CHAPTER - V

TRADE DEFICIT AND BUDGE DEFICIT: CO-INTEGRATION ANALYSIS

5.1 Introduction

In economic analysis, it is necessary to examine if long-run equilibrium relationship among macroeconomic variable concerned exists. The study of long-run relationship among variables was formulated by Granger in 1981 through 'Co-integration Study' and it was developed and elaborated by Engle and Granger 1987. Engle and Granger established that long-run relationship among variables could exist if and only if the variables were co-integrated.

We have sought to examine the co-integrating relationship between the variables TD and BD by using Engle-Granger method. Moreover, Durbin Watson method of Co-integrating Regression (CRDW) and Johansen' method of Co-integration have also been employed for further confirmation in the present study.

5.2 Budget Deficit and Trade Deficit in Nepal – A Co-integration Study

Time plots of the Budget Deficit and Trade Deficit (at level) are presented through the Figures 1.2 and 1.3 in Chapter I. A close observation of these plots shows that

(i) both the time plots exhibit declining pattern until 1999.

(ii) both the time plots exhibit rising trend for a very brief period i.e. 2003 –2003.

(iii) the declining phases in both the time plots are marked by some finite numbers of ups and downs.

These observations seem to indicate that

(a) there might exist a long-run relationship between Budget Deficit (BD) and Trade Deficit (TD)

(b) The long-run relationship might have been stable

We seek to address these issues in this chapter. More specifically, we seek to examine if there exists any 'long-run' stable relationship between the Trade Deficits and Budget Deficits in Nepal over the period of our study (1964-2004).

5.3 Methodology of Co-integration

Let Y_t have a long-run relationship with X_t such that,

$$Y_t = \alpha + \beta X_t + u_t$$

or, $$u_t = Y_t - \alpha - \beta X_t$$

Therefore, Y_t and X_t will have a stable long-run relationship if u_t is stationery. In such case, Y_t and X_t are co-integrated in, CI (0).

If on the other hand, if u_t is not stationery, Y_t and X_t series at level cannot define a long-run relationship. In such case, differencing of the u_t series will be necessary. It u_t is stationary at first differencing, then

$$\Delta u_t = \Delta Y_t - \alpha - \beta \Delta X_t$$

defines a stationary process. In such case,

$$\Delta Y_t = \alpha + \beta \Delta X_t + \varepsilon_t$$

where, $t_i \sim iid\, N(0, a_n^2)$

indicates that ΔY_t has a long-run relation with ΔX_t. Consequently, Y_t and X_t are co-integrated in, CI (0).

5.4 The Models

The estimable cointegration models (5.1 and 5.2) for the present study of the long run relationship between budget deficit (BD) and trade deficit (TD) consist of the following equations:

$$TD_t = \alpha + \beta BD_t + u_t \tag{5.1}$$

$$u_t = TD_t - \alpha - \beta BD_t \tag{5.2}$$

where,

TD_t = Real Trade Deficit

BD_t = Real Budget Deficit, and

u_t = Residual term

5.4.1 Estimation of the Models

Equation (5.1) has been estimated. The corresponding estimated equation is given by equations (5.3) below:

$$TD_t = -1533.173 + 2.6618 BD_t \tag{5.3}$$

S.E.: (1220.41) (0.4198)

t-stat.: [-1.256] [6.3405]

$R^2 = 0.5076$

Adj. $R^2 = 0.4950$

Durbin-Watson stat.= 0.4608

From the estimated equations (5.3), the residual series for e_t has been estimated. TD_t and BD_t. will be co-integrated if e_t is stationary.

5.4.2 Tests of Stationarity of Residuals

Stationarity of the residuals e_t has been tested through ADF and Phillips- Perron methods. The results of the tests are being presented through the Tables 5.1 and 5.2.

Table - 5.1

Results of Augmented Dickey Fuller Unit Root Tests on Residuals

Null Hypothesis: The residual has a unit root

Exogenous: Constant **Lag length** :-(Automatic based on SIC, MAXLAG=9)

Variable	ADF test statistic	Prob* value	Lag Length	Test critical values		
				1%	5%	10%
e_t	-1.947387	0.3081	0	-3.605593	-2.936942	-2.606857
Exogenous: None						
e_t	-1.984000	0.0464	0	-2.624057	-1.949319	-1.611711

- *MacKinnon (1996) One-sided P-values*

Again the results of the Phillips-Perron unit root test on residuals has been presented in Table 5.2.

Table - 5.2

Results of Phillips-Perron Unit Root Test on Residuals

(Null Hypothesis: The residual has a unit root)

Exogenous: Constant **Bandwidth:** (Newey-West using Bartlett kernel)

Variable	P-P test statistic	Prob* value	Band**Width	Test critical values		
				1%	5%	10%
e_t	-2.059065	0.2617	3	-3.605593	-2.936942	-2.606857
Exogenous: None						
e_t	-2.100304	0.0358	2	-2.624057	-1.949319	-1.611711

- *MacKinnon (1996) One-sided P-values* ***Newey-West using Bartlett kernel*

5.4.3 Findings of the Unit Root Test of Residuals (of the Equation 5.3)

It is observed from the Tables 5.1 and 5.2 that,

(i) the ADF Test statistic indicate the presence of Unit Root in the in the residuals at 1% level with both the, 'exogenous constant' and 'no exogenous' cases.

(ii) the value of PP test statistic is lower than the absolute value of the critical value at 10% and 5% level. This also testifies for the non-stationarity of residuals.

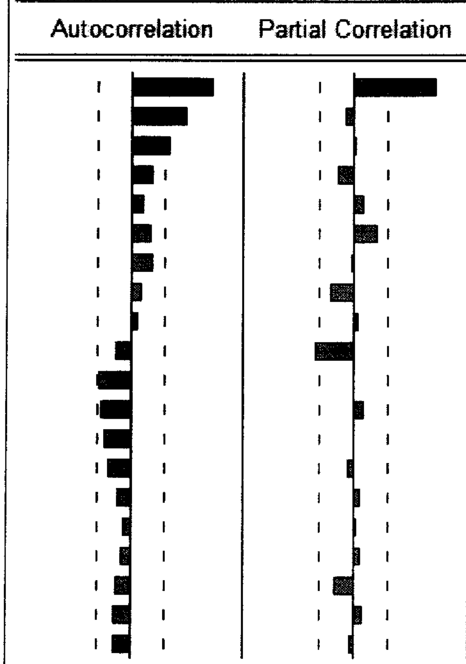
The non-stationarity of residuals (e_t) indicates that the series TD_t and BD_t at levels are not Co-integrated at level i.e BD and TD are not CI(1,1).

5.4.4 Correlogram of Residuals

Another important way of analyzing the stationarity of the residual (e_t) of the respective equation of the concerned data series is the study of Correlogram of the respective residual series. ACF and PACF of the residuals e_t as given in Figure 5.1 help us examine whether the residual is stationary.

Figure - 5.1

Correlogram of Residuals of $TD_t = \alpha + \beta BD_t + u_t$



	AC	PAC	Q-Stat	Prob
1	0.738	0.738	23.998	0.000
2	0.510	-0.076	35.748	0.000
3	0.353	0.009	41.516	0.000
4	0.182	-0.138	43.092	0.000
5	0.113	0.097	43.721	0.000
6	0.168	0.202	45.150	0.000
7	0.186	-0.013	46.942	0.000
8	0.095	-0.220	47.423	0.000
9	0.051	0.025	47.567	0.000
10	-0.145	-0.358	48.766	0.000
11	-0.293	0.005	53.809	0.000
12	-0.281	0.095	58.626	0.000
13	-0.246	-0.002	62.442	0.000
14	-0.209	-0.045	65.294	0.000
15	-0.116	0.042	66.208	0.000
16	-0.058	0.015	66.447	0.000
17	-0.092	0.054	67.065	0.000
18	-0.140	-0.168	68.563	0.000
19	-0.152	0.066	70.408	0.000
20	-0.156	-0.035	72.458	0.000

5.4.5 Findings from the Correlogram of the Residuals

The Correlogram of the residual is given by the Fig 5.1. The plots of the ACF and PACF of the residual show that,

(i) there is long declining step spike pattern in the ACF before it crosses the base, and

(ii) there exists a significant spike at lag one in the PACF

These findings confirm the existence of non-stationarity in the residuals. Consequently, it appears that the BD_t and TD_t series at level are not co-integrated and there exists no long-run relationship between the variables concerned.

5.4.6 Durbin-Watson method of Co-integrating Regression (CRDW)

An alternative method of testing whether the variables are co-integrated is the CRDW test. The critical values for the test statistics were provided by Sargan and Bhargava (Gujarati, 1995:727). In CRDW, significance of the Durbin-Watson statistic (d value) obtained from the co-integrating regression is determined. The null hypothesis is that d=0.

The results of the CRDW test along with critical values have been presented in Table 5.3.

Table - 5.3

Results of Durbin-Watson Test of Co-integrating Regression (CRDW)

Null Hypothesis	D-W statistic	Critical Values		
		1%	5%	10%
No cointegration between TD_t & BD_t	0.4608	0.511	0.386	0.322

It is observed from the Table 5.3 that the null hypothesis of no cointegration between trade deficit (TD) and budget deficit (BD) in real terms has been accepted at 1% level. Consequently, the BD and TD series at level are found not to maintain any long-run relationship between them.

5.4.7 Johansen's Method of Co-integration: Further Confirmation

The Johansen Method of Co-integration has been adopted for further confirmation of our findings on stationarity.

The Johansen Method of Co-integration is quite different from Engle-Granger and CRDW method. This test is based on trace statistic and max-eigen statistic (λ_{max}). The results of such test have been presented in the Table 5.4 and 5.5.

Table - 5.4

Results of Johansen Cointegration Test

Unrestricted Cointegration Rank Test **Lags interval** (in first differences): 1 to 2

Series: TD_t BD_t **Trend assumption**: Linear deterministic trend

Null Hypothesis.	Alternative Hypo.		Eigen value	Trace statistic	5% critical value	1% critical value	Max-eigen statistic	5% critical value	1% critical value
	λ_{max}-tests	Trace tests							
r=0	r =1	r≥1	0.135717	6.136599	15.41	20.04	5.688339	14.07	18.63
r≤1	r =2	r≥2	0.011428	0.448259	3.76	6.65	0.448259	3.76	6.65

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

Max-eigenvalue test indicates no cointegration at both 5% and 1% levels

Table - 5.5

Results of Johansen Cointegration Test

Unrestricted Cointegration Rank Test **Lags interval** (in first differences): 1 to 2

Series: TD_t BD_t **Trend assumption**: No deterministic trend (restricted constant)

Null Hypothesis.	Alternative Hypo.		Eigen value	Trace statistic	5% critical value	1% critical value	Max-eigen statistic	5% critical value	1% critical value
	λ_{max}-tests	Trace tests							
r=0	r =1	r≥1	0.169694	11.00478	19.96	24.60	7.252469	15.67	20.20
r≤1	r =2	r≥2	0.091730	3.752315	9.24	12.97	3.752315	9.24	12.97

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

Trace test indicates 1 cointegrating equation(s) at the 5% level and Trace test indicates no cointegration at the 1% level.

5.4.8 Findings from the Johansen's Co-integration Test Results

Table 5.4 and 5.5 provide the following observations,

(i) For r = 0, with assumption of liner deterministic trend in the series is smaller than the critical trace statistics (6.136599) at 5% and 1% level. So the null hypothesis of non-existence of co-integration between BD and TD has been accepted at 5% (and 1%) level of significance.

(ii) Again for r = 0, with the assumption of linear deterministic trend in the data series, Max-Eigen statistics (5.688339) is smaller than the critical values even at 5% level. Consequently, the null hypothesis of absence of Co-integration between BD and TD has been accepted even at 5% level.

(iii) For r = 0, without the assumption of linear deterministic trend in the series concerned, the estimated trace statistics and Max-Eigen statistics fall short of the corresponding critical values even at 5% level of significance.

These observations confirm our findings in sections 5.4.3 – 5.4.7 that

(a) BD and TD at level are not Co-integrated, and, therefore,

(b) there exists no long-run relation between BD and TD when datasets of these variables are considered at level.

5.5 Test of Co-integration with First Differenced Data

We now seek to examine if long-run relation existed between first differenced datasets for BD and TD. The relevant estimable models for this purpose are explained below.

5.5.1 The Model

The estimable co-integration models for the present study of the long run relationship between budget deficit (ΔBD) and trade deficit (ΔTD) consists of the following equations:

$$\Delta TD_t = \alpha + \beta\, \Delta BD_t + u_t \qquad (5.4)$$

$$u_t = \Delta TD_t - \alpha - \beta\, \Delta BD_t \qquad (5.5)$$

where,

ΔTD_t = First Difference of Real Trade Deficit

ΔBD_t = First Difference of Real Budget Deficit, and

u_t = Residual term

5.5.2 Estimation of the Models

The corresponding estimated equation is given by equation (5.6) below:

$$\Delta TD_t = -501.578 - 0.9599\Delta BD_t \qquad (5.6)$$

S.E.: (298.632) (0.4061)

t-stat.: [-1.6796] [-2.364]

$R^2 = 0.128$

Adj. $R^2 = 0.105$

Durbin-Watson stat. = 2.215

From the estimated equations (5.6), the residual series for $\hat{u}_t$ has been estimated. ΔTD_t and ΔBD_t. will be co-integrated if $\hat{w}_t$ is stationary.

5.5.3 Tests of Stationarity of Residuals

Stationarity of the residuals $\hat{u}_t$ has been tested through ADF and Phillips- Perron methods. The results of the tests are being presented through the Tables 5.6 and 5.7.

Table - 5.6

Results of Augmented Dickey Fuller Unit Root Test on Residuals ($\hat{u}_t$)

Null Hypothesis: The residual has a unit root

Exogenous: Constant **Lag length**:- (Automatic based on SIC, MAXLAG=9)

Variable	ADF test statistic	Prob* value	Lag Length	Test critical values		
				1%	5%	10%
RESID	-6.827777	0.0000	0	-3.610453	-2.938987	-2.607932
Exogenous: None						
RESID	-6.918109	0.0000	0	-2.625606	-1.949609	-1.611593

- *MacKinnon (1996) One-sided P-values*

The Phillips-Perron unit root test on residuals u_t has been presented in the Table 5.7.

Table - 5.7

Results of Phillips-Perron Unit Root Test on Residuals ($\hat{u}_t$)

(Null Hypothesis: The residual has a unit root)

Exogenous: Constant **Bandwidth:** (Newey-West using Bartlett kernel)

Variable	P-P test statistic	Prob* value	Band**Width	Test critical values		
				1%	5%	10%
RESID	-6.926266	0.0000	4	-3.610453	-2.938987	-2.607932
Exogenous: None						
RESID	-7.024417	0.0000	4	-2.625606	-1.949609	-1.611593

- *MacKinnon (1996) One-sided P-values* ***Newey-West using Bartlett kernel*

5.5.4 Findings of the Unit Root on Residuals ($\hat{u}_t$)

It is observed from the Tables 5.6 and 5.7 that

(iii) the ADF Test statistic indicate the presence of no Unit Root in the residuals at 1% level with both the, 'exogenous constant' and 'no exogenous' cases.

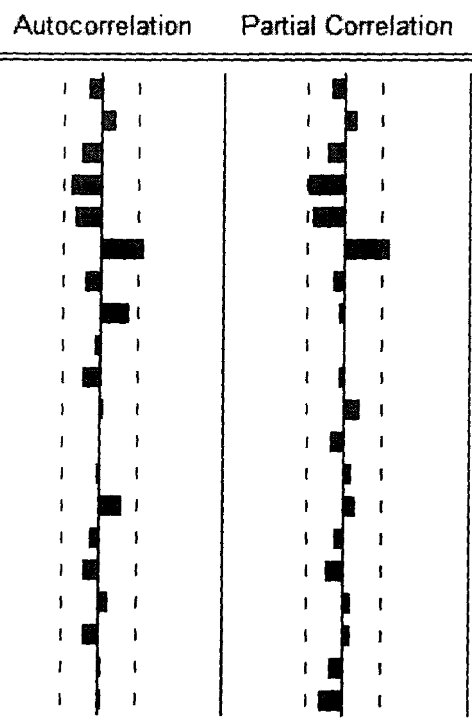
(iv) the above value of PP test statistic is lower than the absolute value of the critical value at 1% level. This also testifies for the stationarity of residuals.

5.5.5 Correlogram of Residuals

Stationarity of the $\hat{u}_t$ residuals has further been examined through the study of Correlogram of the series concerned.

Figure - 5.2

Correlogram of Residuals ($\hat{u}_t$)



	AC	PAC	Q-Stat	Prob
1	-0.114	-0.114	0.5568	0.456
2	0.101	0.089	1.0042	0.605
3	-0.153	-0.135	2.0683	0.558
4	-0.245	-0.293	4.8732	0.301
5	-0.202	-0.270	6.8393	0.233
6	0.348	0.368	12.830	0.046
7	-0.128	-0.096	13.663	0.058
8	0.222	-0.039	16.259	0.039
9	-0.030	-0.007	16.308	0.061
10	-0.136	-0.031	17.340	0.067
11	0.010	0.129	17.345	0.098
12	-0.005	-0.106	17.347	0.137
13	-0.022	0.053	17.378	0.183
14	0.175	0.088	19.359	0.152
15	-0.075	-0.061	19.734	0.182
16	-0.115	-0.147	20.663	0.192
17	0.064	0.051	20.967	0.228
18	-0.128	0.045	22.222	0.222
19	0.023	-0.100	22.263	0.271
20	0.017	-0.184	22.286	0.325

5.5.6 Findings from the Correlogram of the Residual

The Correlogram of the residuals ($\hat{u}_t$) is given by the Fig 5.2 above, the plots of the ACF and PACF of the residual show that

(i) *the residual ($\hat{u}_t$) dataset display no significant spike in the ACF at the first lag.*

(ii) *the PACF is free from any singularly significant spike at the first lag for the $\hat{u}_t$.*

These findings confirm stationarity for $\hat{u}_t$. Consequently, it also indicates that the ΔBD and ΔTD are Co-integrated i.e. BD and TD are CI (1, 0).

5.6 Overview of Findings and Economic Interpretations

The study in sections 5.4 – 5.5 indicates that

(i) *Budget Deficits (BD) and Trade Deficits (TD) series at level are not Co-integrated. Consequently, no long-run relationship can be expected to exist between TD and BD when level datasets are being considered.*

(ii) *since both BD ~ I (1) and TD ~ I (1), we could go for examining the existence of Co-integration between ΔBD and ΔTD series. It is found that ΔBD and ΔTD series are Co-integrated. Consequently, a long-run relation can be expected to exist between first differenced datasets for BD and TD. Consequently, BD and TD series are CI (1, 0).*

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