CHAPTER FIVE: EMPIRICAL RESULTS

5.0 INTRODUCTION

This chapter, in addition to adopting a time series approach to the development of our growth model, reports the results of the various tests discussed in the previous chapter. The statistical properties of the data pertaining to the variables used in the two models are checked for stationarity through unit root tests and for cointegration in order to examine the long term equilibrium relations and ensure that the causality tests do not produce spurious results.

5.1 STOCHASTIC AND DETERMINISTIC TRENDS

A casual inspection at the graphs of detrended LGDP, LGNT, LEX, LIO and LTOT, to some extent, enables us to detect the kinds of trends which are inherent in the data being used.

Figure 1 on the next page suggests that both output of the non-trade sector and overall output growth are subject to smaller cyclical fluctuations around an upward trend path; higher fluctuations are associated with LEX, LTOT and LIO. In fact, the OLS estimates obtained after regressing LGDP, LGNT, LEX, LIO and LTOT - each at a time - on an intercept term and a linear time trend, prove to be positive and significant at the 1% level as shown in Table 3.

FIGURE 1: EXISTING TRENDS

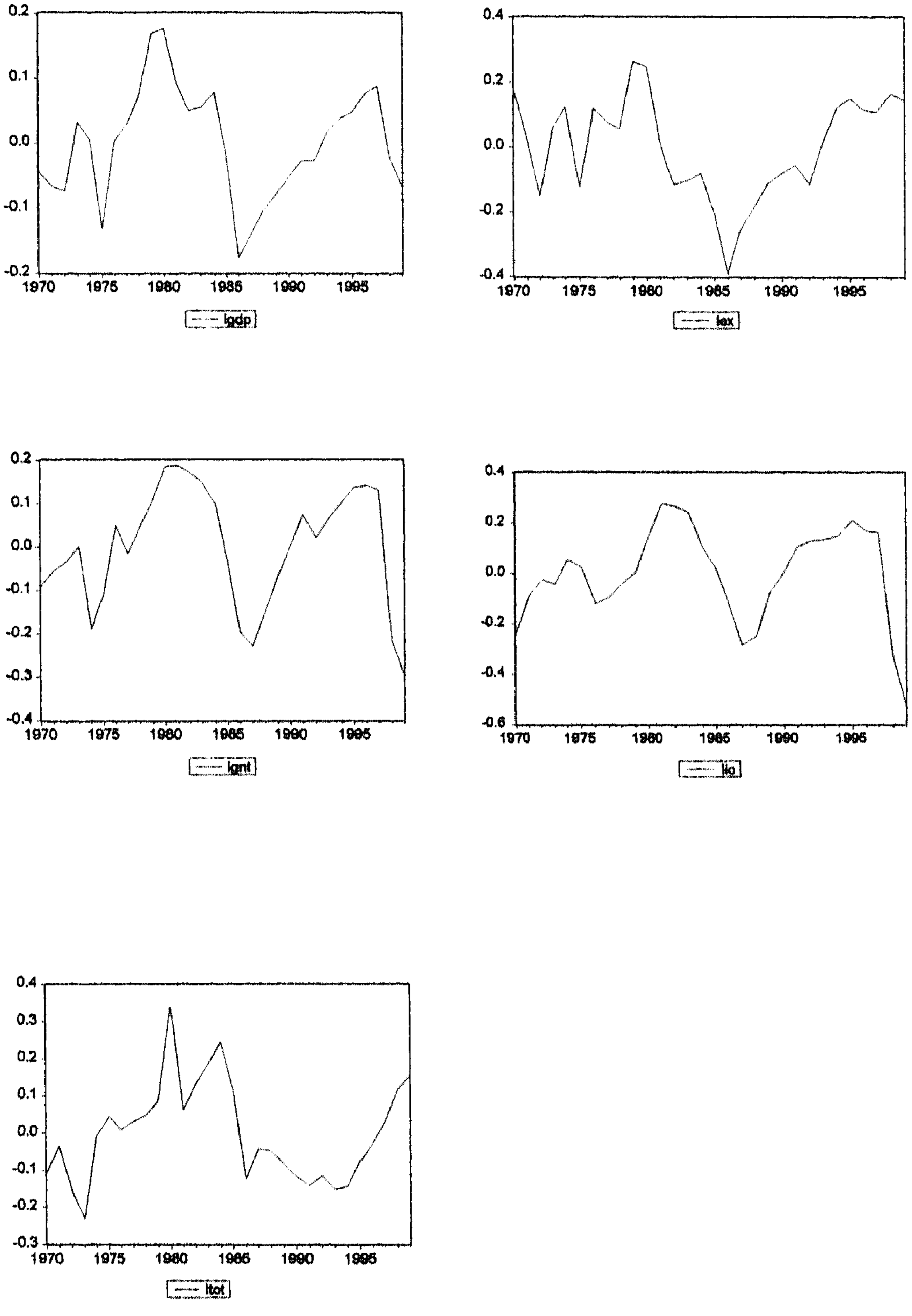


TABLE 3: REGRESSION RESULTS OF DETRENDED VARIABLES

		DEPENDENT VARIABLES				
		(i)	(ii)	(iii)	(iv)	(v)
		LGDP	LGNT	LEX	LIO	LTOT
Intercept	coefficient	10.48371	10.45977	9.375723	-1.519318	4.57946
	s.error	0.032444	0.051978	0.059611	0.072744	0.014087
	t-value	323.1275	201.2349	157.2826	-20.88592	325.0929
	p-value	0.000	0.000	0.000	0.000	0.000
time trend	coefficient	0.068487	0.067467	0.104841	0.018297	0.0527
	s.error	0.001828	0.002928	0.003358	0.004098	0.000793
	t-value	37.47475	23.0432	31.22329	4.4665328	2.861361
	p-value	0.000	0.000	0.000	0.000	0.000
R- SQUARED		0.980452	0.949916	0.972081	0.415926	0.82625
R- BAR SQUARED		0.979754	0.948121	0.971084	0.395066	0.820044
DW STATISTIC		0.605054	0.546915	0.648981	0.483928	0.653981
F-STATISTICS		1404.357	530.9893	974.8938	19.93915	438.18739
PROB(F-STATISTICS)		0.000	0.000	0.000	0.000	0.000

Source: computed

Based on these results, one may be tempted to say that LGDP, LGNT, LEX, LIO and LTOT follow a long run deterministic trend so that stationarity can be achieved in their level forms, that is they are I(0) variables.

A closer examination of the graphs of the detrended variables reveals that these variables appear to be difference stationary as the OLS disturbances do not tend to revert back to the existing positive linear trend path. In fact, based on testing the respective disturbance terms for stationarity by the ADF tests reveal that the time series represent a difference stationary process. The results of the stationarity tests performed on the disturbance term when each variable is regressed on an intercept term and a linear time trend are given in Table 4.

TABLE 4: RESULTS OF STATIONARITY TESTS ON ERROR TERMS

DEPENDENT VARIABLE	DICKEY - FULLER TESTS		AUGMENTED DICKEY-FULLER TESTS		
	DF	DF(t)	NO. OF LAGS	ADF	ADF(t)
LGDP	-2.806544	-4.107796	1	-2.667209	-2.551975
LGNT	-1.627848	-1.402025	1	-2.571197	-2.267002
LEX	-2.422336	-4.314672	1	-2.732571	-2.013462
LIO	-1.219225	-0.823916	1	-2.699536	-2.275553
LTOT	-2.338350	-2.236860	1	-1.925966	-1.802253

Source: computed

Note: DF and ADF: without a drift term and a time trend

DF(t) and ADF(t): with a drift and a time trend

The critical values of the DF and ADF tests at the 10%, 5% and 1% level of significance are -1.6218, -1.9530 and -2.6453 for the DF and -1.6221, -1.9535 and -2.6486 for the ADF while those for the DF(t) and ADF(t) are -3.4773, -3.57731 and -4.3082 for DF(t) and -3.4899, -3.5796 and -4.3226 for ADF(t)

From Table 4, since the absolute values of the ADF tests statistics are less than the absolute critical values at the 1%, 5% as well as the 10% level, we cannot therefore reject the null of unit root. This means that the disturbances are not stationary and that the series can be modeled as a difference stationary process[18].

5.1.1 Malaysian Exports and GDP Growth Path

Based on Figure 1, the irregular components in the trend path of exports and GDP are explained in this part of the paper. A peak can be observed for LGDP and LEX during the period 1979-80. It seems that this period was time of economic fortune for Malaysia. According to **Islam et al. (2000)**, the economic performance of Malaysia has, in general, been outstanding since 1975 to earlier 1997 except for the period 1985-86. According to the same source, the real GDP of Malaysia increased from RM 21.5 billion in 1970 to RM

18. For further detail, refer to Gujarati (1995)

141.1 billion in 1997 indicating a growth rate of 8.2% per year between 1991-97.

As far as exports are concerned, the promotion of exports of manufactures by the government started in the 1970s. Significant export-promotion measures such as Free Trade or Export Processing Zone (EPZs) and Licensed Manufacturing Warehouses (LMWs) under the Free Trade Zone Act of 1971 were taken **(Warr, 1987)**. According to the latter, these incentives gave rise to the emergence of a wide range of manufacturing activities as multinationals established subsidiaries for labour-intensive electronics and garment assembly in LMWs and the EPZs and this led to the diversification of the export-base and ultimately to a rapid export-growth in manufactures.

However, in the early 1980s, Malaysia witnessed a slow-down in growth rates. Despite the various measures taken, the overall export growth during 1980-86 was much lower than in the 1970s. As a result of the substantial fall in commodity prices, all non resource-based leading exports lost market share in Malaysia in this period.

A trough is reached in the year 1986 after which exports and output growth appear to regain momentum. After the 1985 Plaza Accord, the Japanese Yen and the East Asian NICs' currencies started to experience an appreciation vis-à-vis the US Dollar to which the Malaysian currency was pegged. In addition, the former countries had to face sharp rises in labour costs and increasing protectionist barriers in the industrial countries. These factors sharpened the competitive edge of the Malaysian exports, leading consequently to a speed-up of growth in a wide variety of export activities in the years following 1985.

In the first half of 1990s, as a consequence of the globalisation of information and communications which fuelled the demand for semi-conductors, PCs, cellular phones and other telecommunication equipment, electronics contributed to the sharp growth in world trade. Malaysian exports were dominated by electronics. However, the 1996 global recession in semi-conductors and the slump in demand for electronics affected exports adversely **(Chia Siow Yue, 1999)**.

The adverse implications of the slow-down in world exports of electronic products on the Malaysian performance highlighted the risks which are inherent in being a small, open and trade-oriented economy. Due to conscious policies to go for export diversification, the domestic economy was relatively insulated from the worst effects of the slow-down in world trade in 1996.

According to the **Bank Negara Malaysia Annual report (1996)**, the moderation in economic activity in 1996 was mainly due to a slow-down in domestic demand (6.3%). The manufacturing sector which was the main source of growth recorded a more moderate expansion in 1996. Furthermore, activity was dampened by the poor performance of the electronic industry which mirrored the excess supply of semi-conductors in the world market.

In 1997, the Malaysian economy witnessed a sharp fall in its rates of growth of investment and GDP. This was the consequence of the South East Asian crisis which hit the country in July 1997. Inspite of the adverse effects of the crisis on the Malaysian economy, exports were on a rising trend due to the depreciation of the Malaysian currency, the Ringgit. However, foreign investors began to fly away from the country due to a loss of confidence. As a result, investment and GDP were on a falling trend.

During the year 1999, Malaysia performed better due to both external factors and the immediate policy response to cushion the severity of the impact of the crisis on Malaysia. On the external side, world growth reached 3% reflecting higher growth enjoyed by the industrialized countries. This amelioration in world growth contributed significantly to the boosting up of the demand for Malaysian exports. Also, the fixing of the exchange rate helped businesses in planning their operations with more certainty. The expansion in exports generated increases in income.

On the supply side, growth was originally led by the remarkable performance of the export-oriented industries in the manufacturing sector. Output in the export-oriented industries increased by 12.9% which was initially buoyed by the strong performance of the electronic goods and subsequently by higher output in the electrical products, off-estate processing and textile and wearing apparel industries **(Bank Negara Malaysia Annual Report, 1999).**

The current trend is, thus, towards improving the level of human resources so that exporting firms in Malaysia can continue to provide quality based services to their customers.

All this is to say that Malaysia has undergone through different phases of economic upheavals and downturns. They seem to be a possible explanation for the irregular components in the trend path identified for LGDP, LGNT, LEX, LIO and LTOT in Figure 1 above.

However, it is very difficult if not impossible to conclude on the order of integration of the economic variables by only visualizing graphs. In fact several tests have been developed to achieve these results taking into account trend stationarity and difference stationarity. Some of these tests have been discussed in Chapter Four and the results are reported in the next section.

5.2 STATIONARITY TESTS AND ORDER OF INTEGRATION

5.2.1 Dickey-Fuller (1979) and Augmented Dickey-Fuller (1981) Tests

In the first step, we need to determine the degree of integration of LGDP, LGNT, LEX, LIO and LTOT. The Dickey-Fuller (1979) and Augmented Dickey-Fuller (1981) tests are performed for this purpose. They both test the null of non-stationarity against the alternative that the variables are trend-stationary. The results obtained are reported in Tables 5A and 5B on the next page.

TABLE 5A: TESTS OF UNIT ROOT IN LEVEL FORM

VARIABLE NAME	DICKEY-FULLER TESTS		AUGMENTED DICKEY-FULLER TESTS		
	DF	DF(t)	NO. OF LAGS	ADF	ADF(t)
CRITICAL VALUES	1%: -2.6453 5%: -1.9530 10%: -1.6218	1%: -4.3082 5%: -3.5731 10%: -3.4773	-	1%: -2.6486 5%: -1.9535 10%: -1.6221	1%: -4.3226 5%: -3.5796 10%: -3.4899
LGDP	1.306519	-2.167796	1	2.204783	-2.551975
LGNT	1.06022	-1.402025	1	1.857639	-2.267002
LEX	1.400001	-2.314672	1	2.579897	-2.013462
LIO	-0.695727	-0.823916	1	-0.215905	-2.275553
LTOT	0.674062	-2.236860	1	0.679305	-1.802253

Source: Computed
Note: DF and ADF: without a drift and time trend
DF(t) and ADF(t): with a drift and time trend

TABLE 5B: TESTS OF UNIT ROOT IN FIRST DIFFERENCE

VARIABLE NAME	DICKEY-FULLER TESTS		AUGMENTED DICKEY-FULLER TESTS		
	DF	DF(t)	NO. OF LAGS	ADF	ADF(t)
CRITICAL VALUES	1%: -2.6486 5%: -1.9535 10%: -1.6221	1%: -4.3226 5%: -3.5796 10%: -3.4899	-	1%: -2.6522 5%: -1.9540 10%: -1.6223	1%: -4.3382 5%: -3.5867 10%: -3.5035
ΔLGDP	-2.804880	-4.640736	1	-3.167549	-4.465640
ΔLGNT	-3.374531	-4.147349	1	-2.297994	-3.006816
ΔLEX	-3.537462	-5.663759	1	-2.534615	-5.917879
ΔLIO	-3.224552	-4.311622	1	-3.149493	-4.113557
ΔLTOT	-6.212276	-6.098294	1	-4.750958	-4.768365

Source: Computed

A variable is stationary and thus has no unit root if the calculated ADF statistic in absolute term exceeds the absolute value of the critical values.

In fact, the DF tests in Table 5A above suggest that LGDP, LGNT, LEX, LIO and LTOT are all non-stationary in their level form. The DF test statistics both with and without trend, lie well below the 90% critical value. Nonetheless, Table 5B reveals that this test rejects the null of non-stationarity for all the variables under consideration in their first differenced form. For LGDP, LGNT, LTOT except LIO and LEX (which are significant at the 5% level), the DF tests accept stationarity at the 1% level in their first differenced form.

However, the ADF tests results are not that straightforward to interpret. Indeed, only for LEX, stationarity is confirmed in its level form at the 5% level. Nevertheless, the ADF test under the trended case supports the existence of a unit root for that same variable. It can be argued that LEX may be subject to both a stochastic trend and a deterministic trend but that the former is dominating the deterministic trend.

All the above-mentioned tests suggest that all the variables are not stationary in their level form but the null of unit root can, in general, be rejected at the 5% level in their first differenced form. Even though the Schwartz Criterion has been used to aid in the choice of the optimal lag length, several lag structures have been used to ensure that the results are not sensitive to the choice of the lag length. As **Pyndick and Rubinfeld (1991)** point out:

" It is best to run the test for a few different lag structures and make sure that the results are not sensitive to the choice of m (lag length)"

5.2.2 Order of Integration

Based on the results of the DF and ADF tests, the order of integration can be established. Since we do not reject the null-hypothesis that the variables are non-stationary in their level form, we reapplied the test procedures after transforming the variables into first differenced form. The null of non-stationarity on the first differenced form can be rejected and we establish that the time series are integrated of order one which can be written as I(1). This is consistent with the **Nelson and Plosser's (1982)** argument that most of the macroeconomic time series have a stochastic trend.

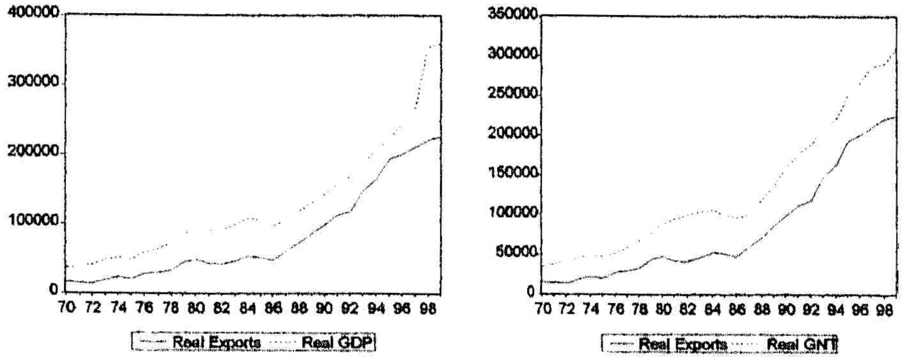
Since, all the variables are integrated of order one or I(1) in the terminology of **Engle and Granger (1987)**, we now proceed to test for a common stochastic trend, that is, cointegration among all variables.

5.3 COINTEGRATION TESTS

In our present study, all variables have been shown to be I(1) and Figure 2 on the next page suggests that both the real exports and output series for model 1 generally appear to move together overtime so that a long run equilibrium between these two, until formally tested, is possible. The same thing applies for model 2.

Therefore, we want to test if there exists a linear combination of LEX and LGDP and LEX and LGNT which reduces the number of unit roots, implying that the low frequency components of LEX_t and $LGDP_t$ and LEX_t and $LGNT_t$ virtually cancel out to produce the mean-reverting so called " equilibrium error"

FIGURE 2: Time series of real (exports, GDP) and real (exports, GNT)



5.3.1 Engle and Granger Two-Step Procedure (Engle and Granger, 1987)

Since the data series are not stationary, there is potential cause for spurious results. In order to deal with spuriousness, **Engle and Granger (1987)** suggest a two-step approach. First, the existence of a cointegrating relationship among the variables in equations (4.3.1.1) and (4.3.1.2) is determined each at a time.

5.3.1.1 Estimating the Cointegrating Equations

Both models 1 and 2 are each estimated by using OLS and the respective residuals are obtained. A test of the null-hypothesis of no cointegration is based on testing for a unit root in the regression residuals using the DF and ADF tests. The OLS estimation results are reported in Table 6.

TABLE 6: OLS RESULTS FOR COINTEGRATING EQUATIONS

Explanatory	Model 1:Dependent variable: $LGDP_t$				Model 2:Dependent variable: $LGNT_t$			
Variables	Coefficient	S. Error	T - Ratios	P-Values	Coefficient	S. Error	T - Ratios	P-Values
Intercept	4.799259	0.369653	12.98316	0.0000	6.487898	0.52048	12.46523	0.0000
LEX_t	0.591724	0.015472	38.24526	0.0000	0.522985	0.021785	24.00697	0.0000
LIO_t	0.266491	0.055476	4.803706	0.0001	0.637395	0.078112	8.160045	0.0000
$LTOT_t$	0.131915	0.081356	1.621466	0.1170	0.012126	0.11455	0.105854	0.9165
R - SQUARED	0.992055				R - SQUARED	0.984275		
R - BAR SQUARED	0.991138				R - BAR SQUARED	0.98246		
DW STATISTIC	0.613733				DW STATISTIC	1.772556		
F - STATISTIC	1082.181				F - STATISTIC	542.4617		
PROB(F - STATISTIC)	0.0000				PROB(F - STATISTIC)	0.0000		

Source: computed

As far as model 1 is concerned, the results obtained are quite reliable as far as the signs of the variables are concerned, despite the fact that LTOT lacks statistical significance. To counter this, it can be argued that this insignificance of the variable arises mainly because the t-statistics are biased downwards due to the presence of autocorrelation among the residuals.

Exports, being a measurement component of GDP will lead to an autocorrelation problem since the presence of a positive correlation between exports and GDP is almost inevitable. Indeed, **Sheehey (1990)** has shown that the same tests that are used to support the export-promotion policy also support all other components of GDP. Quoting his words,

" ... their tests have no bearing at all on the export-promotion/import-substitution controversy"

It can, therefore, be argued that due to the presence of autocorrelation among the residuals, it is not possible to assess the true significance of the coefficient estimates. Moreover, given that we are dealing here with non-stationary variables, the usual t-distribution does not provide reliable interpretations about the long run relationships. This has already been discussed in section 4.0

Model 2 performs well in terms of explaining the log of GNT (GDP net of trade) as a function of LEX, LIO and LTOT. All the coefficients have the appropriate sign although LTOT is not significant. This lack of significance comes as no surprise since the dependent variable represents the output of the non-trade sector which is insulated from the effects of changes in the terms of trade, thus accounting for the extremely low significance level.

However, unlike model 1, model 2 is not plagued with the problem of autocorrelation. Exports are no longer a component of the dependent variable. Thus, the t-statistics may not be biased.

5.3.1.2 Stationarity Tests For Residuals

Table 7 below reports the results of the unit root tests applied to the residuals of the cointegrating equations.

TABLE 7: ENGLE AND GRANGER APPROACH TO COINTEGRATION

Cointegrating Equation	DF	AUGMENTED DICK EY - FULLER TEST	
		NO. OF LAGS	TEST STATISTIC
1. LGDP = f (LEX, LIO, LTOT)	-2.58155	1	-2.984212
2. LGNT = f (LEX, LIO, LTOT)	-3.449333	1	-3.195043

Source: computed
Critical values for the tests at the 1%, 5% and 10% significance levels are respectively:
DF : -2.6453, -1.9530 and -1.6218
ADF : -2.6486, -1.9535 and -1.6221

From Table 7, we gather that the calculated ADF test statistics for the residuals are greater than the critical value at the 1% level for both models. As regards to the DF statistic for model 1, the estimated statistic (-2.58) is not very far from the critical value at the 1% level (-2.64) required to achieve stationarity. However, it is significant at the 5% level. In other words, the residuals are stationary. It is important to note that no trend has been included in the calculation of the ADF statistic since the residuals must have a zero mean and we do not expect them to have a deterministic trend **(see Gylfason, 1999)**.

5.3.1.3 Findings Based On The Engle-Granger Approach To Cointegratiom

Given that all the variables are I(1) and that the residuals are stationary, we can, therefore, conclude that the series are cointegrated of order (1,1). Since the variables in both models are cointegrated, the cointegrating regressions may not be spurious and the usual t and F-tests are valid **(Gujarati, 1995)**. As **Granger (1986)** notes,

" A test for cointegration can be thought of as a pretest to avoid spurious regression situations."

However, it has been argued that when there are more than two I(1) variables under consideration, residual–based cointegration tests tend to be inefficient. For example, they may be sensitive to the so-called direction normalization rule, that is sensitivity to the choice of the left hand side endogenous variable. Also, these tests ignore the possibility of more than one cointegrating vector when there are more than two variables in a given equation, as in our present study. Thus, due to the weaknesses of the Engle-Granger two-step procedure, in the next section the Johansen test (1990) for cointegration is applied because the maximum likelihood framework involved is known to offer better properties than the traditional Engle and Granger approach which is residual-based **(Johansen and Juselius, 1990)**.

5.3.2 Johansen Cointegration Method

Firstly, the Johansen estimation technique is linked to our exports and growth relationship in a four variable framework. Following **Engle and Granger (1987)**, we say that if our set of four variables are contained in a vector x_{it} where x_{1t} = [LGDP, LEX, LIO, LTOT]' for model 1 and x_{2t} = [LGNT, LEX, LIO, LTOt]' for model 2 are I(1) and cointegrated, then there exist vector error-correction model representations of the types:

$$\Delta x_{1t} = \theta_0 + \theta_1 \Delta x_{1t-1} + \theta_2 \Delta x_{1t-2} + \ldots + \theta_k \Delta x_{1t-k} + \gamma\alpha' x_{1t-1} + \varepsilon_t \text{ and}$$

$$\Delta x_{2t} = \Omega_0 + \Omega_1 \Delta x_{2t-1} + \Omega_2 \Delta x_{2t-2} + \ldots + \Omega_k \Delta x_{2t-k} + \lambda\mu' x_{2t-1} + \xi_t$$

where $\Delta x_{it-j} = [x_{it-j} - x_{it-(j+1)}]$ is the first difference of the j^{th} lag of x_{it}; $\theta_0, \ldots, \theta_k$ and $\Omega_0, \ldots, \Omega_k$ are (pxp) matrices of parameters, α' and μ' are (qxp) matrices with each row representing a cointegrating vector and ε_t and ξ_t are white noise error terms.

5.3.2.1 Johansen Cointegration Results

More formally, the results of the Johansen's multivariate cointegration tests are reported in Table 8 below where r represents the number of cointegrating vectors.

TABLE 8: COINTEGRATION TESTS USING JOHANSEN PROCEDURE

HYPOTHESIS	MODEL1: Series:LGDP, LEX, LIO, LTOT		MODEL2: Series:LGNT, LEX, LIO, LTOT		Critical Values	
	Eigenvalue	Trace Statistic	Eigenvalue	Trace Statistic	5%	1%
r = 0	0.620933	54.92298**	0.657664	59.57426**	53.12	60.16
r ≤ 1	0.417348	27.76181	0.453905	29.55929	34.91	41.07
r ≤ 2	0.221457	12.63719	0.235618	12.62035	19.96	24.60
r ≤ 3	0.182085	5.627906	0.166431	5.097091	9.24	12.97
Cointegrating Equation	$LGDP_t = 5.905 + 0.6692LEX_t + 0.1501LIO_t + 0.2738LTOT_t$		$LGNT_t = 0.7387 + 0.0863LEX_t + 1.572LIO_t + 2.452LTOT_t$			

Source: computed
**: significant at the 95% level

Table 8 reveals that in the multivariate case, the Trace test statistics support the existence of a single cointegrating vector for both models. The cointegrating vector for each model takes the form reported in Table 8. The cointegrating equations suggest a positive relationship between LGDP and LEX and LGNT and LEX. It says that a 1% increase in real exports results in a 0.67% rise in real GDP in model 1 and a 0.09% in real GDP net of exports and imports. Thus, following the results of model 2, it can be said that exports tend to generate positive externalities to the non-trade sector which tend to boost the level of output in the non-trade sector and in the economy as a whole.

5.3.3 Summary On Cointegration

On the whole, both the Engle-Granger and Johansen tests carried out so far tend to reject the null-hypothesis of no cointegration between exports and growth, that is, they are driven by a common stochastic trend. There seems, therefore, to be strong support for a long run relationship between these two macroeconomic variables. In fact, the slope coefficients of LEX reported in Table 8 shows a positive long run relation which is consistent with the export-led growth in the Malaysian case.

Furthermore, it can be argued that if the variables are cointegrated, an OLS regression yields 'super-consistent' estimates of the cointegrating parameters. **Stock (1987)** proves that when the variables are cointegrated, the OLS estimators converge to their true value at a much faster rate than the usual estimators with the I(0) variables. Also, the estimators of the I(1) variables will be consistent regardless of whether there is serial correlation or not and the regression results may not be spurious **(see Gujarati, 1995)**

5.4 ERROR-CORRECTION MODEL AND CAUSALITY RESULTS

5.4.1 Causality Results

Although, it has already been established that there exists a positive long run relationship between exports and growth, the question remaining to be answered is which variable causes the other and provides the short run dynamic adjustments towards the long run equilibrium.

Since the existence of cointegrated variables implies causality in at least one direction, the only outcome that is ruled out is the possibility of causality in no direction. Bi-causality may also exists between any independent variable and the dependent variable.

In this section, we determine the direction of causality and conclude whether or not the export-led growth or growth-driven exports or both hold true in the case of Malaysia. The presence of a cointegrating relationship allows us to use **Engle and Granger (1987)**'s error-correction models to test for Granger causality.

5.4.1.1 Optimal Lag Length Selection

Since the results of causality tests are very sensitive to the specification of the model, it is important to determine the number of lags to be incorporated while performing the causality tests. In many studies testing for exports and growth relationship, such lag length has been arbitrarily used **(see Jung and Marshall, 1985; Chow, 1987).**

If the number of lags is chosen arbitrarily, misspecification may arise. If the number of lags is too large, the estimates will be unbiased but inefficient. Conversely, if the number of lags is too small, the estimates will be biased but efficient. In this study, the Schwartz Criterion is used to determine the optimum number of lags in each model. The results are reported in Table 9 below.

TABLE 9: SCHWARTZ CRITERION[19]

Dependent Variable	1 lag	2 lags	3 lags	4 lags	Optimal lag
MODEL 1					
ΔLGDP	-4.878552	-4.830120	-4.723882	-4.573021	1
ΔLEX	-5.089393	-5.050613	-4.926098	-4.947683	1
ΔLIO	-4.061605	-3.935150	-3.772838	-3.991405	1
ΔLTOT	-3.959016	-3.859203	-3.757706	-3.741038	1
MODEL 2					
ΔLGNT	-4.717742	-4.577397	-4.408081	-4.119842	1
ΔLEX	-3.873970	-3.602713	-3.4189905	-3.856802	1
ΔLIO	-4.160833	-3.987715	-3.810969	-4.003397	1
ΔLTOT	-3.985609	-3.875069	-3.774605	-3.728733	1

Source: computed

19. The values of the Schwartz Criterion must be as small as possible

Based on the results of Table 9, only one lag for each variable is used in the causality tests.

5.4.1.2 Causality Results

After determining the optimal number of lags, the Granger causality tests (1969) are performed and the F-tests results are reported in Table 10 on the next page.

Thus, according to the F-tests results, it is observed that exports, investment to output ratio and terms of trade each individually does not granger cause overall economic growth and growth of the non-trade sector. Also, there is no evidence showing that the dependent variable causes each of the explanatory variable since the F-statistics are insignificant. Thus, causality in any direction finds no support based on the F-tests.

TABLE 10: STANDARD CAUSALITY RESULTS

MODEL 1			MODEL 2		
WAY OF CAUSATION	**F-TESTS**	**PROB**	**WAY OF CAUSATION**	**F-TESTS**	**PROB**
ΔLEX Does not granger cause ΔLGDP	2.68259	0.61553	**ΔLEX Does not granger cause ΔLGNT**	0.60663	0.44320
ΔLGDP Does not granger cause ΔLEX	0.25861	0.21398	**ΔLGNT Does not granger cause ΔLEX**	0.83110	0.37033
ΔLIO does not granger cause ΔLGDP	0.12727	0.72427	**ΔLIO does not granger cause ΔLGNT**	0.11979	0.73205
ΔLGDP Does not granger cause ΔLIO	4.04735	0.32120	**ΔLGNT Does not granger cause ΔLIO**	0.07580	0.78525
ΔLTOT does not granger cause ΔLGDP	1.35402	0.25556	**ΔLTOT does not granger cause ΔLGNT**	0.61496	0.44001
ΔLGDP Does not granger cause ΔLTOT	1.05826	0.49260	**ΔLGNT Does not granger cause ΔLTOT**	1.03837	0.31759

Source: computed

So far, based solely on the standard causality tests, we find that the export-promotion hypothesis does not seem to get strong empirical support in the Malaysian economy. In many cases, the F-tests statistics prove to be insignificant. This tends to confirm the results of **Afxentiou and Serletis (2000)** who also found non-causality between exports and growth for Malaysia for the period 1970-1993.

5.4.1.3 ECM – Based Causality Results

Nevertheless, the conclusions of the standard causality tests may be misleading because we have not yet examined the different t-statistics of the ECT terms involved in our analysis. In fact, such consideration may significantly alter our causality results for exports and growth.

TABLE 11: ECM – BASED CAUSALITY RESULTS

MODEL 1			MODEL 2		
WAY OF CAUSATION	**F-TEST**	**COEF.OF $ECT1_{t-1}$ (PROB)**	**WAY OF CAUSATION**	**F-TEST**	**COEF.OF $ECT2_{t-1}$ (PROB)**
ΔLEX→ΔLGDP	0.1539	0.647 (0.0032)	ΔLEX→ΔLGNT	0.79703	-0.669830 (0.0014)
ΔLGDP→ΔLEX	1.6676	-0.336499 (0.0118)	ΔLGNT→ΔLEX	2.71584	0.912554 (0.0013)
ΔLIO→ΔLGDP	1.5408	-0.854040 (0.0464)	ΔLIO→ΔLGNT	0.66064	-0.42327 (0.0484)
ΔLGDP→ΔLIO	2.7163	-0.344584 (0.0149)	ΔLGNT→ΔLIO	0.55227	-0.38825 (0.1330)
ΔLTOT→ ΔLGDP	0.0108	-0.003860 (0.6508)	ΔLTOT→ ΔLGNT	1.68224	-0.62758 (0.3007)
ΔLGDP→ ΔLTOT	1.099	-0.300386 (0.3280)	ΔLGNT→ ΔLTOT	0.14850	-0.916004 (0.8081)

Source: computed

Table 11 tells us that the coefficients of the error-correction terms are all significant for both models except for LTOT for which both the F-statistics and the coefficient of the error term are insignificant. We observe that, according to the ECM-based causality tests, exports and investment to output ratio each individually granger causes growth. There is also evidence showing that GDP growth causes exports growth. Even though, the F-statistics are insignificant, the significance of the error-correction terms implies that exports granger cause output, that is lagged exports predict output and hence provides strong evidence in favour of the export-led growth hypothesis for the 1970-1999 period.

Thus, it is found that a two-way causal relationship exists between exports and GDP. This result stands against the findings of **Ahmed and Harnhirun (1995)**'s study which did not support the export-led growth hypothesis for ASEAN countries except Singapore.

5.4.2 Error-Correction Modeling

Since the variables are cointegrated, by the Engle and Granger Representation Theorem (1987), an error-correction model will represent the most efficient estimation. The regression results of the dynamic short run error-correction equations are given below in Table 12A.

The results suggest that overall economic growth and growth of the non-trade sector are basically determined by the level of exports and investment to output ratio. The terms of trade do not affect the growth process in the short run. The ECT terms in both models are highly significant, confirming our earlier assertion that the variables are cointegrated. There is about 31% and 58% feedback from the previous period into the short run dynamic process for model 1 and 2 respectively.

5.4.2.1 Dealing With Serial Correlation

While examining the serial correlation diagnostic test from Table 12B, it is found that there is serial correlation. This correlation reflects the fact that some variables that belong

TABLE 12A: ERROR-CORRECTION MODELING RESULTS

Explanatory Variables	Model 1: Dependent variable: $\Delta LGDP_t$ Coefficient	S. Error	T – Ratios	P-Values	Model 2: Dependent variable: $\Delta LGNT_t$ Coefficient	S. Error	T - Ratios	P-Values
Intercept	0.02301	0.01074	2.14181	0.0435	0.01869	0.01889	0.98962	0.3331
$\Delta LGDP_{t-1}$	-0.1225	0.10505	-1.16606	0.2561	-	-	-	-
$\Delta LGNT_{t-1}$	-	-	-	-	-0.13345	0.150422	-0.88714	0.3846
ΔLEX_t	0.50267	0.05221	9.62822	0.0000	0.4772	0.12233	3.90089	0.0008
ΔLIO_t	0.23098	0.051399	4.49423	0.0002	0.60582	0.11172	5.42288	0.0000
$\Delta LTOT_t$	-0.03446	0.05966	-0.57765	0.3694	-0.028744	0.12826	-0.22411	0.554
$ECT1_{t-1}$	-0.3143	0.11621	-2.70468	0.0129	-	-	-	-
$ECT2_{t-1}$	-	-	-	-	-0.578743	0.190243	-3.04213	0.006
R-SQUARED		0.839187			R – SQUARED		0.66708	
R - BAR SQUARED		0.802639			R - BAR SQUARED		0.591419	
F - STATISTIC		22.96105			F – STATISTIC		8.816489	
PROB(F - STATISTIC)		0.0000			PROB(F - STATISTIC)		0.0001	

Source: computed

TABLE 12B: SERIAL LM TEST ON ECM EQUATIONS

TESTS	Model 1	Model 2
$N * R^2$	8.349493	2.561891
Probability	0.015379	0.277775

Source: computed

to the models are included in the error terms and, therefore, need to be introduced as explanatory variables. Thus, one lag for each variable, as determined by the Schwartz Criterion, is introduced in the models and the estimated regressions are presented in Table 13A.

TABLE 13A: SERIALLY-CORRECTED ECM EQUATIONS

Explanatory	Model 1:Dependent variable: $\Delta LGDP_t$				Model 2:Dependent variable: $\Delta LGNT_t$			
Variables	Coef	S. Error	T - Ratio	P-Value	Coef	S. Error	T - Ratio	P-Value
Intercept	0.02815	0.01045	2.69299	0.0144	0.05006	0.0235	2.12967	0.0465
$\Delta LGDP_{t-1}$	0.22692	0.17801	1.27478	0.2178	-	-	-	-
$\Delta LGNT_{t-1}$	-	-	-	-	0.05316	0.2128	0.24977	0.8054
ΔLEX_t	0.46238	0.05223	8.85201	0.0000	0.39519	0.1281	3.08287	0.0061
ΔLEX_{t-1}	0.22794	0.10017	2.27555	0.0346	-0.30169	0.1481	-2.03588	0.0559
ΔLIO_t	0.25659	0.005349	4.97666	0.0001	0.68748	0.1193	5.76222	0.0000
ΔLIO_{t-1}	-0.09908	0.06319	-1.56779	0.1334	-0.06873	0.1663	-0.41314	0.6841
$\Delta LTOT_t$	0.00819	0.06519	0.12566	0.9013	-0.08946	0.1588	-0.56329	0.5798
$\Delta LTOT_{t-1}$	-0.00671	0.06685	-0.10031	0.9212	0.15119	0.1569	0.96339	0.3475
$ECT1_{t-1}$	-0.35042	0.13371	-2.62074	0.0168	-	-	-	-
$ECT2_{t-1}$	-	-	-	-	-0.46981	0.2464	-1.90638	0.0718
R SQUARED				0.8758	R - SQUARED	0.73202		
R - BAR SQUARED				0.82351	R BAR SQUARED	0.619754		
Schwartz Criterion				-6.41327	Schwartz Criterion	-4.81131		
F - STATISTIC				16.7474	F - STATISTIC	6.500836		
PROB(F - STATISTIC)				0.0000	PROB(F - STAT)	0.0004		

Source: computed

TABLE 13B: Serial LM Test On Corrected Equations

TESTS	Model 1	Model 2
$N * R^2$	3.239531	0.236961
Probability	0.297945	0.888269

Source: computed

Due to the introduction of these lags, it is found, from Table 13B, that the problem of serial correlation has been dealt with, the probability being high.

From Table 13A, it can be inferred that, in the short run, exports seem to exert a very strong effect on the overall growth process. The growth elasticity with respect to exports is nearly 0.5

A similar interpretation can be made for model 2. Based on Table 13A, in the short run, investment to output ratio has a stronger impact on the growth of the non-trade sector than exports – for each percentage increase in the investment to output ratio, the non - trade sector grows by about 0.7% while 1% increase in exports leads to only approximately 0.4% increase in the rate of growth of the non-trade sector.

5.4.2.2 Decomposition Of The Total Impact

The regression results of the error-correction models should, however, be interpreted with great caution. For each factor, there are direct and indirect effects on growth. This decomposition method was implemented by **Sowa (1994)**.

For example, a change in exports has an impact on growth as follows:

(a) the direct impact which is given by the coefficients of the contemporaneous and lagged exports variables.

(b) The indirect effects are given by:

(i) the lagged dependent variable multiplied by the coefficient of exports meaning that a shock to exports will have an additional effects on growth and similarly for effects coming through lagged exports

(ii) the second indirect impact comes through the error-correction model and it, therefore, depends on the relative size of the direct effects of exports in the cointegrating and error correction model equations. Following **Sowa (1994)**, this effect is given by:

[coefficient of exports in ECM equation – coefficient of exports in cointegrating equation] x coefficient of ECT $_{t-1}$

Thus, the direct, indirect and total effects of each variable are shown in table 14 below:

TABLE 14: DECOMPOSITION OF TOTAL EFFECT

IMPACT	MODEL 1				MODEL 2			
	DIRECT	INDIRECT		TOTAL	DIRECT	INDIRECT		TOTAL
		(I)	(II)			(I)	(II)	
LEX	0.69032	0.15665	0.04532	0.89229	0.0935	0.00497	0.06	0.1585
LIO	0.1575	0.03574	0.00347	0.19671	0.6187	0.03289	0.0235	0.67517
LTOT	0.00149	0.00034	0.04335	0.04518	0.0617	0.00328	0.0803	0.14526

Source: computed

Thus, according to the total impact of each factor, it is found that exports are dominant in the determination of overall economic growth. This is consistent with the findings of **Bank Negara Malaysia (1999)** and **Chia Siow Yue (1999)** in which they argue that exports have contributed significantly to the high growth performance of Malaysia.

Also, the impact of exports on the non-trade sector is quite substantial although investment plays a more important role in determining the growth of the non-trade sector. Thus, it can be found that exports can propel the non-trade sector.

5.4.2.3 Estimating A More Parsimonious Equation

In an attempt to work towards a more parsimonious equation, insignificant variables are dropped and the restricted growth models are shown in Table 15A below.

TABLE 15A: PARSIMONIOUS REGRESSION RESULTS

Explanatory Variables	Model1:Dependent variable: $\Delta LGDP_t$				Model 2:Dependent variable: $\Delta LGNT_t$			
	Coef	S. Error	T - Ratio	P-Value	Coef	S. Error	T - Ratio	P-Value
Intercept	0.02826	0.01014	2.78681	0.0114	0.0510	0.01941	2.62543	0.0151
ΔLEX_t	0.46246	0.05092	9.08198	0.0000	0.3375	0.10304	3.27584	0.0033
ΔLEX_{t-1}	0.23028	0.09498	2.4245	0.0249	-0.2798	0.09882	-2.83178	0.0095
ΔLIO_t	0.25713	0.05189	4.95539	0.0001	0.6365	0.09741	6.53449	0.0000
ΔLIO_{t-1}	-0.09892	0.06159	-1.60594	0.1240	-	-	-	-
$\Delta LTOT_t$	0.01073	0.05857	0.18323	0.8565	-	-	-	-
$ECT1_{t-1}$	-0.34333	0.11067	-3.10225	0.0056	-	-	-	-
$ECT2_{t-1}$	-	-	-	-	-0.5248	0.16752	-3.13283	0.0047
R - SQUARED	0.87573				R – SQUARED	0.68868		
R - BAR SQUARED	0.83224				R - BAR SQUARED	0.63454		
Schwartz Criterion	-6.53173				Schwartz Criterion	-5.13594		
F - STATISTIC	20.13504				F – STATISTIC	12.7197		
PROB(F - STATISTIC)	0.0000				PROB(F - STAT)	0.0000		

Source: computed

TABLE 15B: Serial LM Test On Parsimonious Equations

TESTS	Model 1	Model 2
$N * R^2$	3.945973	2.155354
Probability	0.329240	0.440385

Source: computed

The Schwartz criteria have decreased for both models. This implies that fewer variables in the parsimonious models are able to explain much of the variation in the dependent variables. Table 15A also reveals that the R- Bar Squared for both models are higher than the R- Bar Squared of the unrestricted models.

As is expected, economic growth in the short run is explained mainly by contemporaneous and one-year lagged growth in exports and investment to output ratio.

5.4.2.4 Estimating The Long Run Functions

While the regression results of the cointegrating equations reported in Table 6 give consistent, even super-consistent estimates, these estimates are not fully efficient. In order to obtain fully efficient parameter estimates, the ECT terms in the error-correction models are replaced by lagged levels of the variables in the cointegrating equations. The long run elasticities can, thus, be obtained by dividing the coefficients of the lagged explanatory variables by the estimated coefficient of the lagged dependent variable.

Thus, the long run growth function of **model 1** becomes:

$$LGDP_t = \underset{(0.68056)}{4.3478^{**}} + \underset{(2.8973)}{0.6002^{***}}LEX_t + \underset{(0.06422)}{0.1982^{*}}LIO_t + \underset{(0.06255)}{0.21473}LTOT_t$$

and for **model 2**:

$$LGNT_t = \underset{(1.34399)}{3.8817^{**}} + \underset{(0.155441)}{0.59974^{***}}LEX_t + \underset{(0.124954)}{0.208133^{*}}LIO_t + \underset{(0.127354)}{0.12658}LTOT_t$$

where the figures in brackets represent the standard errors and *** denotes significance at the 1% level and ** represents significance at the 5% level.

Thus, according to the long run functions, it is found that exports tend to be a very significant determinant in the growth process. A 1% increase in exports leads to about 0.6% rise in GDP. Similarly, in the long run, exports tend to have a very crucial impact on the non-trade sector, even though in the short run, this impact is not as significant.

5.5 CONCLUSION

On the whole, therefore, our ecm-based causality tests tend to confirm a bi-directional causal relationship between exports and output growth. The fact that there is a two-way causality between GDP and exports in the Malaysian economy indicates that exports granger cause output as argued in the standard development economics literature but output also causes exports by 'improving exports performance through technical progress and spin-off effects.' **(Ghartey, 1993)**

The addition of LIO and LTOT variables in our analysis has helped to solve the feedback causal relation.

In short, we have been able to provide an econometric justification based on non-stationary time series techniques for both the existence of export-promotion hypothesis in the case of Malaysia and the spill-over effects associated with increases in exports to the non-trade sectors.