CHAPTER 5

RESULTS AND ANALYSIS

5.1 The Unit Root Test

As mentioned in the earlier chapter, subsequent investigations in this study depend on the stationarity of all the variables used. By applying the ADF test on the process similar to Equation (5) in the earlier chapter, the test statistic of all the variables on levels for up to $m = 10$ lags are obtained as in Table 5.1. It can be observed that there are instances where the null hypothesis is rejected.

Table 5.1
ADF Test for the Presence of Unit Roots (Levels)

	Number of Lags									
	1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*
INTR1YR	-1.926	-2.271	-2.351	-1.787	-2.254	-2.406	-2.241	-1.805	-2.164	-2.730
INTR3MON	-1.980	-2.252	-2.571	-2.060	-2.429	-2.637	-2.622	-2.035	-2.227	-2.490
RDEFP	-4.655**	-2.899*	-1.543	-1.531	-1.574	-1.466	-1.801	-1.953	-2.104	-1.425
INFL	-3.870**	-3.682**	-2.523	-2.151	-1.922	-2.285	-2.287	-2.509	-2.150	-2.099
RM1GROW	-8.025**	-6.133**	-2.891	-4.533**	-5.179**	-4.992**	-2.862	-2.817	-3.359*	-3.084*
LNRGNP	-0.581	-0.726	-0.668	-0.121	-0.114	-0.153	-0.019	0.130	0.135	0.015
LNRGEXP	-2.206	-1.577	-1.716	-1.288	-1.315	-1.165	-1.109	-0.723	-0.417	-0.123
LNRGTRAN	-4.756**	-3.848**	-3.485*	-3.150*	-3.432*	-3.442*	-2.554	-2.297	-2.838	-2.711
RECON	-0.888	-0.601	-0.618	-0.825	-0.685	-0.427	-0.223	-0.299	0.045	-0.305

*(**) denotes rejection of the hypothesis at 5% (1%) significance level

The optimal lag length for each of the variables is determined by the value that minimizes the AIC. Table 5.2 shows the AIC values of all the variables for 10 lags. It also reports that the optimal lag for $INTR1YR_t$ and $INTR3MON_t$ is lag order of 1; lag order of 7 for $RM1GROW_t$ and $LNRGNP_t$; and lag order of 9 for both $LNRGTRAN_t$ and

RECON$_t$. The optimal lag for *RDEFP$_t$*, *INFL$_t$* and *LNRGEXP$_t$* is lag order of 10, 6 and 5 respectively.

Table 5.2
AIC values (All Variables)

	Number of lags									
	1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*
INTR1YR	1.541*	1.544	1.571	1.572	1.562	1.584	1.619	1.639	1.642	1.623
INTR3MON	1.910*	1.921	1.929	1.934	1.925	1.935	1.967	1.980	2.003	2.014
RDEFP	0.154	0.055	-0.307	-0.288	-0.260	-0.230	-0.251	-0.269	-0.246	-0.326*
INFL	1.895	1.881	1.829	1.798	1.804	1.782*	1.814	1.812	1.840	1.786
RM1GROW	5.818	5.846	5.568	5.356	5.325	5.346	5.208*	5.241	5.219	5.253
LNRGNP	-3.593	-3.600	-3.569	-3.729	-3.707	-3.677	-3.788*	-3.764	-3.734	-3.706
LNRGEXP	0.474	0.427	-0.664	-0.691	-0.705*	-0.688	-0.654	-0.680	-0.657	-0.639
LNRGTRAN	0.838	0.831	0.627	0.649	0.654	0.666	0.590	0.599	0.586*	0.616
RECON	-3.455	-3.512	-3.492	-3.592	-3.569	-3.590	-3.590	-3.618	-3.625*	-3.620

* denotes the value that minimizes the AIC for each variable

Table 5.3
ADF Test for the Presence of Unit Roots for Each Variable (Levels & First-Difference)

	Optimal Lag	**Levels**	**First Difference**
INTR1YR	1	-1.926	-5.677**
INTR3MON	1	-1.98	-6.12**
RDEFP	10	-1.425	-4.069**
INFL	6	-2.285	-4.315**
RM1GROW	7	-2.862	-6.157**
LNRGNP	7	-0.019	-4.354**
LNRGEXP	5	-1.315	-3.709**
LNRGTRAN	9	-2.838	-4.11**
RECON	9	0.045	-3.073*

*(**) denotes rejection of the hypothesis at 5% (1%) significance level

Table 5.3 summarizes the optimal lag chosen for each of the variables and their test statistics on levels and after first order differencing. As the null hypothesis is not rejected for the levels of all the variables, this implies that all the variables contain at least one unit root and is not stationary. Therefore, first order differences are taken for each of the variables. The following ADF tests suggest that the null hypothesis is rejected at 5% significance level for all the variables and therefore confirms that all the variables are integrated of order one, $I(1)$.

5.2 Cointegration Test and Error Correction Modeling

As all the variables are integrated to the same order, which is $I(1)$ as obtained in the earlier section, the cointegration approach can be used to test for the existence of long-run equilibrium relationships among all the variables. This section will report the results of the cointegration approach using the Johansen methodology on 1-year rates and the other variables in *5.2.1* and 3-month rates and the other variables in *5.2.2*.

5.2.1 Medium-term Treasury bill rates

The cointegration approach in this subsection focuses on the medium-run Treasury bill rates (1-year rates) and the other variables, namely $RDEFP_t$, $LNRGNP_t$, $INFL_t$, $LNRGEXP_t$, $LNRGTRAN_t$, $RECON_t$ and $RM1GROW_t$. These eight variables will be referred to as Group 1 in subsequent discussions. The results are as in Table 5.4 and based on it, there are 2 cointegrating relations for lags 2, 3, 4, 5 and 6 while there are 3, 4, 5 and 7 cointegrating relations for lags 1, 6, 7 and 8 respectively at 5% significance level.

Then, the Vector Error Correction (VEC) estimates of each pairing (e.g. lag order of 1 with 3 cointegrating relations, lag order of 2 with 2 cointegrating relations etc) is generated to obtain the system AIC. The system AIC is subsequently used to determine the optimal pairing. The findings are reported in Table 5.5 and as can be observed, the pairing of lag order of 8 and 7 cointegrating relations is the optimal pairing as it minimizes the system AIC.

Table 5.4
Trace Test Statistics of Group 1

Lag	H_0: r = 0	H_0: r = 1	H_0: r = 2	H_0: r = 3	H_0: r = 4	H_0: r = 5	H_0: r = 6	H_0: r = 7
1	255.664**	165.987**	101.631*	64.725	34.861	17.840	4.984	0.821
2	190.858**	132.779*	84.047	47.802	29.105	17.505	6.936	2.074
3	195.539**	128.936*	84.647	49.737	26.262	14.861	6.440	1.097
4	180.273**	125.129*	80.084	49.265	29.145	14.697	6.077	0.051
5	202.560**	139.625**	83.872	48.135	27.569	14.400	5.515	0.121
6	250.484**	160.510**	114.365**	69.039*	41.908	20.455	6.914	0.095
7	282.848**	192.076**	125.353**	81.206**	53.418*	29.119	8.035	0.000
8	560.489**	379.315**	253.659**	148.575**	95.655**	53.556**	16.149*	2.325

*(**) denotes rejection of the hypothesis at 5% (1%) significance level

Table 5.5
System AIC of Group 1

lag	No. of cointegrating relations (5% sig. level)	System AIC
1	3	1.668
2	2	1.333
3	2	0.617
4	2	0.643
5	2	0.48
6	4	0.03
7	5	-1.166
8	7	-5.232

By utilizing the optimal pairing, the VEC estimates are obtained. As there are seven cointegrating relations for this system, seven error correction terms are generated. The following are the normalized error correction terms generated by EViews;

$$EC_{11} = INTR1YR_{t-1} + 12.737RM1GROW_{t-1} - 28.419$$

$$EC_{12} = RDEFP_{t-1} + 1.994RM1GROW_{t-1} - 4.889$$

$$EC_{13} = LNRGNP_{t-1} - 6.724RM1GROW_{t-1} + 2.074$$

$$EC_{14} = LNRGEXP_{t-1} - 4.886RM1GROW_{t-1} + 0.17$$

$$EC_{15} = LNRGTRAN_{t-1} - 3.432RM1GROW_{t-1} - 1.376$$

$$EC_{16} = INFL_{t-1} + 7.272RM1GROW_{t-1} - 14.146$$

$$EC_{17} = RECON_{t-1} - 3.243RM1GROW_{t-1} + 5.228$$

It is important to note that the ordering of the variables will generate different normalized error correction terms but the end result will not be affected.

Two EC models that are of particular interest will be constructed from the variables in Group 1. Table 5.6I shows the EC model of all the lagged variables in Group 1 as a function of 1-year interest rates while Table 5.6II shows the EC model of all the lagged variables in Group 1 as a function of budget deficits. The EC model with the 1-year rates as the dependent variable is referred to as EC Model 1 while the EC model with the budget deficits as the dependent variable for Group 1 is referred to as EC Model 2 in later discussions.

Based on the results in Tables 5.6I, the coefficients for the error correction terms of Model 1 are in the range of (– 4.824) and 9.387. The coefficient for EC_{11}, $\lambda_{1,11} = -0.4267$ indicates that the 1-year interest rates need to adjust by a drop of 0.4267% from its previous quarter in order to return to the long-run equilibrium.

The adjustments for the error correction terms of Model 2 based on the results in Table 5.6II are in the range of (– 1.263) and 1.118. The coefficient for EC_{12}, $\lambda_{1,22} = -1.263$ indicates that the budget deficit proxy has to adjust by a drop of 1.263 from its previous quarter in order to restore its long-run equilibrium.

Table 5.6I
Error Correction Model 1

Variables	Coefficients				
EC_{11}	-0.4267	D(LNRGNP(-2))	2.8297	D(INFL(-2))	-0.8220
	(-3.466)		(-0.764)		(-2.738)
EC_{12}	-3.2418	D(LNRGNP(-3))	6.9094	D(INFL(-3))	-0.7713
	(-1.614)		(-1.549)		(-2.783)
EC_{13}	-4.8235	D(LNRGNP(-4))	-1.8860	D(INFL(-4))	-1.0480
	(-1.657)		(-0.476)		(-3.485)
EC_{14}	-0.8934	D(LNRGNP(-5))	3.5110	D(INFL(-5))	-0.7718
	(-0.391)		(-0.775)		(-3.085)
EC_{15}	0.2304	D(LNRGNP(-6))	1.6857	D(INFL(-6))	-0.5826
	(-0.33)		(-0.454)		(-2.557)
EC_{16}	0.8661	D(LNRGNP(-7))	2.6780	D(INFL(-7))	-0.6122
	(-2.641)		(-0.730)		(-2.876)
EC_{17}	9.3865	D(LNRGNP(-8))	0.8473	D(INFL(-8))	-0.2575
	(-2.300)		(-0.161)		(-1.719)
D(INTR1YR(-1))	0.1514	D(LNRGEXP(-1))	-0.2940	D(RECON(-1))	-0.4562
	(-0.871)		(-0.138)		(-0.116)
D(INTR1YR(-2))	0.1208	D(LNRGEXP(-2))	0.0182	D(RECON(-2))	-9.7228
	(-0.715)		(-0.010)		(-1.945)
D(INTR1YR(-3))	0.2951	D(LNRGEXP(-3))	-0.4048	D(RECON(-3))	-8.1470
	(-1.399)		(-0.193)		(-2.021)
D(INTR1YR(-4))	-0.2158	D(LNRGEXP(-4))	0.0766	D(RECON(-4))	-11.2066
	(-1.14)		(-0.039)		(-2.451)
D(INTR1YR(-5))	0.2442	D(LNRGEXP(-5))	-2.7629	D(RECON(-5))	-6.0859
	(-1.237)		(-1.598)		(-1.794)
D(INTR1YR(-6))	0.5675	D(LNRGEXP(-6))	-2.7097	D(RECON(-6))	-7.3915
	(-3.074)		(-1.693)		(-1.789)
D(INTR1YR(-7))	0.5560	D(LNRGEXP(-7))	-1.916	D(RECON(-7))	-2.2225
	(-2.322)		(-1.488)		(-0.687)
D(INTR1YR(-8))	0.0060	D(LNRGEXP(-8))	-1.8568	D(RECON(-8))	-6.4109
	(-0.031)		(-2.406)		(-2.094)
D(RDEFP(-1))	2.7892	D(LNRGTRAN(-1))	0.0093	D(RM1GROW(-1))	-0.0254
	(-1.593)		(-0.014)		(-0.265)
D(RDEFP(-2))	2.1274	D(LNRGTRAN(-2))	0.2206	D(RM1GROW(-2))	-0.1262
	(-1.259)		(-0.350)		(-1.339)
D(RDEFP(-3))	3.0833	D(LNRGTRAN(-3))	0.0947	D(RM1GROW(-3))	-0.1513
	(-1.597)		(-0.132)		(-1.552)
D(RDEFP(-4))	3.3119	D(LNRGTRAN(-4))	-0.7122	D(RM1GROW(-4))	-0.1785
	(-1.627)		(-0.952)		(-2.123)
D(RDEFP(-5))	3.1652	D(LNRGTRAN(-5))	-1.1400	D(RM1GROW(-5))	-0.0628
	(-1.719)		(-1.484)		(-0.9879)
D(RDEFP(-6))	2.4494	D(LNRGTRAN(-6))	-0.7529	D(RM1GROW(-6))	-0.0200
	(-1.356)		(-1.184)		(-0.401)
D(RDEFP(-7))	1.5916	D(LNRGTRAN(-7))	-0.6413	D(RM1GROW(-7))	0.0338
	(-1.202)		(-1.273)		(0.781)
D(RDEFP(-8))	1.5820	D(LNRGTRAN(-8))	-0.7173	D(RM1GROW(-8))	-0.0092
	(-1.720)		(-1.903)		(-0.286)
D(LNRGNP(-1))	12.6649	D(INFL(-1))	-0.5516	C	0.0933
	(-2.171)		(-1.863)		(-0.333)

(Figures in parentheses indicate the *t*-statistics)

Table 5.6II
Error Correction Model 2

Variables	Coefficients				
EC_{11}	-0.0383	**D(LNRGNP(-2))**	1.4251	**D(INFL(-2))**	0.0335
	(-0.944)		(1.168)		(0.339)
EC_{12}	-1.2634	**D(LNRGNP(-3))**	-1.5195	**D(INFL(-3))**	-0.0395
	(-1.911)		(-1.035)		(-0.433)
EC_{13}	-1.0105	**D(LNRGNP(-4))**	0.6348	**D(INFL(-4))**	-0.0411
	(-1.055)		(0.487)		(-0.415)
EC_{14}	0.2721	**D(LNRGNP(-5))**	-1.9083	**D(INFL(-5))**	-0.0407
	(0.362)		(-1.280)		(-0.494)
EC_{15}	-0.1176	**D(LNRGNP(-6))**	-1.1800	**D(INFL(-6))**	-0.0217
	(-0.511)		(-0.965)		(-0.289)
EC_{16}	0.0982	**D(LNRGNP(-7))**	1.5355	**D(INFL(-7))**	-0.0327
	(0.910)		(1.271)		(-0.466)
EC_{17}	1.1179	**D(LNRGNP(-8))**	-2.5007	**D(INFL(-8))**	0.0209
	(0.832)		(-1.441)		(0.424)
D(INTR1YR(-1))	-0.0189	**D(LNRGEXP(-1))**	0.1719	**D(RECON(-1))**	-1.3484
	(-0.330)		(0.246)		(-1.042)
D(INTR1YR(-2))	0.1513	**D(LNRGEXP(-2))**	-0.1488	**D(RECON(-2))**	0.9886
	(2.720)		(-0.257)		(0.601)
D(INTR1YR(-3))	-0.1382	**D(LNRGEXP(-3))**	-0.0247	**D(RECON(-3))**	-1.4646
	(-1.990)		(-0.036)		(-1.103)
D(INTR1YR(-4))	0.0437	**D(LNRGEXP(-4))**	0.9112	**D(RECON(-4))**	0.2640
	(0.702)		(1.420)		(0.175)
D(INTR1YR(-5))	0.0351	**D(LNRGEXP(-5))**	0.8018	**D(RECON(-5))**	0.7112
	(0.5397)		(1.409)		(0.637)
D(INTR1YR(-6))	-0.0221	**D(LNRGEXP(-6))**	0.5486	**D(RECON(-6))**	-1.5553
	(-0.363)		(1.041)		(-1.144)
D(INTR1YR(-7))	0.0658	**D(LNRGEXP(-7))**	0.6791	**D(RECON(-7))**	0.2779
	(0.834)		(1.602)		(0.261)
D(INTR1YR(-8))	-0.0383	**D(LNRGEXP(-8))**	0.4713	**D(RECON(-8))**	0.1033
	(-0.592)		(1.855)		(0.102)
D(RDEFP(-1))	0.1775	**D(LNRGTRAN(-1))**	0.2282	**D(RM1GROW(-1))**	0.0637
	(0.308)		(1.0686)		(2.016)
D(RDEFP(-2))	-0.2005	**D(LNRGTRAN(-2))**	0.3274	**D(RM1GROW(-2))**	0.0562
	(-0.361)		(1.578)		(1.810)
D(RDEFP(-3))	-0.0625	**D(LNRGTRAN(-3))**	0.1312	**D(RM1GROW(-3))**	0.0357
	(-0.098)		(0.554)		(1.112)
D(RDEFP(-4))	-0.4891	**D(LNRGTRAN(-4))**	0.3365	**D(RM1GROW(-4))**	0.0190
	(-0.730)		(1.366)		(0.686)
D(RDEFP(-5))	-0.2197	**D(LNRGTRAN(-5))**	0.1747	**D(RM1GROW(-5))**	0.0186
	(-0.363)		(0.691)		(0.890)
D(RDEFP(-6))	-0.1337	**D(LNRGTRAN(-6))**	0.2712	**D(RM1GROW(-6))**	0.0387
	(-0.225)		(1.296)		(2.359)
D(RDEFP(-7))	-0.0971	**D(LNRGTRAN(-7))**	0.1196	**D(RM1GROW(-7))**	0.0226
	(-0.223)		(0.721)		(1.587)
D(RDEFP(-8))	-0.3509	**D(LNRGTRAN(-8))**	0.0515	**D(RM1GROW(-8))**	0.0259
	(-1.159)		(0.415)		(2.440)
D(LNRGNP(-1))	-3.1466	**D(INFL(-1))**	-0.0757	**C**	0.0282
	(-1.638)		(-0.776)		(0.306)

(Figures in parentheses indicate the *t*-statistics)

5.2.2 *Short-term Treasury bill rates*

The interest rates definition of 1-year rate Treasury bill rates in the previous section is replaced with 3-month rates in this section. Therefore, the cointegration analysis will include the 3-month rates and the other variables listed earlier, namely $RDEFP_t$, $LNRGNP_t$, $INFL_t$, $LNRGEXP_t$, $LNRGTRAN_t$, $RECON_t$ and $RM1GROW_t$. These eight variables will be referred from this point onwards as Group 2. Based on the results in Table 5.7, there are 2 cointegrating relations for lag of order 2, 3, 4, 5 and 6; 3 cointegrating relations for lag of order 1 and 6; and 4, 5 and 7 cointegrating relations for lag of order 1, 6, 7 and 8 respectively at 5% significance level.

Table 5.7
Trace Test Statistics of Group 2

Lags	H: r = 0	H: r = 1	H: r = 2	H: r = 3	H: r = 4	H: r = 5	H: r = 6	H: r = 7
1	252.600**	165.756**	101.697*	65.371	35.269	18.317	5.147	0.911
2	189.362**	131.549*	82.847	46.637	28.427	16.879	6.373	1.722
3	199.345**	133.394*	86.944	52.174	27.972	16.147	7.571	0.773
4	186.842**	126.085*	80.912	48.999	28.312	14.411	6.071	0.207
5	209.093**	145.747**	84.697	47.901	28.458	14.340	5.782	0.212
6	246.589**	157.060**	105.713**	62.446	38.312	16.519	6.358	0.145
7	276.105**	179.738**	120.243**	77.660**	51.428*	26.748	8.917	0.017
8	505.607**	356.347**	236.606**	144.478**	95.995**	53.661**	15.860*	1.018

*(**) denotes rejection of the hypothesis at 5% (1%) significance level

Table 5.8 indicates that the pairing of lag of order 8 and 7 cointegrating relations minimizes the System AIC and thus, is the optimal pairing in generating the vector error correction (VEC) estimates. Below are the normalized error correction terms generated by EViews;

$$EC_{21} = INTR3MON_{t-1} + 7.711RM1GROW_{t-1} - 19.033$$

$$EC_{22} = RDEFPt_{-1} + 1.202RM1GROW_{t-1} - 3.437$$

$$EC_{23} = LNRGNP_{t-1} - 4.094RM1GROW_{t-1} - 2.744$$

$$EC_{24} = LNRGEXP_{t-1} - 2.953RM1GROW_{t-1} - 3.371$$

$$EC_{25} = LNRGTRAN_{t-1} - 2.087RM1GROW_{t-1} - 3.839$$

$$EC_{26} = INFL_{t-1} + 4.608RM1GROW_{t-1} - 9.265$$

$$EC_{27} = RECON_{t-1} - 1.981RM1GROW_{t-1} + 2.917$$

Table 5.8
System AIC of Group 2

lag	No. of cointegrating relations (5% sig. level)	System AIC
1	3	2.001
2	2	1.652
3	2	0.871
4	2	0.863
5	2	0.766
6	3	0.221
7	5	-1.297
8	7	-4.125

The error correction (EC) models of Group 2 with two different dependent variables, the 3-month rates and budget deficits, and eight lags for each of the variables are presented in Tables 5.9I and 5.9II respectively. The EC model with the 3-month rates as the dependent variable is referred to as EC Model 3 while the EC model with the budget deficits as the dependent variable for Group 2 is referred to as EC Model 4 in later discussions.

Table 5.9I
Error Correction Model 3

Variables	Coefficients				
EC_{21}	-0.4687	D(LNRGNP(-2))	2.9154	D(INFL(-2))	-0.9936
	(-3.423)		(0.640)		(-2.819)
EC_{22}	-4.1753	D(LNRGNP(-3))	8.3821	D(INFL(-3))	-0.8509
	(-1.703)		(1.447)		(-2.634)
EC_{23}	-6.3352	D(LNRGNP(-4))	-3.1746	D(INFL(-4))	-1.2381
	(-1.847)		(-0.584)		(-3.516)
EC_{24}	-0.1522	D(LNRGNP(-5))	5.0449	D(INFL(-5))	-0.8650
	(-0.052)		(0.887)		(-2.978)
EC_{25}	0.8364	D(LNRGNP(-6))	3.8370	D(INFL(-6))	-0.6681
	(0.894)		(0.790)		(-2.487)
EC_{26}	1.0939	D(LNRGNP(-7))	3.3578	D(INFL(-7))	-0.9099
	(2.854)		(0.724)		(-.3413)
EC_{27}	10.6297	D(LNRGNP(-8))	3.7159	D(INFL(-8))	-0.4355
	(2.173)		(0.574)		(-2.277)
D(INTR3MON(-1))	0.1537	D(LNRGEXP(-1))	-0.5276	D(RECON(-1))	-2.6191
	(0.819)		(-0.199)		(-0.496)
D(INTR3MON(-2))	0.2904	D(LNRGEXP(-2))	-0.1016	D(RECON(-2))	-9.5346
	(1.471)		(-0.046)		(-1.496)
D(INTR3MON(-3))	0.3262	D(LNRGEXP(-3))	-1.5576	D(RECON(-3))	-9.4433
	(1.573)		(-0.617)		(-1.862)
D(INTR3MON(-4))	-0.1650	D(LNRGEXP(-4))	-1.4791	D(RECON(-4))	-10.8631
	(-0.822)		(-0.636)		(-1.948)
D(INTR3MON(-5))	0.1591	D(LNRGEXP(-5))	-4.5076	D(RECON(-5))	-6.3459
	(0.714)		(-2.153)		(-1.489)
D(INTR3MON(-6))	0.4871	D(LNRGEXP(-6))	-4.6632	D(RECON(-6))	-6.4081
	(2.385)		(-2.395)		(-1.309)
D(INTR3MON(-7))	0.4790	D(LNRGEXP(-7))	-3.6340	D(RECON(-7))	-5.2398
	(1.855)		(-2.322)		(-1.323)
D(INTR3MON(-8))	0.1558	D(LNRGEXP(-8))	-2.6380	D(RECON(-8))	-5.8251
	(0.737)		(-2.757)		(-1.565)
D(RDEFP(-1))	3.6175	D(LNRGTRAN(-1))	-0.3109	D(RM1GROW(-1))	-0.0677
	(1.705)		(-0.373)		(-0.533)
D(RDEFP(-2))	2.7918	D(LNRGTRAN(-2))	0.0928	D(RM1GROW(-2))	-0.1283
	(1.381)		(0.120)		(-1.012)
D(RDEFP(-3))	4.3119	D(LNRGTRAN(-3))	-0.0544	D(RM1GROW(-3))	-0.1604
	(1.852)		(-0.063)		(-1.267)
D(RDEFP(-4))	4.9467	D(LNRGTRAN(-4))	-0.9689	D(RM1GROW(-4))	-0.2128
	(2.044)		(-1.062)		(-1.996)
D(RDEFP(-5))	4.9834	D(LNRGTRAN(-5))	-1.4667	D(RM1GROW(-5))	-0.1168
	(2.185)		(-1.586)		(-1.472)
D(RDEFP(-6))	4.3532	D(LNRGTRAN(-6))	-1.1097	D(RM1GROW(-6))	-0.0654
	(1.933)		(-1.430)		(-1.082)
D(RDEFP(-7))	3.1553	D(LNRGTRAN(-7))	-0.8864	D(RM1GROW(-7))	0.0158
	(1.906)		(-1.461)		(0.289)
D(RDEFP(-8))	2.3794	D(LNRGTRAN(-8))	-0.8937	D(RM1GROW(-8))	-0.0211
	(2.094)		(-1.895)		(-0.5190)
D(LNRGNP(-1))	17.7070	D(INFL(-1))	-0.7024	C	0.1087
	(2.494)		(-2.032)		(0.309)

(Figures in parentheses indicate the *t*-statistics)

Table 5.9II
Error Correction Model 4

Variables	Coefficients				
EC_{21}	-0.0491	**D(LNRGNP(-2))**	1.6054	**D(INFL(-2))**	0.0279
	(-1.174)		(1.152)		(0.259)
EC_{22}	-1.5043	**D(LNRGNP(-3))**	-1.4307	**D(INFL(-3))**	-0.0495
	(-2.007)		(-0.808)		(-0.502)
EC_{23}	-1.3485	**D(LNRGNP(-4))**	0.6566	**D(INFL(-4))**	-0.0644
	(-1.286)		(0.395)		(-0.599)
EC_{24}	0.3832	**D(LNRGNP(-5))**	-1.5712	**D(INFL(-5))**	-0.0644
	(-0.428)		(-0.903)		(-0.731)
EC_{25}	-0.1250	**D(LNRGNP(-6))**	-1.4049	**D(INFL(-6))**	-0.0486
	(-0.437)		(-0.946)		(-0.592)
EC_{26}	0.1231	**D(LNRGNP(-7))**	1.7103	**D(INFL(-7))**	-0.0439
	(1.050)		(1.206)		(-0.538)
EC_{27}	1.5557	**D(LNRGNP(-8))**	-2.2749	**D(INFL(-8))**	-0.0144
	(1.040)		(-1.149)		(-0.247)
D(INTR3MON(-1))	-0.025	**D(LNRGEXP(-1))**	0.0522	**D(RECON(-1))**	-1.6160
	(-0.437)		(0.064)		(-1.002)
D(INTR3MON(-2))	0.1169	**D(LNRGEXP(-2))**	-0.1977	**D(RECON(-2))**	0.6312
	(1.938)		(-0.294)		(0.324)
D(INTR3MON(-3))	-0.0618	**D(LNRGEXP(-3))**	-0.1301	**D(RECON(-3))**	-1.3927
	(-0.975)		(-0.169)		(-0.898)
D(INTR3MON(-4))	0.0231	**D(LNRGEXP(-4))**	0.7709	**D(RECON(-4))**	-0.3274
	(0.376)		(1.085)		(-0.192)
D(INTR3MON(-5))	0.0263	**D(LNRGEXP(-5))**	0.7518	**D(RECON(-5))**	0.7584
	(0.386)		(1.175)		(0.582)
D(INTR3MON(-6))	-0.0185	**D(LNRGEXP(-6))**	0.4733	**D(RECON(-6))**	-1.6979
	(-0.296)		(0.795)		(-1.135)
D(INTR3MON(-7))	0.0852	**D(LNRGEXP(-7))**	0.5276	**D(RECON(-7))**	0.0567
	(1.080)		(1.103)		(0.047)
D(INTR3MON(-8))	-0.0190	**D(LNRGEXP(-8))**	0.3920	**D(RECON(-8))**	-0.2145
	(-0.294)		(1.340)		(-0.189)
D(RDEFP(-1))	0.3040	**D(LNRGTRAN(-1))**	0.2158	**D(RM1GROW(-1))**	0.0649
	(0.469)		(0.848)		(1.672)
D(RDEFP(-2))	-0.1091	**D(LNRGTRAN(-2))**	0.3501	**D(RM1GROW(-2))**	0.0589
	(-0.177)		(1.482)		(1.520)
D(RDEFP(-3))	-0.0208	**D(LNRGTRAN(-3))**	0.1689	**D(RM1GROW(-3))**	0.0393
	(-0.029)		(0.642)		(1.016)
D(RDEFP(-4))	-0.3336	**D(LNRGTRAN(-4))**	0.3421	**D(RM1GROW(-4))**	0.0153
	(-0.451)		(1.227)		(0.469)
D(RDEFP(-5))	-0.1014	**D(LNRGTRAN(-5))**	0.2118	**D(RM1GROW(-5))**	0.0158
	(-0.146)		(0.749)		(0.650)
D(RDEFP(-6))	0.0216	**D(LNRGTRAN(-6))**	0.2684	**D(RM1GROW(-6))**	0.0332
	(0.031)		(1.131)		(1.796)
D(RDEFP(-7))	0.0485	**D(LNRGTRAN(-7))**	0.1601	**D(RM1GROW(-7))**	0.0253
	(0.096)		(0.863)		(1.512)
D(RDEFP(-8))	-0.2431	**D(LNRGTRAN(-8))**	0.0589	**D(RM1GROW(-8))**	0.0274
	(-0.700)		(0.409)		(2.209)
D(LNRGNP(-1))	-2.5766	**D(INFL(-1))**	-0.1026	**C**	0.0297
	(-1.187)		(-0.971)		(0.277)

(Figures in parentheses indicate the *t*-statistics)

Based on the results in Tables 5.9I, the coefficients for the error correction terms of Model 3 are in the range of (– 6.335) and 10.63. The coefficient for EC_{21}, $\lambda_{2,11}$ = – 0.469 indicates that the 3-month interest rates need to adjust by a drop of 0.469% from its previous quarter in order to return to the long-run equilibrium.

The adjustments for the error correction terms of Model 4 based on the results in Table 5.9II are in the range of (– 1.504) and 1.556. The range for Models 3 and 4 is relatively larger compared to the range for Models 1 and 2 respectively. The coefficient for EC_{22}, $\lambda_{2,22}$ = – 1.504 indicates that the budget deficit proxy need to adjust by a drop of 1.504 from its previous quarter in order to restore the long-run equilibrium.

5.3 Granger Causality Test

5.3.1 Causality Direction between Medium-term Rates and Budget Deficits

By using the Wald's coefficient test on the EC Models 1 and 2, the F-statistics of both null hypotheses; that 1-year rates do not Granger-cause budget deficits and budget deficits do not Granger-cause 1-year rates; are assessed. The findings in Table 5.10 show that the null hypothesis of 1-year rates do not Granger-cause budget deficits is rejected at 5% significance level but the null hypothesis of budget deficits do not Granger-cause 1-year rates is not rejected at 5% significance level.

This means that budget deficits do not Granger-cause 1-year rates but 1-year rates Granger-cause budget deficits. This is a unidirectional causality from 1-year rates to budget deficits.

Table 5.10
Results of Causality Direction for 1-Year Rates and Budget Deficits

Causality Direction	
H_0: 1-Year Interest Rates do not Granger Cause Budget Deficits	**H_0: Budget Deficits do not Granger Cause 1-Year Interest Rates**
3.1298* (0.0104)	1.6214 (0.159)

* denotes rejection of the hypothesis at 5% significance level
(Figures in parentheses indicate the *p*-values)

5.3.2 Causality Direction between Short-term Rates and Budget Deficits

Based on the EC models in Table 5.9, the Wald's test is again performed in order to obtain the F-statistics in order to assess the null hypotheses involving the 3-month rates and budget deficits. The results are presented in Table 5.11

Table 5.11 reports that the null hypothesis of 3-month rates not Granger causing budget deficits is not rejected while the null hypothesis of budget deficits Granger causing budget deficits is also not rejected at the 5% significance level based on the *p*-values. This implies that there is no causality whatsoever between the 3-month Treasury bill rates and budget deficits.

Table 5.11
Results of Causality Direction for 3-Month Rates and Budget Deficits

Causality Direction	
H_0: 3-Month Interest Rates do not Granger Causes Budget Deficits	**H_0: Budget Deficits do not Granger Causes 3-Month Interest Rates**
2.1526 (0.058)	1.6804 (0.142)

* denotes rejection of the hypothesis at 5% significance level
(Figures in parentheses indicate the p-values)

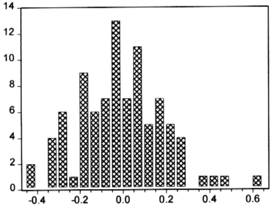
5.4 Normality test

Figures 5.1I, 5.1II, 5.1III and 5.1IV show the results of the histogram and normality test on all the four EC models. The kurtosis statistic is 3.26, 4.03, 3.32 and 3.3 for EC Model 1, 2, 3, and 4 respectively. All of the values are approximately 3 (except for EC Model 2 which is relatively higher but is still considered close to 3), thus indicating that the data in all the models are normally distributed.

Meanwhile, the skewness statistic is 0.28, 0.15, 0.39 and 0.27 for EC models 1, 2, 3 and 4 respectively. These small positive values indicate a slightly longer tail on the right in their respective histograms, indicating only a slight deviation from normality in the histogram.

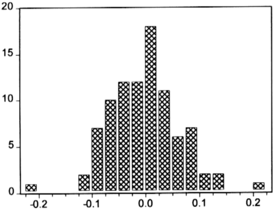
The Jarque-Bera normality test results also show that the null hypothesis of independent normally distributed residuals is not rejected for all four EC models, thus confirming the residuals of all the models are normally distributed, $N \sim (0, \sigma^2)$ and that the results obtained in this study are valid.

Figure 5.1I
Histogram & Normality Test Results for EC Model 1



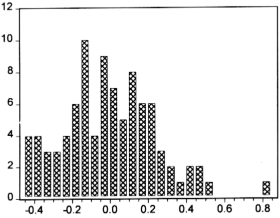
Series: Residuals	
Sample 1980:2 2002:4	
Observations 91	
Mean	2.13E-15
Median	-0.010875
Maximum	0.620771
Minimum	-0.420502
Std. Dev.	0.198935
Skewness	0.282240
Kurtosis	3.252927
Jarque-Bera	1.450733
Probability	0.484147

Figure 5.1II
Histogram & Normality Test Results for EC Model 2



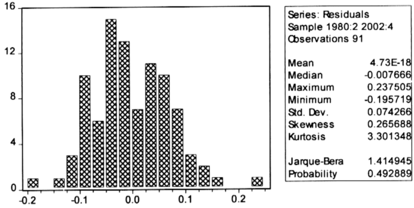
Series: Residuals	
Sample 1980:2 2002:4	
Observations 91	
Mean	-1.50E-16
Median	0.003734
Maximum	0.215497
Minimum	-0.210905
Std. Dev.	0.065495
Skewness	0.150499
Kurtosis	4.033741
Jarque-Bera	4.395377
Probability	0.111060

Figure 5.1III
Histogram & Normality Test Results for EC Model 3



Series: Residuals	
Sample 1980:2 2002:4	
Observations 91	
Mean	-3.17E-17
Median	-0.009399
Maximum	0.816159
Minimum	-0.431529
Std. Dev.	0.242947
Skewness	0.388176
Kurtosis	3.320215
Jarque-Bera	2.674111
Probability	0.262618

Figure 5.1IV
Histogram & Normality Test Results for EC Model 4



5.5 Stability test

The final test, the CUSUM of Squares Test, is performed on all the four EC models to investigate the parameter stability of the models. Figures 5.2I, 5.2II, 5.2III and 5.2IV show the CUSUM of Squares plots of all the models.

Based on the CUSUM of Squares analysis, it is obvious that none of the plots fall outside of the defined bounds. This indicates that there is no evidence of parameter instability for all four EC models.

Figure 5.2I
CUSUM of Squares Test Results for EC Model 1

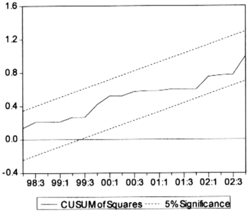


Figure 5.2II
CUSUM of Squares Test Results for EC Model 2

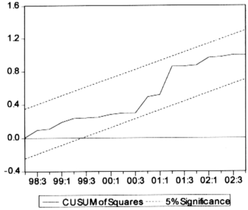


Figure 5.2III
CUSUM of Squares Test Results for EC Model 3

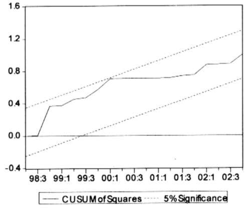


Figure 5.2IV
CUSUM of Squares Test Results for EC Model 4