causes p_t, then the equation can be used to forecast future values of p_t. If, on the other hand, p_t, in *Granger's Sense*, causes e_t, then the equation may serve as an *effective forecasting equation* for e_t. If there exists *bi-directional causality*, in *Granger Sense*, then the equations can serve as the basis for the forecasting of both e_t and p_t.

We, therefore, seek to examine, the nature and direction of *Granger Causality* between e_t and p_t in their long-run relationship over the sub-period 1993:2-2006:1, as evidenced by the study of *Cointegration* in Chapter 6. The study in this Chapter is devoted to address this issue. The study is carried through the estimation of an appropriate *Vector Autoregressive Model* (VAR) for e_t and p_t over the period 1993:2-2006:1.

8.2 The Vector Autoregressive (VAR) Model

The Vector Autoregressive (VAR) Model for Rupee/Nepalese Rupee Exchange Rate(e_t) and relative price level(p_t) is as follows.

$$E_t = \alpha_1 + \sum_{i=1}^{m} \beta_{1i} E_{t-i} + \sum_{i=1}^{m} \gamma_{1i} p_{t-i} + u_{1t} \quad (8.1)$$

$$p_t = \alpha_2 + \sum_{i=1}^{m} \beta_{2i} E_{t-i} + \sum_{i=1}^{m} \gamma_{2i} p_{t-i} + u_{2t} \quad (8.2)$$

Here $E_t = \Delta e_t$ and $P_t = \Delta p_t$ represent the first differenced stationary time series dataset for e_t and p_t respectively over the sub-period 1993:2-2006:1. Since $e_t \sim I(1)$ and $p_t \sim I(1)$, the stationarity of E_t and P_t is ensured through the first difference filtering of e_t and p_t respectively.

$u_{1t} \sim GWN\ (0, \sigma^2_{u_1})$ and $u_{2t} \sim GWN\ (0, \sigma^2_{u_2})$ are the stochastic error terms which are known as *impulse* or *innovations* or *shocks* in the VAR Model.

The equations (8.1) and (8.2) represent '*Seemingly Unrelated Regression Equations*' (SURE) since the joint estimation of these equations considers and uses the '**Contemporaneous Var-Covariance matrix (Ω)** of the cross equation error terms involved such that **Ω = Var-Covar (u_{1t}, u_{2t})** where **Ω** is a **Positive Definite Matrix.**

8.3 Selection of Lag Length in the VAR Estimation

The *optimum lag length* (m) has been determined on the basis of some *Information Criteria* like *Akaike Information Criterion* (AIC), *Schwartz Information Criterion* (SIC), *Hannan-Quin Information Criterion* (HQIC), *Sequential Modified LR Test Statistic* (SMLST), *Forecast Prediction Error(FPE) Statistic* etc. The Table 8.1.presents the relevant lag length statistics as given by these criteria.

Table 8.1

VAR LAG ORDER SELECTION CRITERIA

Endogenous variables: E_t, P_t Exogenous variables: C

Sample: 1993:2 2006:1 Included observations: 46

Lag	LogL	LR	FPE	AIC	SIC	HQ
0	321.8117	NA	3.14E-09	-13.905	-13.825	-13.875
1	328.3466	12.21741	2.81E-09	-14.015	-13.776	-13.926
2	339.0528	19.08504	2.10E-09	-14.307	-13.909*	-14.158*
3	339.3525	0.508246	2.48E-09	-14.146	-13.589	-13.937
4	**346.4020**	**11.34037***	**2.18E-09**	**-14.278**	**-13.563**	**-14.010**
5	352.4333	9.178141	2.01E-09*	-14.367*	-13.492	-14.039

* indicates lag order selected by the criterion

LR: sequential modified LR test statistic (each test at 5% level)

FPE: Final Prediction Error

AIC: Akaike Information Criterion

SIC: Schwarz Information Criterion

HQ: Hannan-Quinn Information Criterion

SIC and HQ statistics suggest for lag 2 as the optimum lag. However, the LR statistics suggest for lag 4 as the optimum lag. The *trial and error* estimations, as suggested by Enders, also conform lag 4 as the optimum lag. So in the VAR model, consisting of equations (8.1) and (8.2), the optimum lag (m) is set to be 4.

8.4 Results of the Estimation of the VAR Model

Results of the estimation of the VAR model are being presented through the Tables 8.2 and 8.3.

Table : 8.2

Results of VAR Model Estimation (Equation 8.1)

Sub-Period: 1993:2-2006:1 Sample (adjusted): 1994:3-2006:1

Included Observations: 47 (after adjusting endpoint)

Dependent Variable	Explanatory Variable/Constant	Coefficient	S.E	t-stat.	Prob.
E_t	Constant	-0.001	0.001	-0.876	0.386
	E_{t-1}	-0.657	0.162	-4.042	0.000
	E_{t-2}	-0.456	0.194	-2.348	0.024
	E_{t-3}	0.030	0.194	0.155	0.877
	E_{t-4}	0.014	0.163	0.088	0.930
	P_{t-1}	0.007	0.092	0.076	0.939
	P_{t-2}	-0.109	0.090	-1.216	0.232
	P_{t-3}	0.035	0.088	0.397	0.694
	P_{t-4}	-0.202	0.087	-2.332	0.025
R^2= 0.433 Adj R^2 = 0.313 F-Stat. = 3.624 Log Likelihood = 188.730 AIC = -7.648 SIC = -7.294 Determinant Residual Covariance = 1.46E-09					

Table : 8.3

Results of VAR Model Estimation (Equation 8.2)

Sub-Period: 1993:2-2006:1 Sample (adjusted): 1994:3-2006:1

Included Observations: 47 (after adjusting endpoint)

Dependent Variable	Explanatory Variable/Constant	Coefficient	S.E	t-stat.	Prob.
P_t	Constant	-0.000	0.001	-0.157	0.876
	E_{t-1}	0.003	0.271	0.013	0.990
	E_{t-2}	0.102	0.324	0.314	0.755
	E_{t-3}	0.240	0.324	0.740	0.464
	E_{t-4}	0.410	0.272	1.509	0.139
	P_{t-1}	0.141	0.154	0.914	0.367
	P_{t-2}	-0.225	0.150	-1.497	0.143
	P_{t-3}	0.047	0.148	0.320	0.751
	P_{t-4}	0.432	0.145	2.986	0.005
R^2= 0.396 Adj R^2 = 0.269 F-Stat. = 3.115 Log Likelihood = 164.656 AIC = -6.624 SIC = -6.269 Determinant Residual Covariance = 1.46E-09					

8.5 Essential Features of the VAR Model

The VAR Model consisting of equations (8.1) and (8.2) requires that

i. E_t and P_t be '*Stationary*'.

ii. the model be '*Stable*'.

iii. u_{1t} and u_{2t} be *white noise terms* such that

$$u_{1t} \sim iidN\ (0, \sigma^2_{u_1})$$

$$u_{2t} \sim iidN\ (0, \sigma^2_{u_2})$$

In this model E_t and P_t are '**Stationary**' since

$E_t = \Delta e_t$ and $P_t = \Delta p_t$

where $e_t \sim I(1)$ and $p_t = I(1)$

Therefore $E_t \sim I(0)$ and $P_t = I(0)$

Consequently, the first requirement is satisfied.

Again the *consistence* of the VAR Model requires that the model be *stable*. The conditions of '*stability*' are derived below and then we proceed to examine if these conditions are met by the estimated VAR model. Once the '*stability*' conditions are satisfied, then we would examine if u_{1t} and u_{2t} are *white noise* by nature.

8.6 Conditions of Stability For the VAR Model

From the equation (8.1) we have

$$E_t - \sum_{i=1}^{4} \beta_{1i} E_{t-i} = \alpha_1 + \sum_{i=1}^{4} \gamma_{2i} P_{t-i} + u_{1t}$$

or $$E_t(1 - \sum_{i=1}^{4} \beta_{1i} L^i) = \alpha_1 + \sum_{i=1}^{4} \gamma_{2i} P_{t-i} + u_{1t}$$

or $$A(L) E_t = \alpha_1 + \sum_{i=1}^{4} \gamma_{2i} P_{t-i} + u_{1t}$$

or $$E_t = [A(L)]^{-1} [\alpha_1 + \sum_{i=1}^{4} \gamma_{2i} P_{t-i} + u_{1t}] \qquad (8.3)$$

where $A(L) = (1 - \beta_{11} L - \beta_{12} L^2 - \beta_{13} L^3 - \beta_{14} L^4$

The absolute value of each of the eigen values of the ***Characteristic Polynomial A(L)*** in equation (8.3) must be less than unity for the **stability** of the equation (8.1).

Similarly, from the equation (8.2) we have

$$P_t = [B(L)]^{-1} [\alpha_2 + \sum_{i=1}^{4} \gamma_{2i} E_{t-i} + u_{2t}]$$

where $$B(L) = (1 - \sum_{i=1}^{4} \beta_{2i} L^i)$$

$$= (1 - \beta_{11} L - \beta_{12} L^2 - \beta_{13} L^3 - \beta_{14} L^4) \qquad (8.4)$$

The modulus of each of the eigen values of the ***Characteristic Polynomial B(L)*** in equation (8.4) must be less than unity for the *stability* of the equation (8.2). The roots of the AR *characteristic polynomial [A(L) or B(L)]* are being presented through the Table 8.4 while the Inverse Roots of AR characteristic polynomial [A(L) or B(L)] are shown by the Figure 8.1 below.

Table 8.4

VAR Stability Condition Check [Roots of the AR Characteristic Polynomial A(L)]

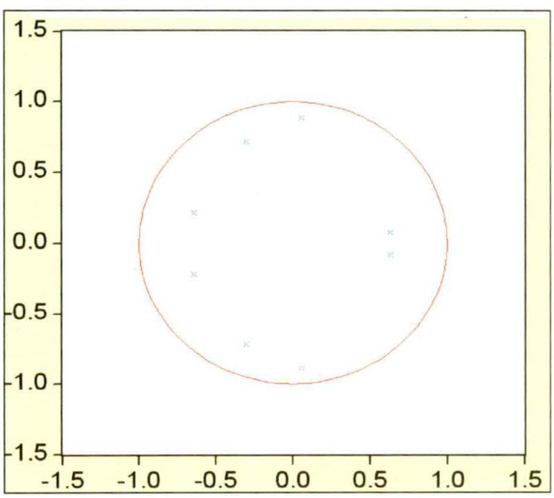
Endogenous Variable: E_t, P_t

Exogenous Variable: C   Lag Specification: 1 4

Root	Modulus
0.055132 - 0.888131i	0.889841
0.055132 + 0.888131i	0.889841
-0.303076 - 0.718820i	0.780101
-0.303076 + 0.718820i	0.780101
-0.640972 - 0.216865i	0.676665
-0.640972 + 0.216865i	0.676665
0.630875 - 0.079582i	0.635874
0.630875 + 0.079582i	0.635874
No root lies outside the unit circle.	

Figure 8.1

Inverse Roots of AR Characteristic Polynomial A(L)



8.7 Examination of the Stability of the VAR Model

(A) The Table 8.4 presents the roots and respective modulus of each of the roots in A(L)

It is observed that

i. four of the eigen values are positive.
ii. four of the eigen value are negative.

Again the Figure 8.1 shows that inverse roots of the **AR *Characteristic Polynomial A(L)*** lie within unit circle. Thus the findings from the Figure 8.1 and the Table 8.4 confirm the '*Stability of the estimated VAR* Model.

8.8 Normality of the VAR Residuals $\hat{u}_{1t}$ and $\hat{u}_{2t}$: Jarque-Bera Test

Normality of the $\hat{u}_{1t}$ and $\hat{u}_{2t}$ is being examined through the *Jarque-Bera VAR Residual Normality Tests*. Results of such tests are being reported through the Table 8.5 below.

Table 8.5

VAR Residual Normality Tests
Orthogonalization: Residual Correlation (Doornik-Hansen)
Null Hypothesis: residuals are multivariate normal
Sample: 1993:2- 2006:1
Included observations: 47

Component	Skewness	Chi-sq	df	Prob.
E_t	-0.186	0.337	1	0.561
P_t	-0.026	0.007	1	0.935
Joint		0.344	2	0.842
Component	Kurtosis	Chi-sq	df	Prob.
E_t	1.851	4.519	1	0.033
P_t	1.276	20.364	1	0.000
Joint		2.632	2	0.000
Component	Jarque-Bera	df	Prob.	
E_t	4.856	2	0.088	
P_t	20.371	2	0.000	
Joint	25.227	4	0.000	

It is observed from the Table 8.5 that

i. the JB statistic for $\hat{u}_{1t}$ = 4.856. It implies that the null hypothesis (i.e residuals $\hat{u}_{1t}$ are normal) has been accepted even at 10% level.

ii. the JB statistic for $\hat{u}_{2t}$ = 20.371. The null hypothesis that residuals $\hat{u}_{2t}$ are normal has been accepted even at 1% level.

iii. the JB statistic for the joint test of normality of $\hat{u}_{1t}$ and $\hat{u}_{2t}$ = 25.227. The null hypothesis of normality for both $\hat{u}_{1t}$ and $\hat{u}_{2t}$ has been accepted at 1% level.

These findings confirm the multivariate normality of the residuals ($\hat{u}_{1t}$ and $\hat{u}_{2t}$) of the VAR model consisting of equations (8.1) and (8.2).

8.9 Serial Independence of the VAR Residuals ($\hat{u}_{1t}$ and $\hat{u}_{2t}$)

The correlograms of the VAR residuals $\hat{u}_{1t}$ and $\hat{u}_{2t}$ are given by the Figures 8.2 and 8.3 below.

Figure : 8.2

Correlogram of Residuals $\hat{u}_{1t}$

Included observations: 47 Sample: 1993:2 2006:1

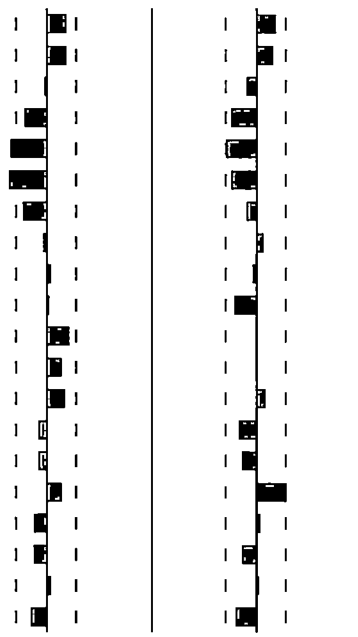
Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	0.080	0.080	0.3231	0.570
		2	0.044	0.037	0.4206	0.810
		3	0.021	0.015	0.4444	0.931
		4	-0.131	-0.137	1.3698	0.849
		5	-0.118	-0.102	2.1371	0.830
		6	-0.208	-0.189	4.5782	0.599
		7	0.006	0.048	4.5806	0.711
		8	-0.287	-0.309	9.4299	0.307
		9	-0.006	0.016	9.4323	0.398
		10	0.128	0.074	10.447	0.402
		11	0.052	0.024	10.617	0.476
		12	0.079	-0.045	11.032	0.526
		13	0.024	-0.027	11.072	0.605
		14	0.038	-0.056	11.175	0.672
		15	-0.209	-0.192	14.320	0.501
		16	-0.108	-0.154	15.184	0.511
		17	-0.081	-0.087	15.685	0.546
		18	-0.099	-0.042	16.464	0.560
		19	0.045	0.010	16.628	0.615
		20	0.153	0.111	18.616	0.547

Figure : 8.3

Correlogram of Residuals $\hat{u}_{2t}$

Included observations: 47 Sample: 1993:2 2006:1

Autocorrelation Partial Correlation



	AC	PAC	Q-Stat	Prob
1	0.193	0.193	1.8713	0.171
2	0.190	0.158	3.7169	0.156
3	-0.014	-0.081	3.7272	0.292
4	-0.201	-0.232	5.9002	0.207
5	-0.340	-0.287	12.229	0.032
6	-0.358	-0.242	19.428	0.003
7	-0.219	-0.077	22.186	0.002
8	-0.031	0.069	22.244	0.004
9	0.035	-0.022	22.318	0.008
10	0.029	-0.206	22.370	0.013
11	0.226	0.010	25.644	0.007
12	0.153	0.015	27.191	0.007
13	0.165	0.089	29.033	0.006
14	-0.061	-0.156	29.292	0.010
15	-0.059	-0.132	29.542	0.014
16	0.140	0.297	30.996	0.013
17	-0.113	0.035	31.975	0.015
18	-0.107	-0.130	32.880	0.017
19	0.033	0.033	32.971	0.024
20	-0.141	-0.189	34.679	0.022

It is observed from the Figures 8.2-8.3 that

i. the corresponding *ACFs* of $\hat{u}_{1t}$ and $\hat{u}_{2t}$ are free from any from significant spikes in the spread of lags from one through twenty.

ii. the corresponding *PACFs* of the VAR residuals $\hat{u}_{1t}$ and $\hat{u}_{2t}$ are also marked by the absence of any significant spikes in lags 1-20.

These observations indicate that the VAR residuals are serially independent, given that quarterly data for e_t and p_t have been used for the estimation of the VAR model.

8.10 Further Confirmation of Serial Independence: Portmanteau Test

Serial independence of the VAR residuals, $\hat{u}_{1t}$ and $\hat{u}_{2t}$, has further been examined through the '*Portmenteau Tests*'. Results of such tests have been presented through the Table 8.6 below.

Table 8.6

VAR Residual Portmanteau Tests for Autocorrelations

Null Hypothesis: No Residual Autocorrelations up to lag h

Sample: 1993:2- 2006:1 Included observations: 47

Lags	Q-Stat	Prob.	Adj Q-Stat	Prob.	df
1	2.544469	NA*	2.599783	NA*	NA*
2	4.946730	NA*	5.108812	NA*	NA*
3	5.418701	NA*	5.612963	NA*	NA*
4	8.013421	NA*	8.449052	NA*	NA*
5	16.95295	0.0020	18.45281	0.0010	4
6	25.12574	0.0015	27.82162	0.0005	8
7	29.29382	0.0036	32.71911	0.0011	12
8	33.71842	0.0059	38.05132	0.0015	16
9	36.17345	0.0147	41.08781	0.0036	20
10	38.68280	0.0295	44.27536	0.0071	24
11	47.93089	0.0109	56.34925	0.0012	28
12	50.61613	0.0194	59.95515	0.0020	32

*The test is valid only for lags larger than the VAR lag order.

The Table 8.6 shows that

i. the adjusted Q-statistics in the Portmenteau Tests for lag h $(4 < h \leq 12)$ are significant even at 1% level.

ii. the null hypothesis of '*no residual autocorrelation*' up to lag h $(4 < h \leq 12)$ therefore, has been accepted at 1% level.

Thus the *Portmenteau Tests* also confirm *serial independence* of the VAR residuals ($\hat{u}_{1t}$ and $\hat{u}_{2t}$).

8.11 Homoscedasticity of the VAR Residuals ($\hat{u}_{1t}$ and $\hat{u}_{2t}$)

Time plots of the VAR residuals ($\hat{u}_{1t}$ and $\hat{u}_{2t}$) are given by the Figures 8.4 and 8.5 respectively.

Figure : 8.4

Time Plot of VAR Residuals $\hat{u}_{1t}$

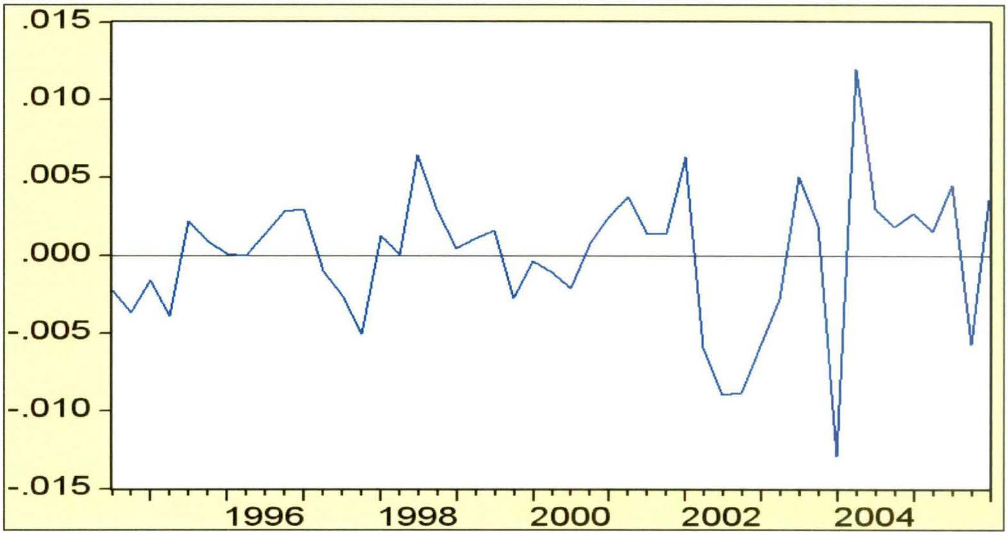
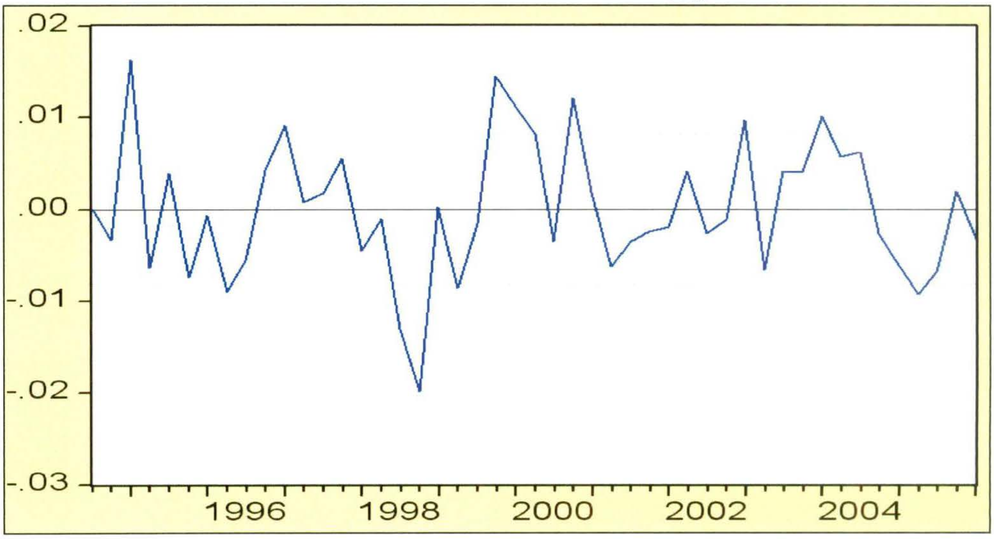


Figure : 8.5

Time Plot of VAR Residuals $\hat{u}_{2t}$



The Figures 8.4 and 8.5 show that

i. time plots of $\hat{u}_{1t}$ and $\hat{u}_{2t}$ exhibit variations around 'zero' mean.

ii. $\hat{u}_{1t}$ exhibits almost uniform variations around the zero-mean over the period concerned.

iii. time plot of $\hat{u}_{2t}$ is devoid of any flutter or concentration of variations at or around any period.

All these observations testify for the 'homoscadasticity' of the VAR residuals $\hat{u}_{1t}$ and $\hat{u}_{2t}$.

8.12 Further Confirmation of Homoscdasticity of VAR Residuals: Correlogram of VAR Residual Variance

The homoscadasticity of VAR residuals $\hat{u}_{1t}$ and $\hat{u}_{2t}$ has further been examined through the study of the correlograms of the variance of the residuals concerned. The relevant correlograms are given by the Figure 8.6 and 8.7.

Figure : 8.6

Correlogram of Variance of VAR Residuals, $\hat{u}_{1t}$

Included observations: 47 Sample: 1993:2 2006:1

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	0.463	0.463	10.744	0.001
		2	0.037	-0.227	10.812	0.004
		3	0.007	0.122	10.815	0.013
		4	-0.023	-0.099	10.842	0.028
		5	0.169	0.308	12.403	0.030
		6	0.377	0.193	20.400	0.002
		7	0.202	-0.080	22.754	0.002
		8	0.052	0.059	22.916	0.003
		9	-0.030	-0.098	22.970	0.006
		10	-0.129	-0.078	24.000	0.008
		11	-0.067	-0.072	24.291	0.012
		12	-0.035	-0.159	24.374	0.018
		13	-0.069	-0.030	24.698	0.025
		14	-0.054	-0.049	24.898	0.036
		15	-0.049	0.035	25.068	0.049
		16	-0.049	0.058	25.243	0.066
		17	-0.007	0.065	25.247	0.089
		18	-0.037	0.025	25.358	0.115
		19	-0.062	0.027	25.674	0.140
		20	-0.054	-0.024	25.924	0.168

Figure : 8.7

Correlogram of Variance of VAR Residuals, $\hat{u}_{2t}$

Included observations: 47 Sample: 1993:2 2006:1

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	0.049	0.049	0.1224	0.726
		2	-0.091	-0.094	0.5454	0.761
		3	-0.071	-0.062	0.8072	0.848
		4	0.176	0.177	2.4662	0.651
		5	0.092	0.064	2.9283	0.711
		6	-0.003	0.013	2.9289	0.818
		7	-0.125	-0.095	3.8339	0.799
		8	0.032	0.025	3.8952	0.866
		9	-0.047	-0.096	4.0265	0.910
		10	-0.135	-0.155	5.1543	0.881
		11	-0.138	-0.105	6.3735	0.847
		12	-0.096	-0.122	6.9820	0.859
		13	-0.111	-0.137	7.8218	0.855
		14	0.034	0.054	7.9003	0.894
		15	0.208	0.280	11.024	0.751
		16	-0.200	-0.200	13.988	0.600
		17	0.031	0.155	14.062	0.663
		18	0.014	0.005	14.078	0.724
		19	0.064	-0.092	14.414	0.759
		20	-0.031	-0.074	14.499	0.804

The Figures show that

i. The *ACF* and *PACF* of the variance of $\hat{u}_{1t}$ series contain singularly significant spike at lag one.

ii. The *ACF* and *PACF* of the variance $\hat{u}_{2t}$ series are free from any significant spikes at any lag.

These observations indicate that

i. Variance of the residuals $\hat{u}_{1t}$ defines an ARMA(0,1) process, and

ii. Variance of the residuals $\hat{u}_{2t}$ defines an ARMA(0,0) process.

Consequently, the VAR residuals, $\hat{u}_{1t}$ and $\hat{u}_{2t}$ are found to be free from *Autoregressive Conditional Heteroscadasticity (ARCH).*

8.13 Findings From the VAR Model (Table 8.2)

In the estimated equation (8.1) in the Table 8.2

i. $\sum_{i=1}^{4} \hat{\beta}_{1i} < 1$, $\sum_{i=1}^{4} \hat{\gamma}_{1i} < 1$. So the *autoregressive and distributed* lag structures are *consistent.*

ii. $\hat{\beta}_{11}$ and $\hat{\beta}_{12}$ are significant at 1% and 5% levels respectively.

iii. $-1 < \hat{\beta}_{11} < 0$ and $-1 < \hat{\beta}_{12} < 0$.

iv. $\hat{\gamma}_{14}$ is significant at 5% level.

8.14 Economic Interpretations of Findings in Section 8.13

The economic significance of the findings in Section 8.13 is as follows:

a. Negative and significant value of $\hat{\beta}_{11}$ and $\hat{\beta}_{12}$ indicate that variations in current exchange rate were inversely related to those in one and two period back exchange rates. It again implies that variations in exchange rate beyond the second lag period failed to exert any significant effect on current exchange rate.

b. Again the negative and significant values of $\hat{\beta}_{11}$ and $\hat{\beta}_{12}$ imply that a rise(fall) in Rupee/ Nepalese Rupee Exchange rate at any period led to a fall (rise) in the exchange rate in the next period (quarter). This feature of exchange rate dynamics is a pointer to the existence of a check on the run-away appreciation/depreciation of Indian Rupee against Nepalese Rupee over the period of study. This feature of exchange rate dynamics testifies for the '*Overshooting*' of E_t over the period of study.

c. $\hat{\gamma}_{14}$ being significant, even in the presence of E_{t-i} (i=1,2,3,4) in the vector of regressors in the VAR equation for E_t, indicates that relative price level '*Granger Caused'* exchange rate over the period of study.

8.15 Findings From the Estimated VAR Model (Table 8.3)

It is observe from the estimated equation (8.2) in the VAR model as given in the Table 8.3 that

i. $\sum_{i=1}^{4} \hat{\beta}_{2i} < 1$, $\sum_{i=1}^{4} \hat{\gamma}_{2i} < 1$ $\quad i = 1,2,3,4$

So the *autoregressive and distributed lag* structures are consistent.

ii. $\hat{\beta}_{2i} (i = 1, \ldots\ldots\ldots ,4)$ are not significant even at 10% level.

iii. $\hat{\gamma}_{24}$ is significant at 1% level.

iv. $0 < \hat{\gamma}_{24} < 1$.

8.16 Economic Interpretations of the Findings in Section 8.15

Economic significance of the findings from the estimated equation (8.2) as given in Section 8.15 is as follows.

(a) $\hat{\gamma}_{24}$, being significant and positive, indicates that current relative price level was positively related to those in past fourth quarter. This is a pointer to the fact that the relative price level (for India and Nepal) exhibited a sustained trend over the sub-period concerned.

(b) again $0 < \hat{\gamma}_{24} < 1$ indicates that in the quarterly dataset, variations in four quarter back relative price level affect the current quarter relative price level directly, non-proportionately.

As a matter of fact, this feature accounts for a declining spell of relative price level over the sub-period concerned. This feature owes its emergence to a lower inflationary rate in India than that in Nepal over the period 1993:2-2006:1.

(c) $\hat{\beta}_{2i} (i = 1,........ 4)$ are not statistically significant in the presence of P_{t-i} (i=1,...4) in the vector of regressors for the P_t equation (equation 8.2) in the VAR model. This indicates that exchange rate *'failed to Granger Cause'* relative price level over the sub-period concerned.

(d) $\hat{\beta}_{2i} (i = 1,........ 4)$ being insignificant even at 10% level indicate that relative price level (P_t) is an exogenous variable in the VAR model. Consequently, relative price level (P_t) in the economy of India and Nepal appeared to be determined by some other factors than exchange rate. Exchange rate variations, therefore, *'failed to Granger Cause'* variations in relative price level over the period 1993:2-2006:1.

8.17 Summary of Findings in Chapter 8

It is, therefore, observed in Section 8.13 through Section 8.16 that over the sub-period 1993:2-2006:1.

i. *relative price level* **'Granger Caused'** *exchange rate.*

ii. *exchange rate* **'failed to Granger Cause'** *relative price level.*

iii. *there did exist, therefore,* ***'Uni-Directional Causality'*** *running from relative price level to exchange rate.*

iv. *Relative price level appeared to be an* **exogenous** *variable in the VAR model (i.e in the system).*