

CHAPTER 5

TESTING OF COINTEGRATION

5.1 Cointegration Test

The government revenue and government expenditure series of all the concerned countries viz. Indonesia, Malaysia, Singapore and Thailand during the period of study are non-stationary, $I(1)$ and therefore these series entail stochastic trends. Now if we regress government revenue on government expenditure, we might get a spurious regression, a problem usually dealt with by differencing the series. Differencing leads to the loss of important information about the concerned series. To deal with this problem of differencing, Engel and Granger (1987) recommend cointegration. According to Engel and Granger (1987), for any non-stationary series, if there exists a linear combination of the series that is stationary, $I(0)$, the series are said to be a cointegrated and the resulting regression is not spurious. Such series come closer to one another over time and a long run relationship exists between them.

Given that these series for all sample countries are found to be integrated of order one, $I(1)$, we perform a cointegration test to find out if a linear combination of both revenue and expenditure series for each country converge to an equilibrium or not. In that case cointegrated variables have a long-run equilibrium relationship. However, the main problem of Engel-Granger Two Step Method is that it assumes existence of only one cointegrating vector.

The Johansen cointegration method is also used to identify multiple cointegrating vector of any number of non-stationary series. Since both revenue and expenditure series are found to be non-stationary, we proceed with the Johansen cointegration test to detect as to whether both the series are cointegrated or not for all sample countries during the sample period. The Trace and maximum Eigen-value statistics are considered to examine the null hypothesis of no cointegration for these time series data for all sample countries over the period of study. Since we are not certain as to which trend assumption is to be used in the cointegration test we can choose the summary of Johansen cointegration test. The overall summaries of results of Johansen cointegration tests for all sample countries based on various assumptions on intercept, trend, linear and non-linear models are also reported in Table 5.1. Results of Johansen cointegration test for all the concerned countries under the assumption with no

deterministic trend are being reported in Table 5.2 to examine the presence of cointegration in the dataset.

Table 5.1
Summary of Johansen Cointegration Test Results

Country	Lag order	Data trend: None		None	Linear	Linear	Quadratic
		Model 1	Model 2	Model 3	Model 4	Model 5	
		Rank or No. of CEs	No intercept No trend	Intercept No trend	Intercept No trend	Intercept Trend	Intercept Trend
Indonesia	1	Trace	2	2	2	0	2
		Max – Eigen	2	2	0	0	0
	2	Trace	1	1	0	0	2
		Max – Eigen	1	0	0	0	0
	3	Trace	1	0	0	0	2
		Max – Eigen	0	0	0	0	0
Malaysia	1	Trace	2	1	0	0	0
		Max – Eigen	2	0	0	0	0
	2	Trace	2	0	0	0	0
		Max – Eigen	0	0	0	0	0
	3	Trace	2	0	0	0	0
		Max – Eigen	0	0	0	0	0
Singapore	1	Trace	2	0	0	0	0
		Max – Eigen	0	0	0	0	0
	2	Trace	2	0	0	0	0
		Max – Eigen	0	0	0	0	0
	3	Trace	1	2	2	0	1
		Max – Eigen	2	0	2	0	0
Thailand	1	Trace	2	1	0	0	0
		Max – Eigen	2	1	0	0	0
	2	Trace	2	1	0	0	0
		Max – Eigen	2	1	0	0	0
	3	Trace	0	0	0	0	0
		Max – Eigen	0	0	0	0	0

Selected (5% level) Number of cointegrating Relations by Model (columns)

*denotes significance at 1%

5.2 Findings

Based on the above statistical results for country Indonesia, the trace and Max Eigen-value statistics reject the null hypothesis of no cointegration with two cointegrating vectors under model 1 (no intercept and no trend in the data) and 2 (intercept and no trend in the data) with lag order 1. For lag order 2, trace and Max Eigen value statistics show one cointegrating vector under model 1 and trace statistics further show one cointegrating vector under model 1 for lag order 3.

From Table 5.1, it is observed that for Malaysia, the trace and Max Eigen-value statistics reject the null hypothesis of no cointegration with one cointegrating vectors suggesting model 1 for lag order 1 and, trace statistics show one cointegrating vector suggesting model 2. For lag order 2 and 3, trace statistics reject the null hypothesis of no cointegration with two cointegrating vectors but Max Eigen value statistics fail to reject the null hypothesis of no cointegration.

Table 5.1 reports that for Singapore, trace statistics reject the null hypothesis of no cointegration suggesting model 1 for lag order 1, 2 and 3 and suggesting two cointegrating vectors under no intercept and no trend assumption in the data and also presents two cointegrating vectors confirming model 2 for lag order 3. However, Max Eigen-value statistics confirm two cointegrating vectors suggesting model 1 for lag order 3.

Table 5.1 presents that for Thailand, the trace and Max Eigen-value statistics rejects the null hypothesis of no cointegration with two cointegrating vectors suggesting model 1 with two cointegrating vectors for lag order 1 and 2. Under trend assumption (intercept and no trend in the data), the trace and Max Eigen-value statistics confirm one cointegrating vector for lag order 1 and 2. Trace and Max Eigen value statistics fail to reject the null hypothesis of no cointegration suggesting all models for lag order 3.

Table 5.1 summarises that empirical results of Johansen cointegration test confirm that at least one cointegrating vector exists for Indonesia, Malaysia, Singapore and Thailand during the study period as evidenced by trace test over three different lag lengths of 1,2 3 years suggesting model 1 with no intercept and no trend. Trace test further shows that at least one cointegrating vector does persist for Indonesia, Malaysia and Thailand suggesting model 2 for lag order 1 and two cointegrating vectors exist in Singapore with lag order 3. Ender¹ states, “Cointegrated variables show the same stochastic trends and so can’t drift too far apart from each other”. Thus the trace test and Max-Eigen value statistics suggest that there is a long-run relationship between government revenue (R_t) and government expenditure (E_t) for all the chosen countries over the respective chosen periods of study.

Note:

1 Walter Enders, “Applied Econometric Time Series” Second Edition. Page:324-328

Table 5.2
Johansen Cointegration Test Results
(Trend assumption: No deterministic trend)

Country	Hypothesized No of CE(s)	Eigenvalue	Trace Test			Max Eigenvalue Test		
			Trace statistic	5% critical value	1% critical value	Max Eigen Statistic	5% critical value	1% critical value
Indonesia	None	0.352803	26.28405	12.53	16.31	16.96905	11.44	15.69
	Lag 1	At most 1	0.212464	9.314998	3.84	6.51	9.314998	3.84
Lag 2	None	0.312671	17.85915	12.53	16.31	14.24780	11.44	15.69
	At most 1	0.090659	3.611350*	3.84	6.51	3.611350*	3.84	6.51
Lag 3	None	0.265188	14.33713	12.53	16.31	11.40123*	11.44	15.69
	At most 1	0.076282	2.935907*	3.84	6.51	2.935907*	3.84	6.51
Malaysia	None	0.302341	21.46217	12.53	16.31	15.48105	11.44	15.69
	Lag 1	At most 1	0.129856	5.981129	3.84	6.51	5.981129	3.84
Lag 2	None	0.218420	15.13741	12.53	16.31	10.35036	11.44	15.69
	At most 1	0.107722	4.787048	3.84	6.51	4.787048	3.84	6.51
Lag 3	None	0.208586	13.71706	12.53	16.31	9.591311*	11.44	15.69
	At most 1	0.095731	4.125750	3.84	6.51	4.125750	3.84	6.51
Singapore	None	0.155847	12.81902	12.53	16.31	6.776879*	11.44	15.69
	Lag 1	At most 1	0.140198	6.042138	3.84	6.51	6.042138	3.84
Lag 2	None	0.192711	12.85973	12.53	16.31	8.348859	11.44	15.69
	At most 1	0.109225	4.510870	3.84	6.51	4.510870	3.84	6.51
Lag 3	None	0.277142	16.75106	12.53	16.31	12.33262	11.44	15.69
	At most 1	0.109769	4.418437	3.84	6.51	4.418437	3.84	6.51
Thailand	None	0.253349	22.62626	12.53	16.31	15.48436	11.44	15.69
	Lag 1	At most 1	0.126068	7.141898	3.84	6.51	7.141898	3.84
Lag 2	None	0.210358	16.84671	12.53	16.31	12.28105	11.44	15.69
	At most 1	0.084057	4.565662	3.84	6.51	4.565662	3.84	6.51
Lag 3	None	0.135384	10.06722*	12.53	16.31	7.418973*	11.44	15.69
	At most 1	0.050601*	2.648244*	3.84	6.51	2.648244*	3.84	6.51

Note: * indicates acceptance of null hypothesis of no cointegration at 5% level. The lag length of 1,2 and 3 is included due to the conventional practice that the data used is yearly in nature.

5.3 Findings

It is observed from the Table 5.2 that the Trace test and Max-Eigen value reject the null hypothesis of no cointegration at 5% level of significance for lag order 2 and for lag order 3. Trace test and Max-Eigen value indicate one Cointegrating vector at 5% level and for lag order 1 in case of Indonesia country over the period of study. This indicates that the government revenue (R_t) and government expenditure (E_t) over the sample period are cointegrated in Indonesia over the period concerned. In case of Malaysian economy, Trace test and Max-Eigen value reject the null hypothesis of no cointegration at 5% level of significance for lag order 1 and for lag order 2 and 3 suggesting at most one Cointegrating vectors at 5% level in case of Malaysian economy over the period of study. This implies that the government revenue (R_t) and government expenditure (E_t) are cointegrated in Malaysia over the chosen periods. For Singapore, Trace test statistics and Max Eigen Value statistics reject the null hypothesis of no cointegration with at most one cointegrating vector at 5% level of significance for lag order 1 and for lag order 2 and 3. Trace test and Max Eigen Value Statistics indicate one Cointegrating vectors at 5% level and for lag order 1, 2 and 3 over the period of study and suggesting a long run equilibrium relationship between government revenue (R_t) and government expenditure (E_t) over the chosen period in Singapore. Again for Thailand economy, Trace test and Max-Eigen value test for lag order 1 and order 2 fail to accept the null hypothesis of no cointegration at 5% level of significance suggesting a long run equilibrium relationship between government revenue (R_t) and government expenditure (E_t) over the sample period in Thailand. Hence the above statistical results confirm that both government revenue (R_t) and government expenditure (E_t) are found to be cointegrated for all chosen countries over the respective chosen periods.