CHAPTER - 5
STUDY OF COINTEGRATION BETWEEN RUPEE / NEPALESE RUPEE EXCHANGE RATE AND RELATIVE PRICE LEVEL

5.1 Introduction:

Rupee/ Nepalese Rupee exchange rate(e_t) and relative price level (p_t) series are non-stationary and both the series are I(1). Since both the series possess the same order of integrability, the possibility of *cointegration* between these series exists. The study of the *cointegration* between e_t and p_t is important in view of the fact that the existence of such *cointegration* implies long-run relationship between exchange rate and relative price level of the two countries concerned. In that case, exchange rates quoted between the currencies will be in parity with the relative prices prevailing at different time sequences of the period of study. This implies, on the other hand, that exchange rates quoted for the currencies are related to and in parity with the relative purchasing power of the currencies over the study-period. Consequently, '*Purchasing Power Parity Doctrine*' becomes a valid phenomenon in the determination of exchange rate of currencies of the countries concerned (viz, India and Nepal). It is, therefore, pertinent to examine if these variables (e_t and p_t) are *cointegrated.* The study in this chapter is devoted to address this issue.

5.2 Johansen Cointegration Test

The Johansen Cointegration Tests are used to examine if Rupee/ Nepalese Rupee exchange rate (e_t) and the relative price level (p_t) series are cointegrated at level over the period 1976:1-2006:1. The results of such tests are being presented through the Table-5.1.

Table-5.1

Results of Johansen Cointegration Tests for

e_t and p_t at level [Period 1976:1-2006:1]

Trend Assumption: Linear Deterministic Trend (Restricted)

Lag Intervals (in first Difference): 1- 4

I Unrestricted Cointegration Rank λ_{trace} Test Variables Involved: e_t and p_t at Level					
Null Hypothesis	Alternative Hypothesis	Eigen Value	Trace Statistics(λ_{trace})	Critical values 5%	1%
r=0	r>0	0.082	14.529	25.32	30.45
r≤1	r≥1	0.039	4.641	12.25	16.26
II Unrestricted Cointegration Rank λ_{max} Test Variables Involved: e_t and p_t at Level					
Null Hypothesis	Alternative Hypothesis	Eigen Value	Maximum Eigen Statistics (λ_{max})	Critical Values 5%	1%
r=0	r=1	0.082	9.888	18.96	23.65
r≤1	r=2	0.039	4.641	12.25	16.26

5.3 Findings From the Table 5.1

It is observed from the Table 5.1 that

i. for the null-hypothesis r=0 against the alternative hypothesis r>0, $\lambda_{trace}(0)$= 14.529 is lower than the corresponding 5% and 1% critical values. Therefore, the null-hypothesis of '*no cointegrating*' relation cannot be rejected even at 5% level.

ii. for the null-hypothesis r≤1 against the alternative hypothesis r>1, the value of λ_{trace} (1) statistic is 4.641 which is lower than 1% and 5% critical values. So the null hypothesis of r≤1 cannot be rejected even at 5% level.

iii. for the null hypothesis r=0 against the alternative hypothesis r=1 under λ_{max} test, λ_{max} (1,0) value is 9.888. It is lower than the corresponding 5% and 1% critical values. It implies that the null hypothesis of '*no cointegration*' cannot be rejected at even 5% level.

iv. for the null hypothesis r =1 against the alternative hypothesis r = 2 under λ_{max} test, λ_{max} (1,2)= 4.641 falls short of the corresponding critical values at 5% and 1% levels. Consequently, the null hypothesis of '*no cointegration*' between the variables appears to be accepted at even 5% level.

5.4 Overview of the Findings of Cointegration Study and Economic Implications

It is observed from the findings in Section 5.3 that

i. there does not exist any '*cointegration*' between Rupee/Nepalese Rupee exchange rate(e_t) and the relative price level (p_t) at level over the period of study (1976:1-2006:1).

ii. though both of e_t and p_t are I(1), these are not CI(I,0).

The absence of *cointegration* between exchange rate (e_t) and relative price level (p_t) at level bears some important economic implications. The '*non-cointegration*' between e_t and p_t implies that the exchange rates quoted between Indian and Nepalese Currency were not related to the relative purchasing power of the currencies over the period of study. Consequently, there did not exist any long-run relationship between exchange rates quoted in international trade and the relative price levels in these countries.

Study of *cointegration* enquires into the existence of equilibrium relationship postulated by the economic theory. In the present context the economic theory refers to the '*Purchasing Power Parity Theory*' which stresses upon the long-run relationship between exchange rate and relative purchasing power of currencies concerned. Under this theory exchange rate, in the long-run, establishes, the *law of one price* (LOOP).

However, the absence of *cointegration* between e_t and p_t, as found in section 5.3, fails to testify for the validity of the '*Purchasing Power Parity Doctrine*' over the period of study concerned. It, therefore, appears that the Rupee/ Nepalese Rupee exchange rates,

prevailing over the period of study, were largely determined by some factors other than contemporary relative price levels.

5.5 Limitations of Study with the Historical Dataset (Covering the period 1976:1 – 2006:1)

Lucas (1976) has pointed out that econometric relationships change over time following changes in economic policies, social set-ups, administrative decisions, management considerations, political liabilities and institutional opportunities etc. Thus multiforced changes affect the behaviour of macroeconomic variables leading to changes in their relations as a consequence. Thus historical dataset embodies such varying economic relations. Consequently, the econometric relations among the variables estimated with the historical dataset fail to represent the true econometric relations among the variables concerned.

The historical dataset used in this study covers a period of about thirty-one years (1976:1-2006:1). This period is marked by spectacular changes in economic-social-administrative-political fronts. In this period fixed exchange rate system gave away for '*crawling peg*' system which was finally replaced by '*flexible exchange rate*' system. Thus exchange rate system finally became free from government intervention and varied over time following variations in market forces. Within this period, era of liberalization dawned and globalization was welcome in the realm of trade. Bilateral and multi-lateral trade expansion took place among the South Asian Countries. **SAARC** was established and consequently both India and Nepal took important steps in bringing forth expansion of trade. Thus both the countries experienced changes in economic-social-political fronts and consequently economic relations among variables also underwent changes.

It may also be noted that these changes do not occur everyday. Changes in economic relations occur and continue for some time. Then again such relations change after the

passage of some time. Such changes in relations embody *'structural changes'* by nature. Consequently, historical dataset is marked by the presence of *'structural changes'*.

In the historical dataset (1976:1-2006:1) used in our study is found to contain two sub-periods giving forth two distinct relations between exchange rate(e_t) and relative price level(p_t). The first sub period ranges from 1976:1 to 1993:1 and the second sub period extends from 1993:2 to 2006:1.

These two sub periods have been identified through the *'Chow Tests'*. However, the exact period i.e, the coverage of the each of the sub-periods has been identified through laborious *'trial and error'* methods. Identification of the end of the first sub-period and the beginning of the second sub period involved laborious econometric estimations. The justifications of such identifications becomes evident from the econometric findings presented in subsequent chapters.

5.6 Stationarity of e_t and p_t in the Sub-period 1976:1-1993:1: ADF Unit Root Test

The stationarity of e_t and p_t in the sub-period 1976:1-1993:1 has been examined through

i. the ADF Unit Root Test, and
ii. the Correlogram Study.

The results of the ADF Unit Root Tests on e_t and p_t at level and at first difference have been presented through the Tables 5.2 and 5.3 below.

Table: 5.2

Results of the ADF Unit Root Tests for e_t and p_t at Level

(Sub-period: 1976:1-1993:1)

Variable	Null Hypothesis	Lag*	ADF Test Stat.	Prob.	Mac-Kinnon Critical Value**		
					1%	5%	10%
e_t	e_t has unit root Exogenous: Constant	0	-2.010	0.282	-3.530	-2.905	-2.590
	e_t has unit root Exogenous: Constant and Linear Trend	0	-2.719	0.232	-4.099	-3.477	-3.166
	e_t has unit root Exogenous: None	0	0.184	0.737	-2.599	-1.946	-1.614
p_t	p_t has unit root Exogenous: Constant	2	-0.737	0.829	-3.533	-2.906	-2.591
	p_t has unit root Exogenous: Constant and Linear Trend	0	-4.196	0.008	-4.099	-3.477	-3.166
	p_t has unit root Exogenous: None	2	-1.503	0.123	-2.600	-1.946	-1.613

**MacKinnon (1996) one-sided p-values. *Based on SIC, Max Lag =10

Table 5.3

Results of the ADF Unit Root Tests for e_t and p_t at First Difference (De_t and Dp_t)

(Sub-period: 1976:1-1993:1)

Variable	Null Hypothesis	Lag*	ADF Test Stat.	Prob.	Mac-Kinnon Critical Value**		
					1%	5%	10%
De_t	e_t has unit root Exogenous: Constant	0	-9.953	0.000	-3.530	-2.905	-2.590
	e_t has unit root Exogenous: Constant and Linear Trend	0	-9.917	0.000	-4.099	-3.477	-3.166
	e_t has unit root Exogenous: None	0	-9.971	0.000	-2.599	-1.946	-1.614
Dp_t	p_t has unit root Exogenous: Constant	1	-8.554	0.000	-3.533	-2.906	-2.591
	p_t has unit root Exogenous: Constant and Linear Trend	1	-8.492	0.000	-4.099	-3.477	-3.166
	p_t has unit root Exogenous: None	1	-8.407	0.000	-2.600	-1.946	-1.613

**MacKinnon (1996) one-sided p-values. *Based on SIC, Max Lag = 10

5.7 Findings From The Tables 5.2-5.3

(A) The Tables 5.2 shows that

i. the ADF test statistic for e_t with *intercept term* as well as that for e_t with 'intercept and *linear trend term* in the maintained regression equations fall short of critical values even at 10% level.

ii. the ADF test statistic for e_t with '*no intercept term and linear trend*' term in the maintained regression equation also falls short of the critical values even at 10% level.

All these findings indicate that e_t is 'non-stationary' in the period 1976:1-1993:1.

(B) The Table 5.2 further shows that

i. the ADF test statistics for p_t with '*intercept*' and without '*intercept as well as linear trend*' in the maintained regression equations are lower than the corresponding critical values even at 10% level.

ii. the ADF test statistic for p_t with intercept and linear trend term in the maintained regression equation exceeds 1% critical values.

These findings indicate contradictory status regarding stationarity of p_t. In order to ascertain its stationarity, study of its correlogram becomes necessary.

(C) The Table 5.3 shows that

a. the ADF test statistic for De_t (i.e. e_t at first difference) with *intercept* or '*with intercept as well as linear trend*' or '*without intercept and linear trend*' term in the maintained regression equations exceed the critical values even at 1% level.

b. the ADF test statistic for Dp_t (i.e. p_t at first difference) exceed the critical values even at 1% level when the maintained regression equations are estimated with '*intercept only*' or '*with intercept and linear trend term*' or without '*intercept and linear trend term*'.

These findings indicate that

i. both De_t and Dp_t are stationary even at 1% level, and therefore,

ii. $e_t \sim I(1)$ and $p_t \sim I(1)$.

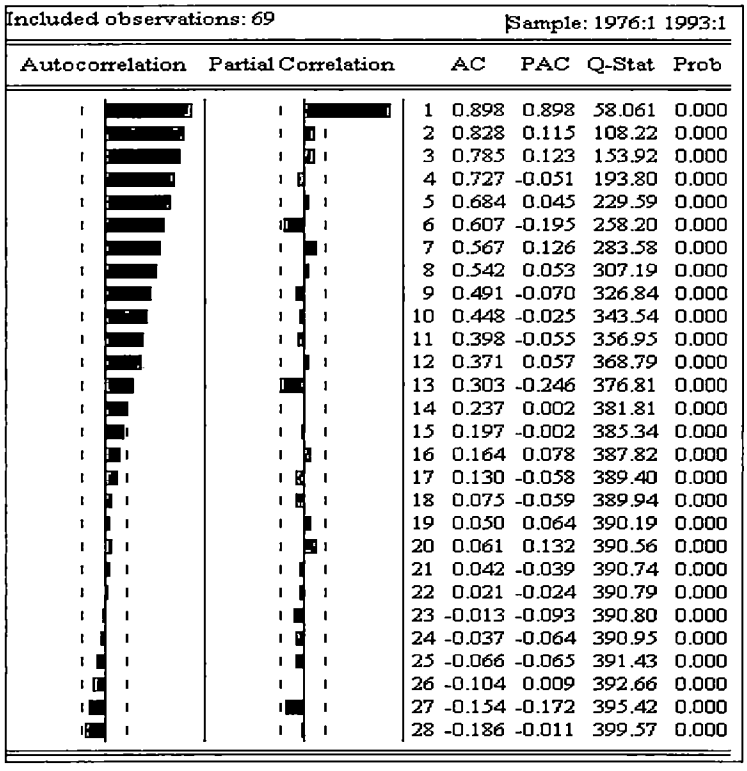
5.8 Stationarity of e_t and p_t in the Sub-period 1976:1-1993:1 : Correlogram Study

The stationarity of e_t and p_t over the sub-period 1976:1-1993:1 has been examined through the study of their correlograms. The correlogram for e_t *at level* and at *first difference* for this sub-period are given by the Figures 5.1-5.2. The correlograms for p_t *at level* and at *first difference* for this sub-period are being presented through the Figures 5.3-5.4.

Figure 5.1

Correlogram of Rupee/Nepalese Rupee (e_t) Series at level

[Sub-Period: 1976:1- 1993:1]



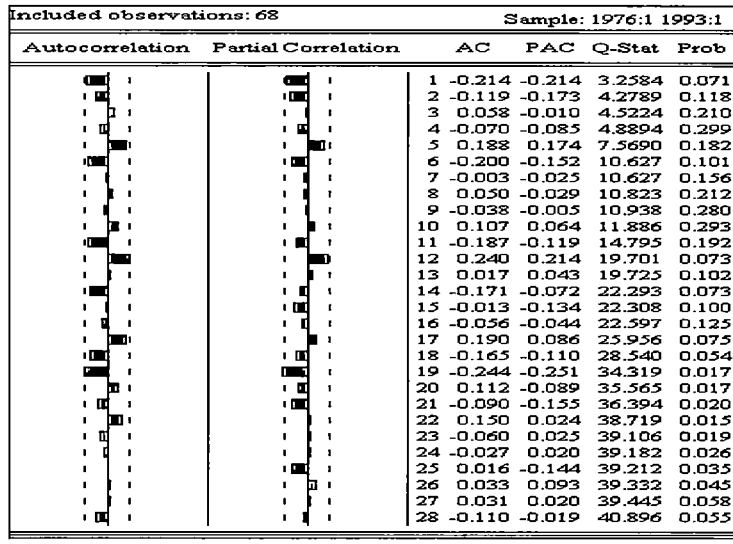
Included observations: 69 Sample: 1976:1 1993:1

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	0.898	0.898	58.061	0.000
		2	0.828	0.115	108.22	0.000
		3	0.785	0.123	153.92	0.000
		4	0.727	-0.051	193.80	0.000
		5	0.684	0.045	229.59	0.000
		6	0.607	-0.195	258.20	0.000
		7	0.567	0.126	283.58	0.000
		8	0.542	0.053	307.19	0.000
		9	0.491	-0.070	326.84	0.000
		10	0.448	-0.025	343.54	0.000
		11	0.398	-0.055	356.95	0.000
		12	0.371	0.057	368.79	0.000
		13	0.303	-0.246	376.81	0.000
		14	0.237	0.002	381.81	0.000
		15	0.197	-0.002	385.34	0.000
		16	0.164	0.078	387.82	0.000
		17	0.130	-0.058	389.40	0.000
		18	0.075	-0.059	389.94	0.000
		19	0.050	0.064	390.19	0.000
		20	0.061	0.132	390.56	0.000
		21	0.042	-0.039	390.74	0.000
		22	0.021	-0.024	390.79	0.000
		23	-0.013	-0.093	390.80	0.000
		24	-0.037	-0.064	390.95	0.000
		25	-0.066	-0.065	391.43	0.000
		26	-0.104	0.009	392.66	0.000
		27	-0.154	-0.172	395.42	0.000
		28	-0.186	-0.011	399.57	0.000

Figure 5.2

Correlogram of Rupee/Nepalese Rupee (e_t) at First Difference

[Sub-Period: 1976:1- 1993:1]



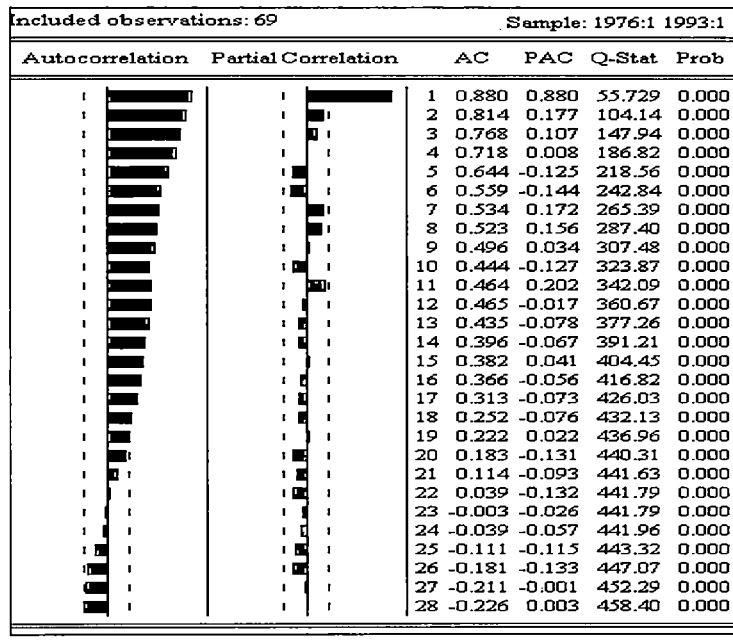
Included observations: 68 — Sample: 1976:1 1993:1

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	-0.214	-0.214	3.2584	0.071
		2	-0.119	-0.173	4.2789	0.118
		3	0.058	-0.010	4.5224	0.210
		4	-0.070	-0.085	4.8894	0.299
		5	0.188	0.174	7.5690	0.182
		6	-0.200	-0.152	10.627	0.101
		7	-0.003	-0.025	10.627	0.156
		8	0.050	-0.029	10.823	0.212
		9	-0.038	-0.005	10.938	0.280
		10	0.107	0.064	11.886	0.293
		11	-0.187	-0.119	14.795	0.192
		12	0.240	0.214	19.701	0.073
		13	0.017	0.043	19.725	0.102
		14	-0.171	-0.072	22.293	0.073
		15	-0.013	-0.134	22.308	0.100
		16	-0.056	-0.044	22.597	0.125
		17	0.190	0.086	25.956	0.075
		18	-0.165	-0.110	28.540	0.054
		19	-0.244	-0.251	34.319	0.017
		20	0.112	-0.089	35.565	0.017
		21	-0.090	-0.155	36.394	0.020
		22	0.150	0.024	38.719	0.015
		23	-0.060	0.025	39.106	0.019
		24	-0.027	0.020	39.182	0.026
		25	0.016	-0.144	39.212	0.035
		26	0.033	0.093	39.332	0.045
		27	0.031	0.020	39.445	0.058
		28	-0.110	-0.019	40.896	0.055

Figure 5.3

Correlogram of Relative Price Level (p_t) at level

[Sub-Period: 1976:1- 1993:1]



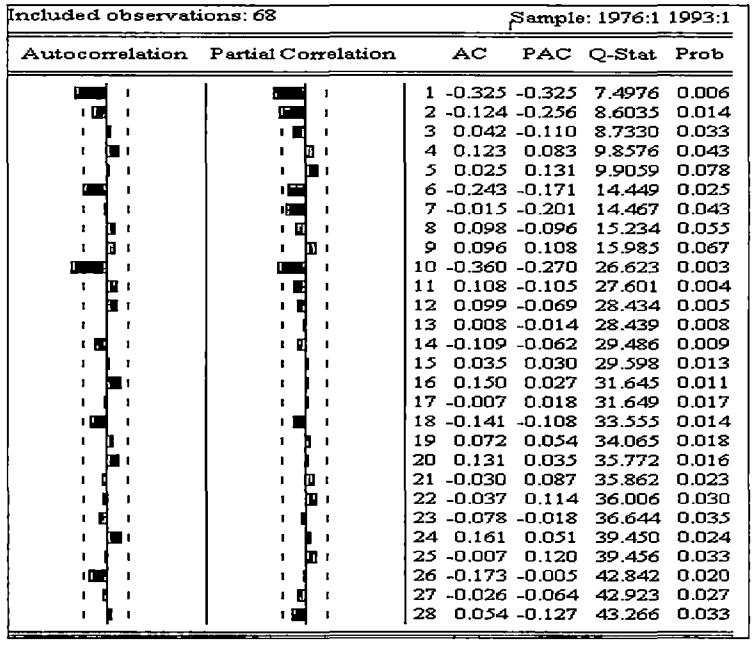
Included observations: 69 — Sample: 1976:1 1993:1

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	0.880	0.880	55.729	0.000
		2	0.814	0.177	104.14	0.000
		3	0.768	0.107	147.94	0.000
		4	0.718	0.008	186.82	0.000
		5	0.644	-0.125	218.56	0.000
		6	0.559	-0.144	242.84	0.000
		7	0.534	0.172	265.39	0.000
		8	0.523	0.156	287.40	0.000
		9	0.496	0.034	307.48	0.000
		10	0.444	-0.127	323.87	0.000
		11	0.464	0.202	342.09	0.000
		12	0.465	-0.017	360.67	0.000
		13	0.435	-0.078	377.26	0.000
		14	0.396	-0.067	391.21	0.000
		15	0.382	0.041	404.45	0.000
		16	0.366	-0.056	416.82	0.000
		17	0.313	-0.073	426.03	0.000
		18	0.252	-0.076	432.13	0.000
		19	0.222	0.022	436.96	0.000
		20	0.183	-0.131	440.31	0.000
		21	0.114	-0.093	441.63	0.000
		22	0.039	-0.132	441.79	0.000
		23	-0.003	-0.026	441.79	0.000
		24	-0.039	-0.057	441.96	0.000
		25	-0.111	-0.115	443.32	0.000
		26	-0.181	-0.133	447.07	0.000
		27	-0.211	-0.001	452.29	0.000
		28	-0.226	0.003	458.40	0.000

Figure 5.4

Correlogram of Relative Price Level (p_t) at First Difference

[Sub-Period: 1976:1- 1993:1]



Included observations: 68 Sample: 1976:1 1993:1

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	-0.325	-0.325	7.4976	0.006
		2	-0.124	-0.256	8.6035	0.014
		3	0.042	-0.110	8.7330	0.033
		4	0.123	0.083	9.8576	0.043
		5	0.025	0.131	9.9059	0.078
		6	-0.243	-0.171	14.449	0.025
		7	-0.015	-0.201	14.467	0.043
		8	0.098	-0.096	15.234	0.055
		9	0.096	0.108	15.985	0.067
		10	-0.360	-0.270	26.623	0.003
		11	0.108	-0.105	27.601	0.004
		12	0.099	-0.069	28.434	0.005
		13	0.008	-0.014	28.439	0.008
		14	-0.109	-0.062	29.486	0.009
		15	0.035	0.030	29.598	0.013
		16	0.150	0.027	31.645	0.011
		17	-0.007	0.018	31.649	0.017
		18	-0.141	-0.108	33.555	0.014
		19	0.072	0.054	34.065	0.018
		20	0.131	0.035	35.772	0.016
		21	-0.030	0.087	35.862	0.023
		22	-0.037	0.114	36.006	0.030
		23	-0.078	-0.018	36.644	0.035
		24	0.161	0.051	39.450	0.024
		25	-0.007	0.120	39.456	0.033
		26	-0.173	-0.005	42.842	0.020
		27	-0.026	-0.064	42.923	0.027
		28	0.054	-0.127	43.266	0.033

5.9 Findings From the Correlogram Study (Sub-period: 1976:1-1993:1)

(A) It is observed from the Figures 5.1-5.2 that

i. the *ACF* for e_t *at level* displays a long dying out pattern of spikes.

ii. the *PACF* for e_t *at level* contains a singular significant spike at lag one.

iii. the *ACF* for e_t at *first difference* is marked by the absence of any dying out pattern of spikes.

iv. the *PACF* for e_t at *first difference* contains no singularly significant spike at lag one.

All these observations confirm that

i. e_t *at level* in the sub-period 1976:1-1993:1 is non-stationary.

ii. e_t attains stationarity upon first differencing over the sub-period 1976:1-1993:1.

(B) The Figures 5.3-5.4 show that

i. the *ACF* of p_t *at level* over the sub-period 1976:1-1993:1 is marked by the presence of a long dying out pattern of spikes.
ii. the *PACF* of p_t at *level* over the sub-period 1976:1-1993:1 contains unique significant spike at lag one.
iii. the *ACF* of p_t at *first difference* exhibits no long dying out pattern of spikes.
iv. the *PACF* of p_t at *first difference* is marked by the absence of any singularly significant spike at lag one.

These features of the correlograms of p_t *at level* and at *first difference* indicate that

i. p_t is non-stationary at level, and
ii. p_t is stationary at first difference over the sub-period 1976:1-1993:1.

5.10 Review of the Findings on Stationarity of e_t and p_t Over the Sub-period 1976:1-1993:1

The Finding in Sections 5.7-5.9 confirm that over the sub-period 1976:1-1993:1

i. both e_t and p_t are non-stationary at level.
ii. both e_t and p_t attain stationarity upon first differencing, and, therefore,
iii. $e_t \sim I(1)$ and $p_t \sim I(1)$.

5.11 Stationarity of e_t and p_t in the Sub-period 1993:2-2006:1: ADF Unit Root Tests

Stationarity of e_t and p_t in the sub-period 1993:2-2006:1 has been examined through ADF unit root tests. Results of such tests for e_t and p_t *at level* and *at first difference* are being presented through the Tables 5.4-5.5.

Table 5.4

Results of ADF Unit Root Tests for e_t and p_t at Level:

[Sub-period: 1993:2-2006:1]

Variable	Hypothesis	Lag*	ADF Test Stat.	Prob.	Mac-Kinnon Critical Value**		
					1%	5%	10%
e_t	e_t has unit root Exogenous: Constant	2	-1.626	0.462	-3.571	-2.922	-2.599
	e_t has unit root Exogenous: Intercept and Linear Trend	2	-1.946	0.615	-4.157	-3.504	-3.182
	e_t has unit root Exogenous: None	2	0.906	0.900	-2.613	-1.948	-1.612
p_t	p_t has unit root Exogenous: Constant	6	-1.383	0.582	-3.585	-2.928	-2.602
	p_t has unit root Exogenous: Intercept and Linear Trend	6	-1.307	0.874	-4.176	-3.513	-3.187
	p_t has unit root Exogenous: None	6	-1.067	0.254	-2.617	-1.948	-1.612

**MacKinnon (1996) one-sided p-values.*Based on SIC, Max Lag = 10

Table 5.5

Results of ADF Unit Root Tests for e_t and p_t at First Difference:

[Sub-period: 1993:2-2006:1]

Variable	Null Hypothesis	Lag*	ADF Test Stat.	Prob.	Mac-Kinnon Critical Value**		
					1%	5%	10%
De_t	De_t has unit root Exogenous: Constant	1	-8.977	0.000	-3.571	-2.922	-2.599
	De_t has unit root Exogenous: Intercept and Linear Trend	1	-8.892	0.000	-4.157	-3.504	-3.182
	De_t has unit root Exogenous: None	1	-8.938	0.000	-2.616	-1.948	-1.612
Dp_t	Dp_t has unit root Exogenous: Constant	5	-4.646	0.0005	-3.585	-2.928	-2.602
	Dp_t has unit root Exogenous: Intercept and Linear Trend	5	-4.621	0.003	-4.176	-3.513	-3.187
	Dp_t has unit root Exogenous: None	5	-4.700	0.000	-2.617	-1.948	-1.612

**MacKinnon (1996) one-sided p-values. *Based on SIC, Max Lag = 10

5.12 Findings From the Table 5.4-5.5

(A) Tables 5.4 and 5.5 show that

i. the ADF Test Statistics for e_t at level fall short of the critical values even at 10% level when the maintained regression equations are estimated with an *intercept term* only or with an *intercept term along with a linear trend* or without *an intercept term as well as a linear trend.*

ii. the ADF Test Statistics for De_t (i.e. e_t at first difference) exceed the critical values even at 1% level when the maintained regression equations are estimated with an *intercept* or with *an intercept along with a linear trend* or without *any intercept and linear trend.*

These findings indicate that

a. e_t is *non-stationary* at level even at 10% level of significance, and
b. De_t (i.e. e_t upon first differencing) is *stationary* even at 1% level.

(B) It is further observed from the Tables that

i. the ADF test statistics for p_t at level are lower than the corresponding critical values even at 10% level when estimated regression equations contain an *intercept term* or an *intercept term together with a linear trend* or without *an intercept term and a time trend.*

ii. the ADF test statistic for Dp_t (i.e. p_t at first difference) exceed the corresponding critical values at 1% level when maintained regression equations are estimated with an *intercept term* or with *an intercept term together with a linear trend* or without *any intercept term and a linear trend.*

These findings indicate that in the sub-period 1993:2-2006:1

i. p_t is *non-stationary* at level, and
ii. p_t attains *stationarity* upon first differencing such that Dp_t is *stationary* at level even at 1% level.

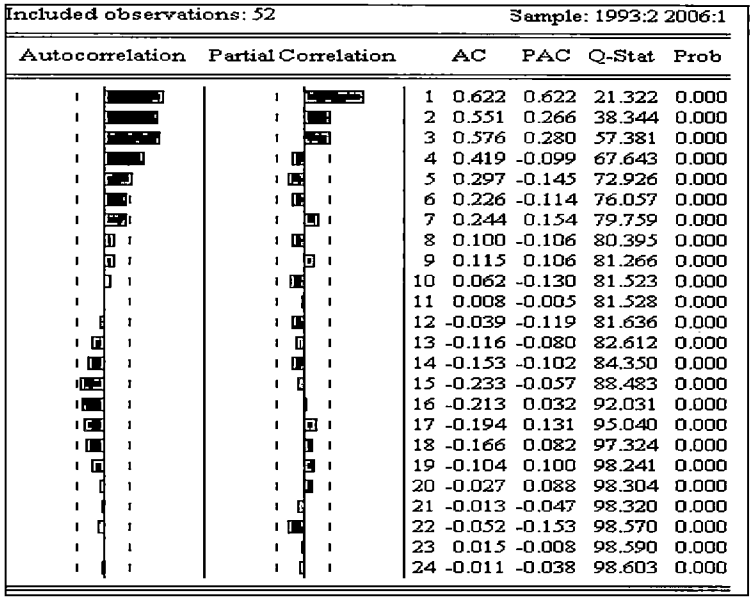
5.13 Stationarity of e_t and p_t in the Sub-period 1993:2-2006:1: Correlogram Study

Stationarity of e_t and p_t in the sub-period 1993:2-2006:1 has also been examined through the study of their respective correlograms. The correlograms of e_t *at level* and at *first difference* are being presented through the Figures 5.5-5.6. Moreover, Figures 5.7 and 5.8 present the correlograms of p_t *at level* and at *first difference* respectively.

Figure 5.5

Correlogram of Rupee/Nepalese Rupee (e_t) at Level

[Sub-Period: 1993:2-2006:1]



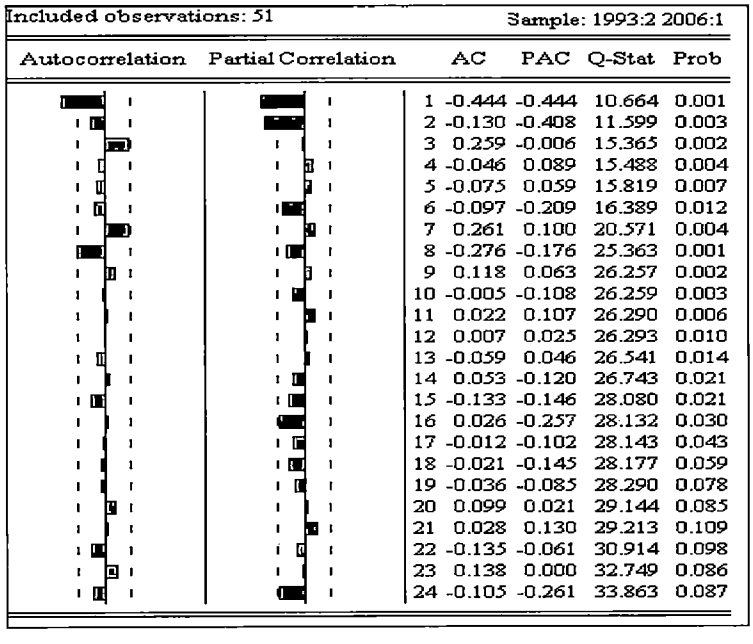
Included observations: 52 Sample: 1993:2 2006:1

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	0.622	0.622	21.322	0.000
		2	0.551	0.266	38.344	0.000
		3	0.576	0.280	57.381	0.000
		4	0.419	-0.099	67.643	0.000
		5	0.297	-0.145	72.926	0.000
		6	0.226	-0.114	76.057	0.000
		7	0.244	0.154	79.759	0.000
		8	0.100	-0.106	80.395	0.000
		9	0.115	0.106	81.266	0.000
		10	0.062	-0.130	81.523	0.000
		11	0.008	-0.005	81.528	0.000
		12	-0.039	-0.119	81.636	0.000
		13	-0.116	-0.080	82.612	0.000
		14	-0.153	-0.102	84.350	0.000
		15	-0.233	-0.057	88.483	0.000
		16	-0.213	0.032	92.031	0.000
		17	-0.194	0.131	95.040	0.000
		18	-0.166	0.082	97.324	0.000
		19	-0.104	0.100	98.241	0.000
		20	-0.027	0.088	98.304	0.000
		21	-0.013	-0.047	98.320	0.000
		22	-0.052	-0.153	98.570	0.000
		23	0.015	-0.008	98.590	0.000
		24	-0.011	-0.038	98.603	0.000

Figure 5.6

Correlogram of Rupee/Nepalese Rupee (e_t) at First Difference

[Sub-Period: 1993:2-2006:1]



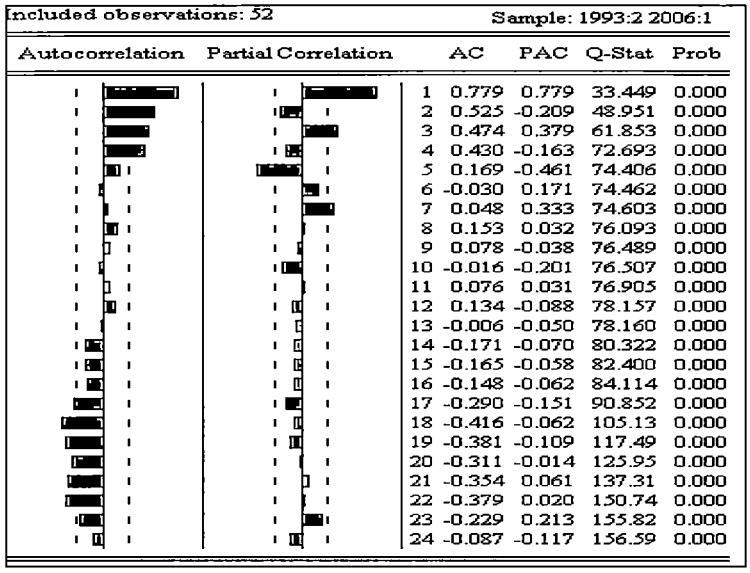
Included observations: 51 Sample: 1993:2 2006:1

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	-0.444	-0.444	10.664	0.001
		2	-0.130	-0.408	11.599	0.003
		3	0.259	-0.006	15.365	0.002
		4	-0.046	0.089	15.488	0.004
		5	-0.075	0.059	15.819	0.007
		6	-0.097	-0.209	16.389	0.012
		7	0.261	0.100	20.571	0.004
		8	-0.276	-0.176	25.363	0.001
		9	0.118	0.063	26.257	0.002
		10	-0.005	-0.108	26.259	0.003
		11	0.022	0.107	26.290	0.006
		12	0.007	0.025	26.293	0.010
		13	-0.059	0.046	26.541	0.014
		14	0.053	-0.120	26.743	0.021
		15	-0.133	-0.146	28.080	0.021
		16	0.026	-0.257	28.132	0.030
		17	-0.012	-0.102	28.143	0.043
		18	-0.021	-0.145	28.177	0.059
		19	-0.036	-0.085	28.290	0.078
		20	0.099	0.021	29.144	0.085
		21	0.028	0.130	29.213	0.109
		22	-0.135	-0.061	30.914	0.098
		23	0.138	0.000	32.749	0.086
		24	-0.105	-0.261	33.863	0.087

Figure 5.7

Correlogram of Relative Price Level (p_t) at Level

[Sub-Period: 1993:2-2006:1]



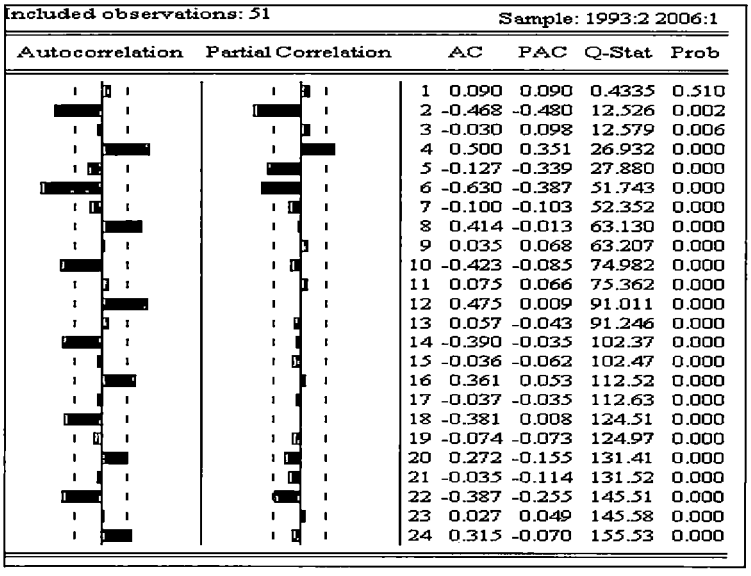
Included observations: 52 — Sample: 1993:2 2006:1

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	0.779	0.779	33.449	0.000
		2	0.525	-0.209	48.951	0.000
		3	0.474	0.379	61.853	0.000
		4	0.430	-0.163	72.693	0.000
		5	0.169	-0.461	74.406	0.000
		6	-0.030	0.171	74.462	0.000
		7	0.048	0.333	74.603	0.000
		8	0.153	0.032	76.093	0.000
		9	0.078	-0.038	76.489	0.000
		10	-0.016	-0.201	76.507	0.000
		11	0.076	0.031	76.905	0.000
		12	0.134	-0.088	78.157	0.000
		13	-0.006	-0.050	78.160	0.000
		14	-0.171	-0.070	80.322	0.000
		15	-0.165	-0.058	82.400	0.000
		16	-0.148	-0.062	84.114	0.000
		17	-0.290	-0.151	90.852	0.000
		18	-0.416	-0.062	105.13	0.000
		19	-0.381	-0.109	117.49	0.000
		20	-0.311	-0.014	125.95	0.000
		21	-0.354	0.061	137.31	0.000
		22	-0.379	0.020	150.74	0.000
		23	-0.229	0.213	155.82	0.000
		24	-0.087	-0.117	156.59	0.000

Figure 5.8

Correlogram of Relative Price Level (p_t) at First Difference

[Sub-Period: 1993:2-2006:1]



Included observations: 51 — Sample: 1993:2 2006:1

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	0.090	0.090	0.4335	0.510
		2	-0.468	-0.480	12.526	0.002
		3	-0.030	0.098	12.579	0.006
		4	0.500	0.351	26.932	0.000
		5	-0.127	-0.339	27.880	0.000
		6	-0.630	-0.387	51.743	0.000
		7	-0.100	-0.103	52.352	0.000
		8	0.414	-0.013	63.130	0.000
		9	0.035	0.068	63.207	0.000
		10	-0.423	-0.085	74.982	0.000
		11	0.075	0.066	75.362	0.000
		12	0.475	0.009	91.011	0.000
		13	0.057	-0.043	91.246	0.000
		14	-0.390	-0.035	102.37	0.000
		15	-0.036	-0.062	102.47	0.000
		16	0.361	0.053	112.52	0.000
		17	-0.037	-0.035	112.63	0.000
		18	-0.381	0.008	124.51	0.000
		19	-0.074	-0.073	124.97	0.000
		20	0.272	-0.155	131.41	0.000
		21	-0.035	-0.114	131.52	0.000
		22	-0.387	-0.255	145.51	0.000
		23	0.027	0.049	145.58	0.000
		24	0.315	-0.070	155.53	0.000

5.14 Findings From the Correlogram Study (Sub-Period: 1993:2-2006:1)

(A) It is observed from the figures 5.5-5.6 that in the Sub-Period: 1993:2-2006:1

i. the *ACF* of e_t *at level* exhibits a long dying out pattern of spikes extending beyond 20^{th} lag.

ii. the *PACF* of e_t *at level* exhibits the presence of a '*unique*' significant spike at lag one.

iii. the *ACF* of De_t (i.e. e_t at first difference) is marked by the absence of a dying out ladder like pattern of spikes.

iv. the *PACF* of De_t contains no *singularly significant* spike at lag one.

All these features of the correlograms of e_t *at level* and *first difference* confirm the findings of the ADF unit root tests that over the period 1993:2-2006:1

i. e_t is non-stationary *at level*, and

ii. De_t is stationary at level i.e, e_t attains stationarity upon *first differencing*.

(B) The Figures 5.7 and 5.8 show that in the sub-period 1993:2-2006:1

i. the *ACF* of p_t *at level* contains a long dying out pattern of spikes extending beyond the 20^{th} lag.

ii. the *PACF* of p_t at level is devoid of any such pattern and any *singularly significant* spike at lag one.

iii. the *ACF* of Dp_t (i.e p_t upon first difference) exhibits no dying out pattern of spikes.

iv. the *PACF* of De_t is marked by the absence of any *unique* significant spike at lag one.

All these features of the correlograms of p_t *at level* and at *first difference* testify that over the sub-period 1993:2-2006:1

a. p_t *at level* is non-stationary, and

b. Dp_t is stationary at level and, therefore, p_t attains stationarity upon first differencing.

5.15 Review of Findings on Stationarity and Integrability of e_t and p_t over the Sub-Period 1993:2-2006:1

The findings on *Stationarity* and *Integrability* of e_t and p_t over the sub-period 1993:2-2006:1 in the sections 5.12 through 5.14 confirm that

i. *e_t and p_t at level are non-stationary.*

ii. *e_t and p_t are stationary upon first differencing, and*

iii. *$e_t \sim I(1)$ and $p_t \sim I(1)$.*

5.16 Summary of the Findings and Economic Implications

The findings in this Chapter (Chapter 5) over the subsections 5.7-5.14 confirm that

i. $e_t \sim I(1)$ and $p_t \sim I(1)$ over the sub-period 1976:1-1993:1, and

ii. $e_t \sim I(1)$ and $p_t \sim I(1)$ over the sub-period 1993:2-2006:1.

In both the sub-periods, e_t and p_t are non-stationary while both of them possess the same order of integrability. These are integrated of order one. This indicates that there exist a scope of enquiring into the existence of long-run relationship between these variables in both the sub-periods. Consequently, the study of *cointegration* between e_t and p_t is theoretically justified in both the sub-periods. The *cointegration* between e_t and p_t, if established in any of the sub-periods, would support the doctrine of '*Purchasing Power Parity*' for the quoted exchange rates between the currencies of India and Nepal in that sub-period. The study in the next chapter is devoted to address this issue.