Chapter 5: Empirical Results

5.1 Empirical Results For Annual Data

All our empirical tests have been carried out using E-Views 3.1. As explained in the previous section, a simple OLS regression is used to estimate annual consolidated public expenditure. Various category of public expenditure which includes total public expenditure (TPE), operating public expenditure (OPE) and developing public expenditure (DPE) are regressed against GDP. These equations represent the formulation of Wagner's Law. The variables appear to be non-stationary and the regressions are estimated in their differences forms in order to obtain their true relations. The regressions are thus formulated as follows:

$$\Delta LNTPE = c_0 + c_1\ \Delta LNGDP + u_t \quad \text{....(1)}$$

$$\Delta LNOPE = c_0 + c_1\ \Delta LNGDP + v_t \quad \text{....(2)}$$

$$\Delta LNDPE = c_0 + c_1\ \Delta LNGDP + e_t \quad \text{....(3)}$$

where PE = Real Total public expenditure of consolidated public sector

OPE = Real Operating public expenditure of consolidated public sector

DPE = Real Net Development expenditure of consolidated public sector

GDP= Gross Domestic Product

Δ represents difference form

u_t, v_t and e_t are serially uncorrelated random disturbance terms and LN denotes natural logarithm.

Estimation output for the regressions are stated below:

i) ΔLNTPE = 0.0139 + 0.8976 ΔLNGDP

(1.4417) (2.0261)

$R^2 = 0.1426$ $\bar{R}^2 = 0.1120$ SER= 0.0897 DW=1.3372

F-statistics=4.6582 (Prob.=0.0396)

ii) ΔLNOPE = 0.0232 + 0.6378 ΔLNGDP

(0.8161) (1.7878)

$R^2 = 0.1025$ $\bar{R}^2 = 0.0704$ SER= 0.0769 DW=2.0655

F-statistics= 3.1963 (Prob.=0.0846)

iii) ΔLNDPE = 0.0129 + 1.1311ΔLNGDP

(0.1932) (1.3558)

$R^2 = 0.0616$ $\bar{R}^2 = 0.0281$ SER= 0.1799 DW=1.2526

F-statistics=1.8383 (Prob.=0.1860)

Notes: t-statistics are in parentheses
No augmentation is necessary to be sufficient to secure lack of autocorrelation of error terms.

The three regressions above yielded very low R^2 and thus GDP can only explain minimal variation of the various categories of public expenditures. The low R^2 indicates that they are other factors that can contribute to explanation of the variation in public expenditure. Overall, GDP is not significant at 5% level in explaining the variation in the various categories of public expenditure. At this stage, the OLS regressions using the annual data do not provide adequate hints about the existence of Wagner's Law in Malaysia. We cannot jump to any conclusion at this point before we explore the quarterly data which may better describe the trend of public expenditure in Malaysia and hence the validity of Wagner's Law.

5.2 Empirical Results for Quarterly Data

We focus on the quarterly data in this section although the annual data did not produce convincing evidence of Wagner's Law. For the quarterly data, we begin by investigating the stationary properties of the data using Augmented Dickey Fuller (ADF) test. The ADF test is regarded as the most efficient test to test the order of integration. When the order of augmentation is zero, the ADF test works in the form of Dickey Fuller test.

The general form of ADF test for a unit root is based on the following regressions:

$$\Delta X_t = c + \alpha X_{t-1} + \sum_{j=1}^{p} \beta_j \Delta X_{t-j} + \gamma t + \varepsilon_t \qquad \text{(for levels)} \qquad (6)$$

$$\Delta\Delta X_t = c + \alpha \Delta X_{t-1} + \sum_{j=1}^{p} \beta_j \Delta\Delta X_{t-j} + \varepsilon_t \qquad \text{(for first differences)} \qquad (7)$$

where Δ y are the first differences of the series, p is the number of lags and t is time trend.

ε_t represents a sequence of uncorrelated stationary error terms with zero mean and constant variance.

The trend term is included in the ADF unit root test when testing for the stationary of the variables at log levels. When testing the first differences of the variables, time trend is not included. As the variables are in term of their growth rates, hence by taking the differences of the present and the previous period's values, time trend is eliminated. The null hypothesis of non-stationary (that the tested variable contains k unit root) is tested against the alternative that the series are trend-stationary. These hypothesis can be written as H_0: $\alpha = 0$ versus H_1: $\alpha < 1$. Rejection of H_0 implies that X_t is I(0) while acceptance implies that it is integrated or order (1). The unit root test results are determined by the t-statistics of the ADF test and compared against MacKinnon critical values of 1%.

In practice the choice of augmentation (that is, of the length and elements of the autoregressive component in unit root test regression) is of the utmost importance and is often neglected in the literature. Since the primary goal of the inclusion of the augmentation terms is to secure a white noise property for ε_t, the emphasis should be put into applying a battery of tests for ensuring that the series ε_t is indeed independently and identically distributed (Charemza and Deadman, 1997:104). The lag order is determined by monitoring the Akaike Information Criteria (AIC). Different numbers of lags are used in the ADF test. Thorough autocorrelation tests are conducted using Durbin Watson statistic and Breusch Godfrey Lagrange Multiplier test are used to ensure that the series ε_t are not correlated.

Results of the unit root test are shown below:

Table 2: DF and ADF Unit Root Tests in Levels (With an Intercept and a Linear Trend)

Variables	Lag Order	ADF Values	Critical Value at 1%	Critical Value at 5%
GDP	4	-3.3788	-4.0373	-3.4478
TPE	4	-1.2441	-4.0373	-3.4478
OPE	3	-0.8423	-4.0373	-3.4478
DPE	4	-1.7707	-4.0373	-3.4478

Notes: ADF test statistics are computed using regressions with an intercept, a linear trend and m lagged first-differences of the dependent variable (m=0,....,4). Critical values taken from MacKinnon(1991) and reported by E-Views.

Table 3: ADF Unit Root Tests in First Differences (ADF Regression with an Intercept)

Variables	Lag Order	ADF Values	Critical Value at 1%	Critical Value at 5%
GDP	3	-5.2590	-3.4865	-2.8859
TPE	3	-6.9411	-3.4865	-2.8859
OPE	2	-27.1122	-3.4865	-2.8859
DPE	3	-9.0073	-3.4865	-2.8859

Notes: ADF test statistics are computed using regressions with an intercept and m lagged first-differences of the dependent variable (m=0,....,4). Critical values taken from MacKinnon(1991) and reported by E-Views.

In the case of the levels of the series, the null hypothesis of non-stationary cannot be rejected for any of the series at 1% significance level. Therefore, the levels of all series are non-stationary. When the unit root tests are conducted in their first differences, the series became stationary as their ADF values are rejected against MacKinnon's critical values at 1% significance. This shows that all the series are integrated of order one [(I(1)]. Since they are integrated of the same level, we then proceed on to test for the existence of a long-run relationship between them, i.e. a cointegrating relationship.

Here, we employ two methods to test the existence of a co integration relationship between the variables. First method is the Engle-Granger method by running an OLS regression to investigate whether the residuals are stationary or not. This method is attractive due to its simplicity. First, the hypothesised long-run relationships (e.g. $ly_t = a + blx_t + e_t$) are estimated by OLS. They are called the co integrating regressions and the residuals are retained to test whether they are stationary or nonstationary. By observing the data, we realized that the public expenditure jumps at every fourth quarter. One reasonable explanation for this scenario is that most of the government departments only rush to fully utilize their budget allocation at the end of the fiscal year. A seasonal dummy variable is included to capture this phenomenon.

Engle and Granger (1991:14) argued that '...when testing non-co integration of series which have a drift, one can include a time trend in the co integrating regression which is equivalent to detrending the series first. The critical values is then even higher'. Following this, we have added a time trend into co integrating regressions.

The co integration results using Engle-Granger are as follows:

Table 4: Co integration Regressions and ADF Tests

Dependent Variable	Constant	Coefficient For GDP	Coefficient for dummy	Time trend	R^2	CRDW	ADF(*)
LNTPE	-1.4812	1.0349	0.5523	-0.0044	0.7029	0.5653	-1.4304(4)
LNOPE	-0.8454	0.8406	0.4529	-0.0016	0.7445	0.7165	-1.0878(4)
LNDPE	-11.4481	3.0612	0.8628	-0.0435	0.5437	1.2086	-2.2429(4)

*Notes: * Number of lags (in parentheses) were chosen by the Akaike Information Criterion.*
Critical values (at 5% significance level) is –1.9426 taken from MacKinnon (1991) as reported by E-Views.

Table 4 presents the results of the ADF unit root tests for the residual series from the three cointegrating regressions. Based on the results, we cannot reject the null hypothesis of nonstationarity for the first two regressions where total public expenditure and operating expenditure are used as dependent variable. The t-statistics of the ADF test is smaller (in absolute values) than the MacKinnon 5% critical values. These results show that there is no long run relationship between total public expenditure and operating expenditure with national income in Malaysia. However, we reject the null hypothesis of nonstationarity when developing expenditure is used as the dependent variable. This suggests to us an existence of a long-run relationship between the developing expenditure with national income. It is also important to note that as expected, signs for the coefficients (except time trend) are found to be positive.

However, there are limitations to the Engle-Granger model. The Engle-Granger method is known to suffer from a large degree of small sample bias due to the omission of short-run dynamics. Even in large samples the bias may still be significant (Oxley, 1994). A more powerful test is needed to test for co integration. We utilise the Johansen method to verify the co integration results above. Results of VAR tests (based on minimum AIC values) indicate that the optimal lag order is determined to be 4 for the various categories of public expenditure.

We believe that the various categories of public expenditure and national income have a deterministic trend but we cannot decide with certainty whether the data should include trend or not. Thus, in order to be in the safe side, both options are to be utilised in the co integration tests. The first option is that the data have a linear deterministic trend and there is an intercept but no trend in the co integrating regression. Subsequently the co integration test is run again by using the second option that specifies that the data have a linear deterministic trend and there is an intercept and trend in the co integrating regression. Both results are shown in the tables below. We can conclude that whether we include a time trend or not, the results did not alter and indicates that all the variables are non-co integrated.

Table 5: Johansen Test - Data have a linear deterministic trend and there is an intercept but no trend in the co integrating equation

Dependent Variable	Eigenvalue	Likelihood Ratio	5% Critical Value	10% Critical Value	Hypothesized No. of CE(s)
LNTPE	0.04592	5.724573	15.41	20.04	None
	0.006645	0.793409	3.76	6.65	At most 1
LNOPE	0.078974	9.838353	15.41	20.04	None
	0.000408	0.048523	3.76	6.65	At most 1
LNDPE	0.045054	6.332070	15.41	20.04	None
	0.007085	0.846083	3.76	6.65	At most 1

Table 6: Johansen Test - Data have a linear deterministic trend and there is an intercept and trend in the co integrating equation

Dependent Variable	Eigenvalue	Likelihood Ratio	5% Critical Value	10% Critical Value	Hypothesized No. of CE(s)
LNTPE	0.098902	16.80523	25.32	30.45	None
	0.036400	4.412411	12.25	16.26	At most 1
LNOPE	0.111457	20.92521	25.32	30.45	None
	0.056038	6.862653	12.25	16.26	At most 1
LNDPE	0.118954	20.55352	25.32	30.45	None
	0.045028	5.482678	12.25	16.26	At most 1

Although our findings do not support a long-run relationship between the variables, we should be caution as this may be the result of a number of factors and not necessarily a rejection of a co integration system. As Demirbas (1999) pointed out, the findings of non-co integration do not exclude the possibility of co integration in some higher order system that includes more variables such as the relative prices, demographic variables, dependency ratio, manufacturing ratio and others. The omission of important variables may produce the non-co integration result. As our statistical procedure measures no long-run relationship between the variables, we cannot proceed on with an error correction procedure to model the short-run dynamics.

5.21 Granger-Causality

Having established that real government expenditure and real GDP are not co integrated, we use Granger causality test to determine the causal direction(s) for the various public expenditure and national income. As the ADF tests showed that all variables are nonstationary, the conventional Granger-type causality test cannot be performed using data in level form. All equations are estimated using their log differences. VAR model in differences is misspecified if the variables are co integrated. Since the Johansen co integration test showed that the variables are non-co integrated, we can safely use the log differences in performing the Granger causality test. Optimal lag is chosen based on the AIC value of the VAR tests.

Table 7: Results from Granger Causality Test

Null Hypothesis	Lags	F-Statistic	Probability
ΔLNGDP does not Granger Cause ΔLNTPE	4	0.96121	0.4.3187
ΔLNTPE does not Granger Cause ΔLNGDP		2.83119	0.02800
ΔLNGDP does not Granger Cause ΔLNOPE	4	1.23006	0.30231
ΔLNOPE does not Granger Cause ΔLNGDP		2.87179	0.02629
ΔLNGDP does not Granger Cause ΔLNDPE	4	1.10079	0.35994
ΔLNDPE does not Granger Cause ΔLNGDP		2.14811	0.07964

Overall, the Granger-causality tests indicate that there is uni-directional causality from real public expenditure (LNTPE, LNOPE and LNDPE) to national income (LNGDP). The empirical results support the Keynesian proposition and refute the validity of Wagner's Law. Thus, the tremendous growth of public expenditure cannot be explained using Wagner's Law. In addition, the results of non-co integration also conclude that there is no long-run relationship between the various categories of public expenditure and national income. This reinforced our conclusion that Wagner's law is not valid in Malaysia. Regressing operating expenditure against GDP is theoretically most conformed to the essence of Wagner's Law idea. When this regression also fails to support Wagner's Law too, we can conclude that there is an outright rejection of Wagner's Law in Malaysia.