CHAPTER 6

DYNAMICS OF SHORT- RUN SHOCKS AND STABILITY OF THE LONG-RUN RELATIONSHIP BETWEEN EXCHANGE RATE AND MONEY SUPPLY

6.1 Introduction

Cointegration study in Chapter 5 confirms the existence of long-run relationship between Rupee/Dollar exchange rate and money supply in India. However, it is imperative to know if such relationship is stable. Stability of the long-run relationship is established if the short-run shocks transmitted through E_t or M_t channel converge before long. The stability of the long-run relationship is studied through the estimation of *Vector Error Correction Model* **(VECM).**

The *Vector Error Correction* specification restricts the long-run behavior of the endogenous variables to converge to their *cointegrating relationships* while allowing for a wide range of short-run dynamics. The *cointegration term* is known as the *error correction term* since the deviation from the long-run equilibrium is corrected gradually through a series of *partial short-run adjustments*. Therefore, **VECM** modeling gives important information about the short-run relationship between the *Cointegrated variables*.

Economic theories hold that money supply can cause variations in exchange rate. Specifically, if the supply increases, *cereris paribus,* domestic currency depreciates, i.e., spot rate rises. Dornbush (1976), Rodriguez (1976) and, Fisher (1978) hold the view. The *Monetary Theory of Exchange Rate* determination **(MAER)** also indicates that money supply causes variations in exchange rate. The process of adjustment of exchange rate, following the monetary shocks, is explained by standard theories of exchange rate.

6.2 The Vector Error Correction (VEC) Model

The Engle and Granger methodology of *Vector Error Correction* **(VEC)** can be applied to analyze the short-run dynamics between Rupee/Dollar exchange rate and money supply in the following way.

The estimable **VEC Model** in this study consists of the following equations

$$\Delta E_t = \alpha_1 + \rho_1 z_{1t-1} + \beta_i \sum_{i=1}^{n} \Delta E_{t-i} + \gamma_i \sum_{i=1}^{n} \Delta M_{t-i} + \omega_t \qquad (6.1)$$

$$\Delta M_t = \alpha_2 + \rho_2 z_{2t-1} + \beta_2 \sum_{j=1}^{m} \Delta M_{t-j} + \gamma_j \sum_{j=1}^{m} \Delta E_{t-j} + \vartheta_t \qquad (6.2)$$

where, ΔE_{t-i} = First Differenced Series of E_t at time t-i; i = 1, 2, 3, ---, n.

ΔM_{t-i} = First Differenced Series of M_t at time t-i; i = 1, 2, 3, ---, n.

Z_{1t-1} and Z_{2t-1} are error correction terms.

$\omega_t \sim$ i i d N $(0, \sigma_w^2)$, and $\upsilon_t \sim$ i i d N $(0, \sigma_\vartheta^2)$

The lag length (n), in estimation, are determined through *AIC* and *SIC*. In the estimation 2 lags have been taken, as suggested by the *AIC* and *SIC* criteria.

6.3 The Estimation and Results of VEC Model

The equations (6.1) and (6.2) have been estimated through OLS with quarterly data sets upon first differencing since the variables are cointegrated at upon first differencing. The results are being presented through the Table (6.1) shown below.

Table 6.1

Results of the VEC Estimation (Equation 6.1)

Sample (adjusted): 1976:1 - 2006:4

Included observations: 124 (after adjusting Endpoints)

Dependent Variable	Explanatory Variables	Coefficients	S.E.	't' statistic
ΔE_t	Constant (γ_1)	-0.019	0.074	- 0.263
	Z_{1t-1}	**-0.768**	**0.137**	**- 5.596**
	ΔE_{t-1}	-0.059	0.121	- 0.488
	ΔE_{t-2}	0.068	0.094	0.726
	ΔM_{t-1}	0.090	0.067	1.350
	ΔM_{t-2}	**0.289**	**0.072**	**3.978**
R^2 = 0.501, Adjusted R^2 = 0.480, F-statistic = 23.71, AIC = 2.507, SC = 2.643				

Table 6.2

Results of the VEC Estimation (Equation 6.2)

Sample (adjusted): 1976:1 - 2006:4

Included observations: 124 (after adjusting Endpoints)

Dependent Variable	Explanatory Variables	Coefficients	S.E.	't' statistic
ΔM_t	Constant (γ_1)	0.057	0.094	0.606
	Z_{2t-1}	0.049	0.174	0.282
	ΔM_{t-1}	**-0.855**	0.085	**-9.988**
	ΔM_{t-2}	**-0.649**	0.092	**-7.013**
	ΔE_{t-1}	-0.037	0.155	-0.239
	ΔE_{t-2}	0.051	0.120	0.427
$R^2 = 0.517$, Adjusted $R^2 = 0.497$ F-statistic = 25.33, AIC = 2.98, SIC = 3.12				

6.4 Stability of the VEC Model

The roots of the characteristic polynomials corresponding to Autoregressive Structures in equations 6.1 - 6.2 are given by the Table 6.3.

Table 6.3

VEC Stability Condition Check

Roots of the Characteristic Polynomial

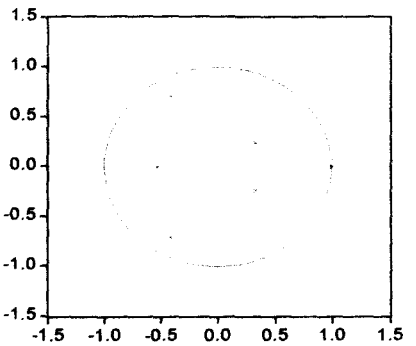
Endogenous Variable: E_t, M_t

Exogenous Variable: C

Root	Modulus
1.000000	1.000000
-0.415168 - 0.707294i	0.820139
-0.415168 + 0.707294i	0.820139
-0.518813	0.518813
0.335202 - 0.241723i	0.413268
0.335202 + 0.241723i	0.413268
VEC specification imposes 1 unit root(s).	

Figure 6.1

Inverse Roots of AR Characteristic Polynomial



It is observed from the Table 6.3 that

(i) the absolute values of the characteristic roots are less than unity,

(ii) two of the characteristic roots are positive,

(iii) two of the characteristic roots are negative,

Again the inverse roots of *AR Characteristic Polynomials* lie within the unit circle. This is being shown in the Figure 6.1. All these testify for the stability of the estimated VEC model consisting of equations (6.1) and (6.2).

6.5 The Findings from the VEC Estimation (Table 6.1)

It is observed from the Table 6.1 that

(i) $\hat{\rho}_1$ being significant at 1% level indicates that short-run shocks, transmitted through the channel of exchange rate, significantly affected the long-run relationship which exchange rate maintained with money supply.

(ii) the negative value of $\hat{\rho}_1$ indicates that exchange rate, following any positive shock transmitted through the channel of exchange rate, declined. Consequently, short-run positive exchange rate shock appeared to pull down exchange rate from its long-run equilibrium level.

(iii) $\left|\hat{\rho}_1\right| < 1$ indicates that short-run exchange rate oscillated around the long-run equilibrium level following short-run exchange rate shocks and these oscillations were damped. Thus the long-run relationship which exchange rate maintained with money supply was stable.

(iv) $\hat{\gamma}_{12}$ being significant (at 1% level), even in the presence of ΔE_{t-i} (i = 1,2) in the vector of regressors for ΔE_t, indicates that money supply *Granger Caused* exchange rate in the short-run.

(v) $0 < \hat{\gamma}_{12} < 1$ indicates that the two period beck money supply led to less than proportionate change in exchange rate. Moreover, rise in money supply appears to cause a rise in spot rate† i.e., a depreciation of rupee. This finding is in conformity with the **MAER** proposition.

6.6 Findings from the VEC Estimation (Table 6.2)

It is observed from the Table 6.2 that

i. ($\hat{\rho}_2$), the coefficient of Z_{2t-1} (in the Equation 6.2) is not significant even at 10% level. This indicates that shocks, transmitted though the monetary channel, fail to disturb the long-run relationship between exchange rate and money supply.

ii. $\hat{\beta}_{21}$ and $\hat{\beta}_{22}$, the coefficient of ΔM_{t-1} and ΔM_{t-2} respectively, are found to be statistically significant at 1% level.

iii. $\hat{\gamma}_{21}$ and $\hat{\gamma}_{22}$, the coefficient of ΔE_{t-1} and ΔE_{t-2} respectively fail to be significant even at 10% level. This indicates that exchange rate fail to *'Granger Cause'* money supply in the short-run over the period concerned.

† Spot rate here stands for the rupee price of dollar/unit.

iv. $\hat{\beta}_{21} < 0$ and $\hat{\beta}_{22} < 0$ 0indicate that money supplies in the past two periods significantly affects the current period money supplies. Again, these indicate that any rise in past two period money supply tend to reduce the current money supply.

v. $\left|\hat{\beta}_{21}\right| < 1$ and $\left|\hat{\beta}_{22}\right| < 1$ indicate that change in past two period money supplies lead to less than proportionate change in the current money supply level.

6.7 Economic Interpretations of Results of the VEC Model

Economic interpretations of the findings from the estimated equations 6.1 and 6.2 are as follows.

(i) The significant coefficient of Z_{1t-1} in the equation 6.1 indicates that the short-run shocks, transmitted through exchange rate channel, significantly affected the long-run dynamic relationship that exchange rate maintained with money supply.

(ii) Again the positive value of $\hat{\rho}_1$, the coefficient of Z_{1t-1} in this equation, indicates that exchange rate, following any positive short-run exchange rate shocks, increases. Consequently, positive short-run shocks, transmitted through exchange rate channel, pushes up exchange rate above the long-run equilibrium level.

(iii) The absolute value of $\hat{\rho}_1$, the coefficient of Z_{1t-1} in equation 6.1 is less than unity and it indicates that change in exchange rate oscillates around the long-run equilibrium level following a short-run exchange rate shocks, and such oscillation is convergent to the long-run path. Thus, long-run relationship between exchange rate (dependent variable) and money supply (independent variable) is stable. Consequently, the short-run dynamics defines an 'equilibrium processes'.

(iv) Significant value of $\hat{\gamma}_{21}$ indicates that money supply *Granger caused exchange rate in* the short-run dynamic adjustment of exchange rate.

(v) Exchange rate failed to Granger cause money supply in the Indian economy.

(vi) Shocks, transmitted through the money supply channel, fail to affect the long-run relationship between exchange rate and money supply. Consequently, the long-run relationship is stable.

6.8 Overview of Findings of VEC Model

Following inferences may be derived from the study of *VEC model* for E_t and M_t in the economy of India.

(i) *The long-run relationship, that exchange rate maintained with money supply, was stable. The shocks, transmitted through exchange rate channel, had significant impact on the long-run relationship and these provided damped oscillations. Consequently, the short-run dynamics of exchange rate defined* ***an 'equilibrium'*** *process.*

(ii) *The long-run relationship, which money supply maintained with exchange rate, was stable. The shocks, transmitted through monetary channel, failed to exert any appreciable impact on such long-run relationship. Consequently, the short-run dynamics of monetary growth defined a* ***'stable equilibrium process'****.*

(iii) *There did exist* ***'Uni-directional' short-run Granger Causality*** *running from money supply to Rupee/Dollar Exchange Rate.*

(iv) *Exchange rate, consequently, failed to* ***Granger cause money supply*** *in the short-run. Exchange rate emerged as an* ***exogenous variable*** *in the equation (6.2) for money supply.*
