CHAPTER 6

SUB-PERIOD ANALYSIS

6.1 Introduction

The full sample period is divided into two sub-periods. We conduct the analysis separately for each sub-period for comparison. The first sub-period is from January 1987 to August 1998 while the second sub-period covers from September 1998 to December 2001. We consider August 1998 as the breakpoint in order to investigate whether there is any significant changes in the results for both sub-periods. There are 140 observations for the first sub-period and 40 observations for the second sub-period.

After accounting for this breakpoint, the unit root analysis for the whole sample period discussed in Chapter 5 has clearly suggested that all the data series are characterized as integrated of order one i.e., $lnIIPS_t \sim I(1)$, $lnSP_t \sim I(1)$, $RIR_t \sim I(1)$, $lnRB1_t \sim I(1)$ and $lnRB2_t \sim I(1)$. First differencing will render the series stationary. Section 6.2 discusses cointegration among the variables for each sub-period. This is followed by the VEC model in Section 6.3. This section also investigates the adjustments to disequilibrium and presents the results for Granger causality test. The final section in this chapter examines the impulse response function.

6.2 Cointegration

We conduct the Johansen cointegration test for both sub-periods. Each sub-period consists of two systems of equations. The first system includes $lnIIPS_t$, $lnSP_t$, RIR_t and $lnRB1_t$. The second system consists of $lnIIPS_t$, $lnSP_t$, RIR_t and $lnRB2_t$. The results of the Johansen cointegration test up to six lags are reported in Tables 6.1 and 6.2 for the first sub-period and Tables 6.3 and 6.4 for the second sub-period.

The results of the first system in the first sub-period show that the null hypothesis of no cointegration among the variables is rejected in all cases of lag length at the 5 percent significance level. Three cointegrating vectors and two cointegrating vectors are found for cointegration test with one lag and three lags, respectively. However, the cointegration test indicates that the Π matrix has full rank, that is $r = 4$ for the cases of two, four, five and six lags. The results of the second system imply that Π matrix has full rank for all cases except the cointegration test with one lag which shows the existence of three cointegrating vectors.

In comparison, the results of the cointegration test are more stable in the second sub period. The rejection of no cointegration among the variables is found for every lag length used in both the systems. The Π matrix has full rank only for the cointegration test with six lags in the second system. The results suggest one cointegrating vector for the cointegration test with two and three lags for the first system and when the lag lengths are set to one and two for the second system. Two cointegrating vectors are found for the cointegration test with one, four and five lags for the first system and cointegration test with three and four lags for the second system. When the lag lengths are set to six for the first system and five for the second system, the results of cointegration test suggest three cointegrating vectors.

Table 6.1: Johansen Cointegration Test for the First Sub-Period with Monetary Aggregate M1

Lag Length	Trace Statistic (Q_r)			
	r=0	r=1	r=2	r=3
1	59.6869**	35.9475**	16.3645**	2.7564
2	71.1584**	42.1833**	17.2679**	4.1108**
3	66.1441**	35.3089**	13.9858	3.7789
4	78.7113**	45.9334**	19.5840**	5.6368**
5	86.4773**	37.8383**	17.8229**	5.7702**
6	81.7021**	41.3132**	21.0204**	5.6565**

** Significant at the 5% level.

Table 6.2: Johansen Cointegration Test for the First Sub-Period with Monetary Aggregate M2

Lag Length	Trace Statistic (Q_r)			
	r=0	r=1	r=2	r=3
1	66.8136**	36.1499**	18.3477**	2.6947
2	65.5932**	40.4682**	22.2631**	6.0043**
3	56.5710**	31.6693**	15.5678**	4.2160**
4	67.5521**	33.8927**	18.6656**	4.9442**
5	71.0045**	31.7829**	16.0567**	4.2689**
6	84.3184**	40.7908**	19.0991**	7.7316**

** Significant at the 5% level

Table 6.3: Johansen Cointegration Test for the Second Sub-Period with Monetary Aggregate M1

Lag Length	Trace Statistic (Q_r)			
	r = 0	r = 1	r = 2	r = 3
1	60.9871**	32.0966**	13.8593	4.9528
2	51.3629**	28.6153	12.2258	3.0732
3	55.7198**	29.4679	12.8011	2.2265
4	81.9989**	33.8209**	12.7328	5.0491
5	96.8927**	40.1498**	14.4830	2.1556
6	307.0830**	110.6356**	35.2895**	2.0197

** Significant at the 5% level.

Table 6.4: Johansen Cointegration Test for the Second Sub-Period with Monetary Aggregate M2

Lag Length	Trace Statistic (Q_r)			
	r = 0	r = 1	r = 2	r = 3
1	58.3862**	28.3337	13.0236	4.0128
2	50.9982**	29.3221	11.5902	3.6361
3	54.1602**	30.3226**	13.4547	2.0506
4	71.3050**	30.8529**	14.3083	3.2359
5	112.3931**	42.0923**	20.2254**	2.3563
6	158.4150**	74.5313**	31.6325**	11.2185**

** Significant at the 5% level.

The procedure to determine the optimal lag length is similar to the full sample period in which the VEC model with the minimum value of BIC or SC is chosen. The results indicate that one lag is the optimal lag length in both the systems for both sub-periods. This finding is consistent with our cointegation results in which the model with one lag is free from the problem of full rank Π matrix. Based on the results in Tables 6.1 and 6.2, there are three cointegrating vectors in both the systems for the first sub-period. For the second sub-period, the results in Tables

6.3 and 6.4 suggest two cointegrating vectors for the first system while a unique cointegrating vector exists for the second system.

6.3 Vector Error Correction Model

Since all the variables in both systems for the two sub-periods are cointegrated, we have the VEC model representation. In the first sub-period, there are three error correction terms for the first system given as below:

$$\hat{z}_{11,t} = 2.9110 + \ln IIPS_t - 0.8314 \ln RB1_t \quad (6.1)$$

$$\hat{z}_{12,t} = 7.1312 + \ln SP_t - 1.3683 \ln RB1_t \quad (6.2)$$

$$\hat{z}_{13,t} = 4.3525 + RIR_t - 1.0845 \ln RB1_t \quad (6.3)$$

For the second system, there are also three error correction terms:

$$\hat{z}_{21,t} = 3.5050 + \ln IIPS_t - 0.7870 \ln RB2_t \quad (6.4)$$

$$\hat{z}_{22,t} = 9.7671 + \ln SP_t - 1.4426 \ln RB2_t \quad (6.5)$$

$$\hat{z}_{23,t} = 17.0471 + RIR_t - 2.0858 \ln RB2_t \quad (6.6)$$

In the second sub-period, there are two error correction terms for the first system:

$$\hat{z}_{11,t} = -1.0062 + \ln IIPS_t - 0.1035 RIR_t - 0.4164 \ln RB1_t \quad (6.7)$$

$$\hat{z}_{12,t} = -6.5999 + \ln SP_t - 0.4018 RIR_t + 0.2281 \ln RB1_t \qquad (6.8)$$

In the second system, only one error correction term as below is found:

$$\hat{z}_{21,t} = 20.7694 + \ln IIPS_t - 0.8474 \ln SPt + 0.2739 RIR_t \qquad (6.9)$$

$$-1.8905 \ln RB2_t$$

Table 6.5: The Vector Error Correction Model for the First Sub-Period with Monetary Aggregate M1

Independent Variable	Dependent Variable			
	$\Delta\ln IIPS_t$	$\Delta\ln SP_t$	ΔRIR_t	$\Delta\ln RB1_t$
Constant	0.0117*** (3.8401)	-0.0033 (-0.4187)	-0.0229 (-0.6574)	0.0070** (2.3445)
$\Delta\ln IIPS_{t-1}$	-0.5298*** (-6.5893)	0.2037 (0.9851)	0.5171 (0.5641)	-0.1513* (-1.9179)
$\Delta\ln SP_{t-1}$	-0.0838** (-2.2039)	0.1159 (1.1862)	-0.5241 (-1.2092)	-0.0358 (-0.9596)
ΔRIR_{t-1}	0.0097 (1.3161)	0.0012 (0.0652)	0.0434 (0.5191)	0.0027 (0.3736)
$\Delta\ln RB1_{t-1}$	0.0379 (0.4073)	0.1561 (0.6527)	-0.9491 (-0.8950)	0.1125 (1.2333)
$\hat{z}_{11,t-1}$	-0.1218** (-2.0231)	-0.2438 (-1.5746)	0.2091 (0.3047)	0.1592*** (2.6953)
$\hat{z}_{12,t-1}$	0.0234 (1.3001)	-0.0197 (-0.4266)	-0.0129 (-0.0630)	0.0789*** (4.4716)
$\hat{z}_{13,t-1}$	-0.0007 (-0.3479)	-0.0041 (-0.8171)	-0.0771*** (-3.4462)	0.0020 (1.0447)

Notes: The numbers in parentheses are t-ratios. ***, ** and * denote significance at the 1%, 5% and 10%, respectively.

Table 6.6: The Vector Error Correction Model for the First Sub-Period with Monetary Aggregate M2

Independent Variable	Dependent Variable			
	$\Delta lnIIPS_t$	$\Delta lnSP_t$	ΔRIR_t	$\Delta lnRB2_t$
Constant	0.0114*** (3.3701)	0.0024 (0.2776)	-0.0085 (-0.2211)	0.0090*** (5.4984)
$\Delta lnIIPS_{t-1}$	-0.4424*** (-5.1795)	-0.1114 (-0.5135)	1.2445 (1.2767)	-0.0120 (-0.2898)
$\Delta lnSP_{t-1}$	-0.0792** (-2.1218)	0.0946 (0.9978)	-0.4712 (-1.1060)	0.0052 (0.2873)
ΔRIR_{t-1}	0.0117 (1.5826)	-0.0090 (-0.4786)	0.0685 (0.8145)	-0.0026 (-0.7289)
$\Delta lnRB2_{t-1}$	-0.0060 (-0.0326)	-0.2905 (-0.6182)	-2.7692 (-1.3115)	-0.0056 (-0.0625)
$\hat{z}_{21,t-1}$	-0.2449*** (-2.9405)	0.5441** (2.5731)	-1.1052 (-1.1631)	0.0851** (2.1168)
$\hat{z}_{22,t-1}$	0.0368*** (4.1102)	0.0289 (1.2727)	0.0387 (0.3785)	0.0021 (0.4950)
$\hat{z}_{23,t-1}$	-0.0051** (-2.0359)	0.0115* (1.8079)	-0.1002*** (-3.5040)	-0.0001 (-0.0778)

Notes: The numbers in parentheses are t-ratios. ***, ** and * denote significance at the 1%, 5% and 10%, respectively.

The estimated VEC models are reported in Tables 6.5 and 6.6 for the first sub-period while Tables 6.7 and 6.8 present the results for the second sub-period. From the results in Tables 6.5 and 6.6, the adjustment of industrial production in the second system is faster than the first system in response to one unit deviation from the long-run relationships. In the first system, there are downward adjustments for stock prices while the results of the second system suggest upward adjustments due to one unit deviation from the first, second and third long-run relationships. For the real money balances, the case of M1 adjusts faster than the case of M2 in response to one unit deviation from the long-run relationships.

The results in Table 6.7 show that among the four variables in the system, the adjustment is the fastest in real interest rate in response to one unit deviation from the first and second long-run relationships. In the second system, given one unit deviation from the long run-relationship, industrial production, stock prices, real interest rate and real money balances for M2 will adjust by about –4.7 percent, 44.6 percent, -162 percent and 1.5 percent, respectively, to return to equilibrium.

Table 6.7: The Vector Error Correction Model for the Second Sub-Period with Monetary Aggregate M1

Independent Variable	Dependent Variable			
	$\Delta lnIIPS_t$	$\Delta lnSP_t$	ΔRIR_t	$\Delta lnRB1_t$
Constant	0.01250*** (2.7918)	0.0033 (0.2474)	0.0455 (0.6876)	0.0071 (1.3725)
$\Delta lnIIPS_{t-1}$	-0.3856*** (-2.8308)	0.0925 (0.2270)	-2.6061 (-1.2948)	-0.0858 (-0.5441)
$\Delta lnSP_{t-1}$	-0.0548 (-1.0646)	0.2100 (1.3625)	-1.2356 (-1.6234)	0.1120* (1.8785)
ΔRIR_{t-1}	0.0030 (0.2370)	-0.0799** (-2.1284)	0.0126 (0.0680)	-0.0023 (-0.1590)
$\Delta lnRB1_{t-1}$	-0.3161** (-2.1682)	0.7644* (1.7526)	0.3190 (0.1481)	0.2961* (1.7544)
$\hat{z}_{11,t-1}$	-0.3635*** (-3.8594)	-0.2254 (-0.8001)	-1.6734 (-1.2025)	0.1266 (1.1611)
$\hat{z}_{12,t-1}$	0.0496* (1.8425)	-0.3243*** (-4.0251)	1.3770*** (3.4611)	-0.0738** (-2.3679)

Notes: The numbers in parentheses are t-ratios. ***, ** and * denote significance at the 1%, 5% and 10%, respectively.

Table 6.8: The Vector Error Correction Model for the Second Sub-Period with Monetary Aggregate M2

Independent Variable	Dependent Variable			
	$\Delta lnIIPS_t$	$\Delta lnSP_t$	ΔRIR_t	$\Delta lnRB2_t$
Constant	0.0116** (2.1232)	-0.0000 (-0.0012)	0.0293 (0.4429)	0.0049 (2.6966)
$\Delta lnIIPS_{t-1}$	-0.3527** (-2.0382)	-0.3084 (-0.7198)	-2.4648 (-1.1738)	-0.0306 (-0.5268)
$\Delta lnSP_{t-1}$	0.0100 (0.1759)	0.2951** (2.0996)	-1.0736 (-1.5583)	0.04160** (2.1813)
ΔRIR_{t-1}	0.0279** (2.2070)	-0.0533* (-1.7018)	0.0533 (0.3472)	-0.0007 (-0.1750)
$\Delta lnRB2_{t-1}$	-0.6942 (-1.3136)	2.7953** (2.1362)	3.7057 (0.5778)	-0.0961 (-0.5413)
$\hat{z}_{11,t-1}$	-0.0471 (-1.1975)	0.4460*** (4.5785)	-1.6207*** (-3.3946)	0.0154 (1.1644)

Notes: The numbers in parentheses are t-ratios. ***, ** and * denote significance at the 1%, 5% and 10%, respectively.

6.3.1 Adjustments to Disequilibrium

We conduct the similar joint F-test as that for the full sample period to examine adjustments to disequilibrium. From the results in Tables 6.9 and 6.10, more variables adjust to disequilibrium in the first sub-period compare to the second sub-period. It is clear that industrial production adjusts to disequilibrium for both the systems in the first sub-period. However, there is no evidence to show that industrial production adjusts to disequilibrium if real money balances in a broader definition is used after the implementation of selective capital controls from September 1998. In the first sub-period, both real interest rate and real money balances adjust significantly to disequilibrium. They act as active tools by BNM for formulating the monetary policy. Real interest rate responds to disequilibrium for both the systems in the second sub-period. However, real money balances for M1 and M2 do not adjust to disequilibrium at the 5 percent significance level.

Table 6.9: F-Test for Adjustments to Disequilibrium (First Sub-Period)

First System (M1)		
Variable	F-Statistic	P-Value
$lnIIPS_t$	5.193***	0.002
$lnSP_t$	1.108	0.348
RIR_t	4.492***	0.005
$lnRB1_t$	6.686***	0.000
Second System (M2)		
Variable	F-Statistic	P-Value
$lnIIPS_t$	6.773***	0.000
$lnSP_t$	3.684**	0.014
RIR_t	5.419***	0.002
$lnRB2_t$	3.691**	0.014

Notes: *** and ** denote significance at the 1% and 5% levels, respectively.

Table 6.10: F-Test for Adjustments to Disequilibrium (Second Sub-Period)

First System (M1)		
Variable	F-Statistic	P-Value
$lnIIPS_t$	7.767***	0.002
$lnSP_t$	10.010***	0.000
RIR_t	6.021***	0.006
$lnRB1_t$	2.940*	0.068
Second System (M2)		
Variable	F-Statistic	P-Value
$lnIIPS_t$	1.434	0.240
$lnSP_t$	20.963***	0.000
RIR_t	11.524***	0.002
$lnRB2_t$	1.354	0.253

Notes: *** and * denote significance at the 1% and 10% levels, respectively.

6.3.2 Granger Causality

We perform the Granger causality test in order to investigate the lead-lag relationships before and after the implementation of selective capital controls. The analysis thus far shows that the results are sensitive to the choice of monetary aggregate. Thus, we concentrate on using M2 for the remaining analysis to facilitate a clearer discussion. M2 is chosen for its broader definition of monetary aggregate. The results of Granger causality test for the first and second sub-periods are presented in Tables 6.11 and 6.12, respectively.

Throughout the period from January 1987 to August 1998, industrial production seems to be Granger-caused by all the variables including its own lag. The stock prices and monetary variables play an importance role in influencing the economic activity. However, the results in Table 6.12 reveal that since September 1998, industrial production only Granger-caused by its previous value at the 5 percent significance level.

There was a prolonged period of stock market boom (1993-97) in the first sub-period. Consequently, the existence of speculative bubbles or fads have caused the stock prices to be less influenced by the fundamental economic conditions. The credit availability manifested through real money balances, and industrial production Granger-caused stock prices. Stock prices depend more on fundamentals in the second sub-period. The results are more statistically significant in which stock prices are Granger-caused by industrial production, real interest rate and also real money balances. Moreover, previous stock prices also react as indicators of future stock prices.

Results from the second sub-period suggest that the real interest rate is Granger-caused by all variables including itself. In other words, future real interest rate is influenced by the current economic conditions. There is feedback causality between real interest rate and stock prices. In the first sub-period, real interest rate is only Granger-caused by real money balances apart from its own previous value.

Real money balances are not Granger-caused by any variables in the second sub-period at the 5 percent significance level. In fact, its own past influence has very little impact. As is explained in the next chapter, money supply is not entirely within the control of the monetary authority under the fixed exchange rate regime.

Table 6.11: Granger Causality Test for the First Sub-Period

Causal Variable	Dependent Variable			
	$IIPS_t$	SP_t	RIR_t	$RB2_t$
$IIPS_t$	33.377***	3.688**	1.003	2.617*
SP_t	8.668***	2.046	0.612	0.249
RIR_t	3.075**	1.688	6.275***	0.275
$RB2_t$	5.080***	2.867**	4.174***	2.791**

Notes: F-statistics are reported in the table. ***, ** and * denote significance at the 1%, 5% and 10% levels, respectively.

Table 6.12: Granger Causality Test for the Second Sub-Period

Causal Variable	Dependent Variable			
	$IIPS_t$	SP_t	RIR_t	$RB2_t$
$IIPS_t$	4.306**	11.051***	9.226***	0.683
SP_t	0.782	11.491***	6.318***	2.734*
RIR_t	2.682*	10.693***	5.867***	0.683
$RB2_t$	1.234	10.868***	7.043***	1.089

Notes: F-statistics are reported in the table. ***, ** and * denote significance at the 1%, 5% and 10% levels, respectively.

6.4 Impulse Response Function

We consider the IRF for both sub-periods in order to trace out the responses of all the variables in the VAR system due to one-time shocks. Based on the results of causality test, we use the IRF for explaining how variables respond to shocks in the variables that have significant causal relations ,with them. The underlying model is VAR(1) for this analysis. The ordering used is $lnIIPS_t$, $lnRB2_t$, RIR_t, and $lnSP_t$. Figures 6.1 to 6.7 graph the dynamic responses to the Cholesky one standard deviation innovations. All the variables are in first differences.

From the results in Figures 6.1(a) and 6.1(b), there is no significant response of industrial production to shocks in the real interest rate for the first sub-period. However, real interest rate does affect industrial production for the second sub-period, the response is felt up to four months after the shocks.

Industrial production does affect real interest rate in the second sub-period in which the response period is up to six months. To shocks in real money balances, response of real interest rate takes two months to settle for the first sub-period and six months for the second sub-period. A larger period of adjustment is also needed in the second sub-period following a shock in stock prices. These results are presented in Figures 6.2 to 6.4.

The response of stock prices due to shocks in the other variables is presented in Figures 6.5 to 6.7. There are significant responses of stock prices due to shocks in industrial production and real money balances in the first and second sub-periods. Little response of stock prices is detected to shocks in real interest rate in the first sub-period but there is evidence of larger response up to four months in the second sub-period.

In general, we can conclude that the magnitude of response is larger due to one-time shocks in the second sub-period and the response period also takes longer time to settle down.

Figure 6.1(a): Response of $\Delta lnIIPS_t$ to Shocks in ΔRIR_t for the First Sub-Period

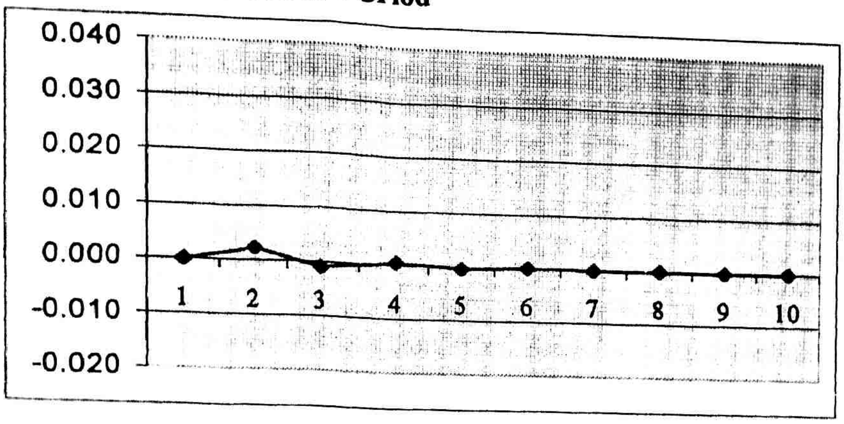

Figure 6.1(b): Response of $\Delta lnIIPS_t$ to Shocks in ΔRIR_t for the Second Sub-Period

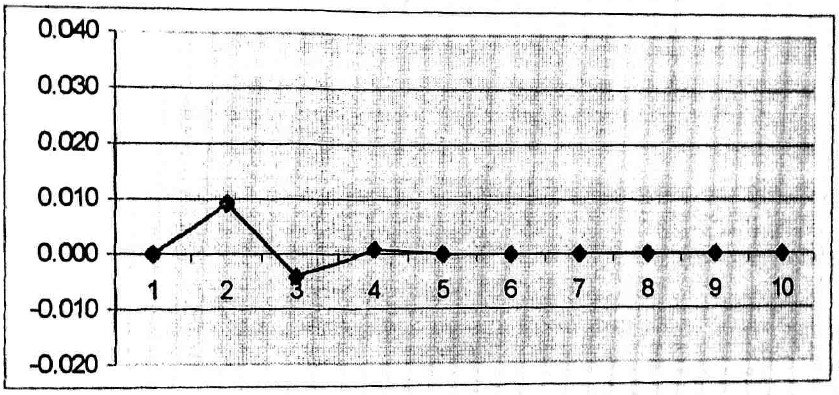

Figure 6.2(a): Response of ΔRIR_t to Shocks in $\Delta lnIIPS_t$ for the First Sub-Period

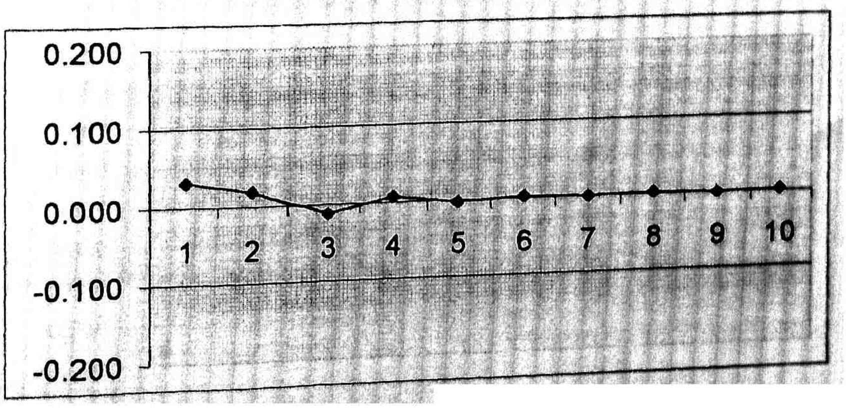

Figure 6.2(b): Response of ΔRIR$_t$ to Shocks in ΔlnIIPS$_t$ for the Second Sub-Period

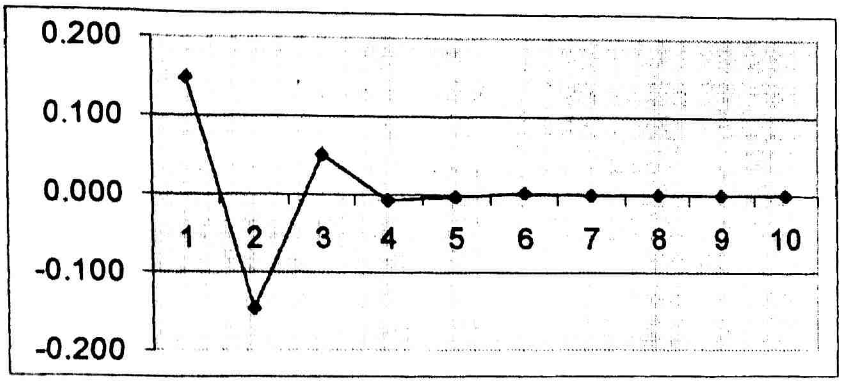

Figure 6.3(a): Response of ΔRIR$_t$ to Shocks in ΔlnRB2$_t$ for the First Sub-Period

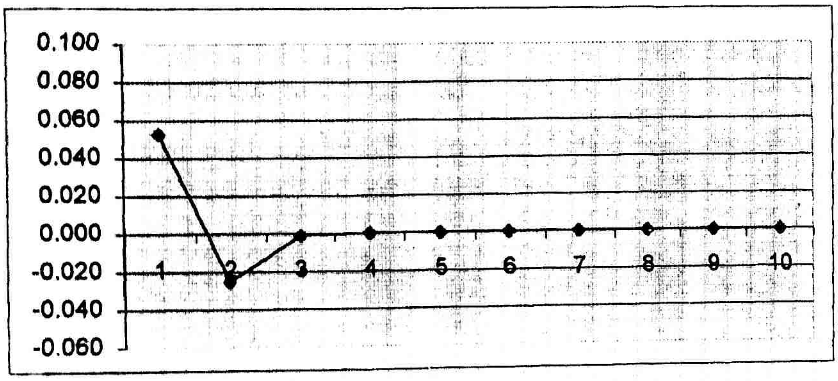

Figure 6.3(b): Response of ΔRIR$_t$ to Shocks in ΔlnRB2$_t$ for the Second Sub-Period

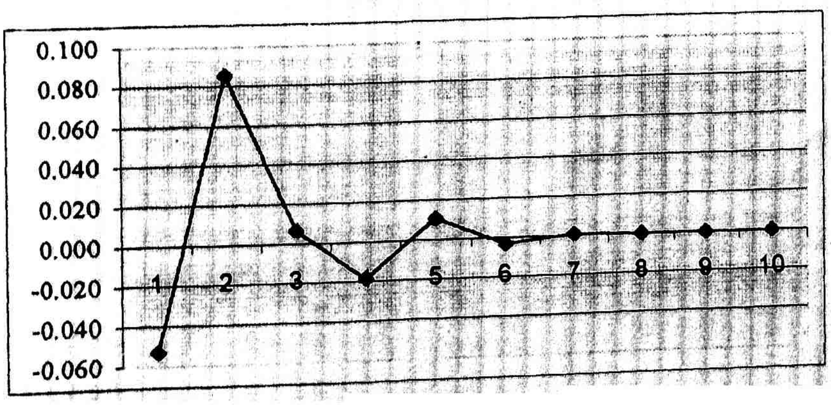

Figure 6.4(a): Response of ΔRIR$_t$ to Shocks in ΔlnSP$_t$ for the First Sub-Period

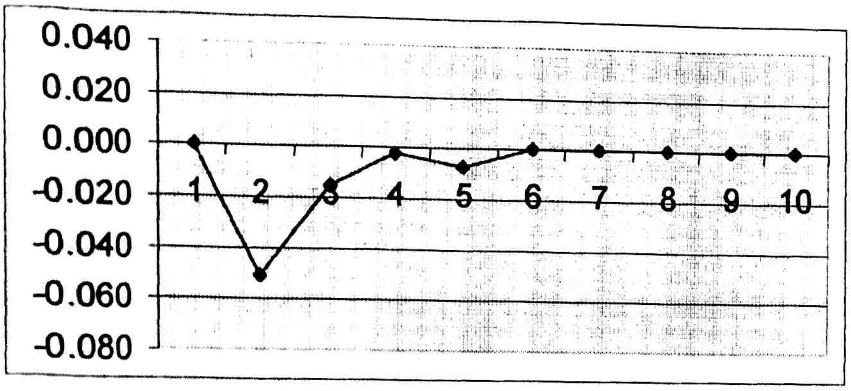

Figure 6.4(b): Response of ΔRIR$_t$ to Shocks in ΔlnSP$_t$ for the Second Sub-Period

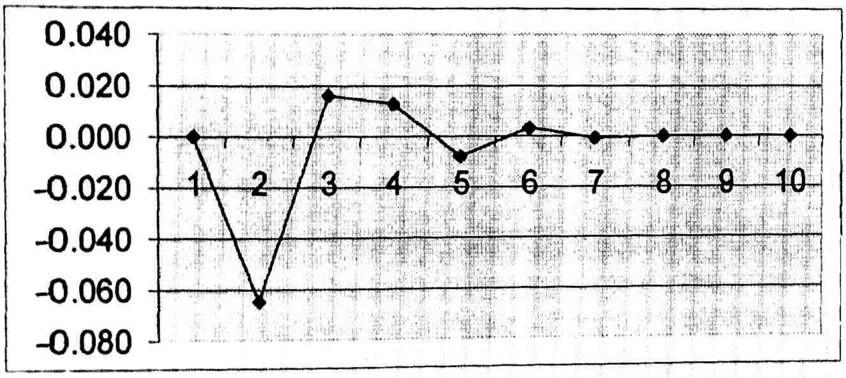

Figure 6.5(a): Response of ΔlnSP$_t$ to Shocks in ΔlnIIPS$_t$ for the First Sub-Period

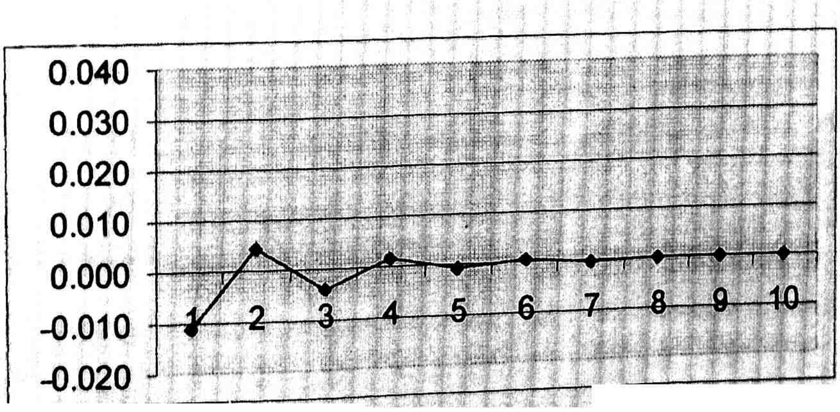

Figure 6.5(b): Response of $\Delta lnSP_t$ to Shocks in $\Delta lnIIPS_t$ for the Second Sub-Period

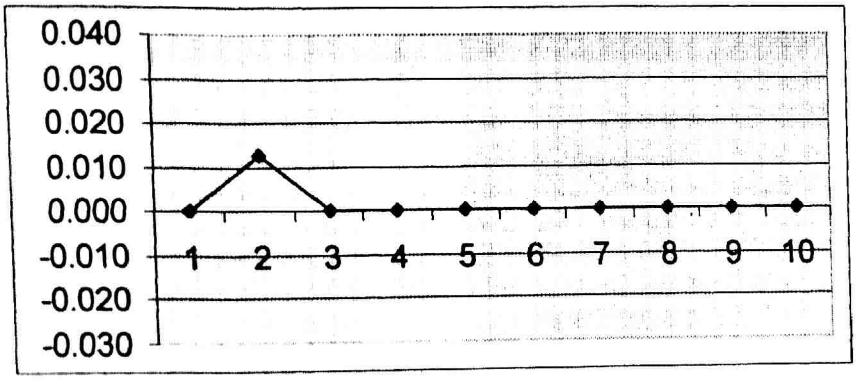

Figure 6.6(a): Response of $\Delta lnSP_t$ to Shocks in $\Delta lnRB2_t$ for the First Sub-Period

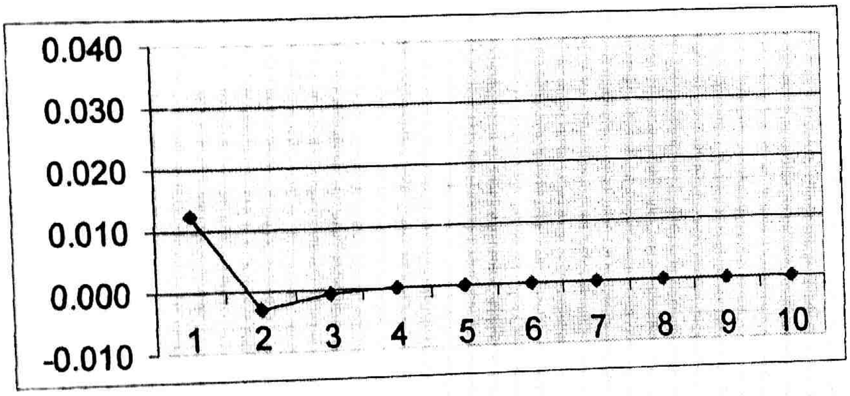

Figure 6.6(b): Response of $\Delta lnSP_t$ to Shocks in $\Delta lnRB2_t$ for the Second Sub-Period

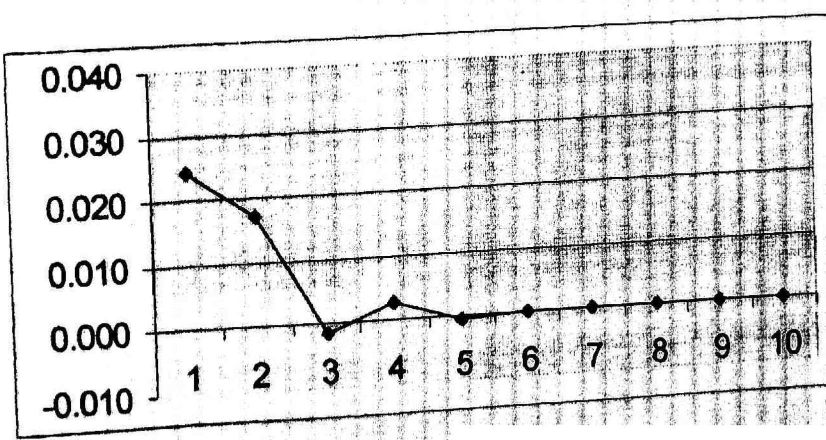

Figure 6.7(a): Response of ΔlnSP$_t$ to Shocks in ΔRIR$_t$ for the First Sub-Period

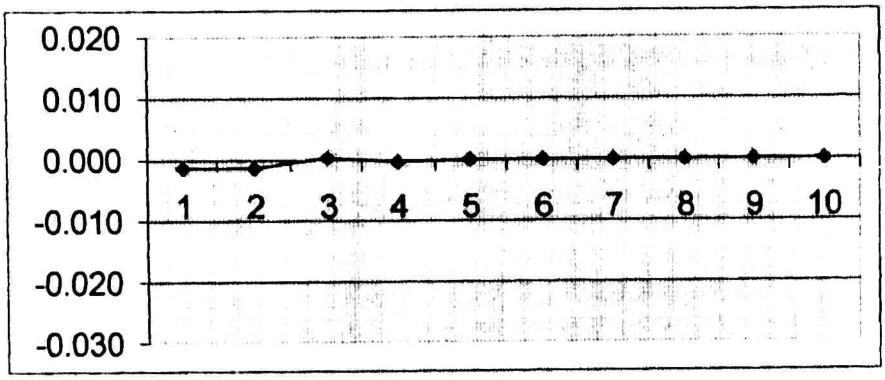

Figure 6.7 (b): Response of ΔlnSP$_t$ to Shocks in ΔRIR$_t$ for the Second Sub-Period