E C O N O M I C S   B U L L E T I N

Disaggregated export demand of Malaysia: evidence from the electronics industry

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Abstract

This study estimates the determinants of foreign demand for Malaysia's top five electronics exports by SITC (Standard International Trade Classification) product groups from 1990 to 2001. Cointegration results indicate a unique long-run relationship between export demand for electronic products and relative prices and foreign income. Both the estimated long-run income and price elasticities of export demand are greater than 1, conforming to a pattern found in most fast-growing economies and implying price is an important factor in explaining export growth with the exception of semiconductor exports. The present study has important policy implications to the competitiveness of electronics exports that can lead Malaysia's transition towards high-technology industrialization.

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1. Introduction

Malaysia is a small open economy, which has been transformed during the past three decades from a commodity-dependent into a manufacturing-based export economy. The rapid structural change in the economy can be attributed to the adoption of a series of industrialization programs e.g. import-substituting industrialization policy in the 1960s, export-oriented industrialization policy in the 1970s and the Industrial Master Plans of the 1980s and 1990s. The relative attractiveness of the country as a destination for foreign direct investment (FDI) flows, especially from the United States (U.S.), Japan, Singapore and the European Union (EU), has also contributed significantly to the growth and development of the manufacturing sector. Currently, the bulk of manufactured exports, which make up the largest share of the country's total gross exports, comprises the exports of electrical and electronic (E&E) products such as semiconductors, air-conditioners, electronic equipment and parts, telecommunication equipment and audio-visual products. Through its increased integration into the international economy as a result of the continued liberalization of trade and investment, the E&E industry has expanded significantly in terms of exports, employment and output. During the last two decades, it has become the leading growth sub-sector. Within the E&E industry, the electronics industry is Malaysia's leading non-resource-based export-oriented industry. It is the largest component in the manufacturing sector in terms of exports, employment and output (MIDA, 2001).

Since the electronic industry is highly linked internationally, it cannot insulate itself against influences from the external sector. Hence, it should adapt and respond to these challenges in order to enhance the competitiveness and resilience of its exports. The electronics export sector will continue to be the engine of growth according Malaysia's Second Industrial Master Plan (IMP2), 1996-2005.

The contributions of the present study are fourfold: Firstly, it provides disaggregated industry-based empirical evidence of export demand. The available evidence is limited for both disaggregated studies and Malaysia's electronics export sector.

Secondly, the disaggregated export demand provides further insights into how each electronics export product category responds to changes in its key determinants i.e. whether there are any intra-sectoral differences in the elasticity estimates of export demand.

Thirdly, the changes in composition of Asia's exports and its major export markets make the sectoral analysis of export performance of heterogeneous electronics product groups pertinent. Thus, empirical knowledge of long-run elasticities of disaggregated export demand assists policy makers to design and target appropriate policies to enhance the export competitiveness of Malaysia and, ultimately, to improve the country's industrial performance as well as its external trade position.

Finally, the findings of this study provide an analysis of the future growth directions of the electronics export sector since it has been identified as one of the key growth sectors in the Eight Malaysia Plan, 2001-2005.

The structure of this paper is as follows. The following section reviews the relevant literature. Section 3 presents the specification of the export demand model using cointegration and error-correction modeling techniques. It also provides a description of the data. Section 4 reports and analyzes the econometric results. Policy implications and concluding remarks are presented in Section 5.

2. Summary of Literature

The estimation of income and price elasticities of export demand is important for the design of exchange rate and trade policies to improve balance of payments positions (Houthakker and Magee, 1969; Stern *et al*., 1976). Most empirical studies found that the price elasticities of demand for newly industrialized economies (NIE) exports as well as exports from other developed and developing countries were low while income elasticities were high. In general, the consensus view is that the price elasticity of export demand lies between –0.6 and –1.0 and income elasticity is above 1.5 (Goldstein and Khan, 1985; Marques and McNeilly, 1988; Feenstra, 1994). The empirical evidence of lower price elasticity and higher income elasticity of export demand in general has important implications for exports of developing countries. Firstly, the export growth of developing countries is highly dependent on the economic performance of developed countries. Secondly, it implies that the developing countries are not capable of using price competition to maintain or increase exports. Moreover, Senhadji and Montenegro (1999) provided new evidence of price and income elasticities for Asian countries. They found that the Asian countries had the highest estimated values for income elasticity among the developing and industrial countries, which advocated the view that exports had been a powerful engine of growth in the Asian region. While the higher price elasticity of export demand faced by Asian countries implies that a real devaluation might be able to increase export revenues.

3. Model Specification and Data

The log-linear export demand model (see Houthakker and Magee, 1969; Arize, 1996; Arize *et al*., 2000; Abbott *et al*. 2001; Bahmani-Oskooee and Wang, 2007), which provides easy interpretation of the estimated elasticity parameters, can be written as

$$lnQ_{SITC\,t} = \beta_0 + \beta_1 ln(P^j_{SITC} / PW)_t + \beta_2 lnYF_t + \beta_3 D1_t + \beta_4 D2_t + e_t \qquad (1)$$ [1]

[1] The estimates are likely to suffer from omitted variable bias since the exchange rate volatility variable is omitted from equation (1). If the model is incorrectly specified, the ordinary least squares estimates are not the best linear unbiased estimator and hence, are inefficient despite of the fact that they are unbiased and consistent.

where Q_{SITC} is export demand at SITC 3-digit level from the electronic industry; (P^j_{SITC} / PW) is the relative price of Malaysia's j^{th} export at SITC 3-digit level. The relative price is the domestic price e.g. of the electronic industry (P^j_{SITC}) deflated by the price of similar products produced by Malaysia's trading partners (PW); YF is foreign income[2]; D1 is a dummy variable capturing the period of the ringgit volatility during the Asian currency crisis (1997:3 to 1998:2); and D2 is a dummy variable that controls for the pegging of the ringgit to the U.S. dollar at RM3.80 per U.S. dollar during the period 1998:3 to 2001:4; and β_1 and β_2 are the parameters for price and income elasticities.

$\beta_1$is expected to be negative because holding other things constant, the higher is the price of Malaysia's exports relative to the prices of similar goods made in other countries, the lower is the quantity demanded for Malaysia's exports. Therefore, (P^j_{SITC} / PW) is expected to be negatively related to Q_{SITC}. On the other hand, β_2 is expected to be positive because other things being equal, if the income from the rest of the world has increased, the greater is the demand by foreign consumers for Malaysia's made goods. For example, an economic boom in the economies of Malaysia's major trading partners tends to increase their quantity demanded for its exports. Thus, YF tends to be positively related to Q_{SITC}.

Homogeneity is imposed on equation (1) by expressing export demand as function of relative prices rather than specifying two separate price terms because the former could reduce collinearity between the price terms and conserve the degrees of freedom. We choose to impose homogeneity as a maintained hypothesis because the economic prior restrictions on these variables cannot be tested as disaggregated unit export prices are not available from published sources for Malaysia's competitors in the electronics export market.

The estimation period spans some 12 years, 1990:1 to 2001:4, and has been determined largely by the availability of the unpublished data of electronics exports by SITC product group provided by the Department of Statistics, Malaysia. The data for YF and PW have been collected from *International Financial Statistics Yearbook* (various issues) (see Appendix for the transformation of the variables).

If a cointegrating relationship exists among all variables which are $I(1)$ (non-stationary), then an error correction representation (ECM) can be found from the data (Engle and Granger, 1987, p.255). An ECM can be estimated to determine the short-run behavior of the electronics export demand. The residuals, which are primarily tested for stationarity, can be considered as 'equilibrium error' and can be used to represent the error correction mechanism in the ECM. Further, this error-correction process can reconcile the long-run equilibrium with disequilibrium behavior in the short run. The ECM specification can be written as follows:

[2] Since world income being the most common choice, trade-weighted index of real GDP of Malaysia's three major trading partners, namely the U.S., Japan and Singapore, is chosen. The choice of using trade as a weighting scheme is judged in relation to the importance of their trade as well as investment in the country.

$$\Delta Q_{SITC\,t} = \alpha_0 + \sum^{p}_{j=1} \alpha_1 \Delta Q_{SITC\,t-j} + \sum^{p}_{j=0} \alpha_2 \Delta P_{SITC\,t-j} + \sum^{p}_{j=0} \alpha_3 \Delta Y_{t-j} + \alpha_4 D1_t + \alpha_5 D2_t + \alpha_6 EC_{t-1} + \varepsilon_t \quad (2)$$

where:

Δ = first-order differencing (e.g. $Q_{SITC\,t} - Q_{SITC\,t-1}$),
$Q_{SITC\,t}$ = $ln Q_{SITC\,t}$,
$P_{SITC\,t-j}$ = $ln(P^{j}_{SITC} / PW)_{t-j}$,
Y_{t-j} = $ln YF_{t-j}$,
EC_{t-1} = previous period's error correction term generated from the Johansen multivariate cointegration procedure (Johansen, 1988, 1991; Johansen and Juselius, 1990, 1992, 1994)).

4. Empirical Results

Before the regression is estimated, each individual series, both in levels and first differences, is tested for unit roots using the augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) tests. The results of unit root tests for stationarity in levels are presented in Table 1. Neither tests rejects the null hypothesis of a unit root at the 5 per cent level of significance. However, if these variables are written in first differences, both tests clearly reject the null hypothesis at 5 per cent significance level or better suggesting that all variables are integrated of order one (see Table 1).

Table1. Results of unit root tests for stationarity (variables in levels and first differences)

Variable	ADF	PP	H_0: unit root
$Q_{SITC\,752}$	-0.37(5)	-3.18	accept
$P_{SITC\,752}$	-2.07(4)	-3.12	accept
$Q_{SITC\,762}$	-2.32(4)	-2.30	accept
$P_{SITC\,762}$	-2.43(4)	-2.97	accept
$Q_{SITC\,763}$	-2.33(1)	-2.31	accept
$P_{SITC\,763}$	-1.95(4)	-3.09	accept
$Q_{SITC\,764}$	-2.02(1)	-2.90	accept
$P_{SITC\,764}$	-2.10(4)	-3.00	accept
$Q_{SITC\,776}$	-3.12(4)	-3.16	accept
$P_{SITC\,776}$	-1.10(4)	-3.11	accept
Y	-3.04^{+}	not applicable	accept
$\Delta Q_{SITC\,752}$	$-6.67(4)^{***}$	-7.46^{***}	reject
$\Delta P_{SITC\,752}$	$-4.77(3)^{***}$	-4.78^{***}	reject
$\Delta Q_{SITC\,762}$	$-3.31(5)^{**}$	-7.37^{***}	reject

$\Delta P_{\text{SITC 762}}$	-3.65(4)***	-7.44***	reject
$\Delta Q_{\text{SITC 763}}$	-6.47(1)***	-7.35***	reject
$\Delta P_{\text{SITC 763}}$	-6.33(3)***	-7.79***	reject
$\Delta Q_{\text{SITC 764}}$	-7.06(1)***	-11.54***	reject
$\Delta P_{\text{SITC 764}}$	-3.43(4)**	-8.10***	reject
$\Delta Q_{\text{SITC 776}}$	-5.29(4)***	-7.24***	reject
$\Delta P_{\text{SITC 776}}$	-3.68(3)***	-8.31***	reject
ΔY	-6.14(2)***	-5.66***	reject

Notes:
(i) The figures in brackets denote the number of lagged dependent variables in the ADF regression.
(ii) The critical values for ADF and PP statistics are -2.94 and -2.93 respectively.
(iii) + denotes logged foreign income in levels had an upward trend with a structural break in the third quarter of 1997. The critical value for unit root with structural break at 5% significance level is -3.76 (Perron, 1989).
(iv) *** denotes 1% significance level; ** denotes 5% significance level.
(v) SITC 752 = automatic data processing
SITC 762 = radio-broadcast receivers with sound recorders or reproducers.
SITC 763 = sound recorders or reproducers; television image and sound recorders or reproducers;
SITC 764 = telecommunication equipment, parts and accessories;
SITC 776 = thermionic valves and tubes; photocells etc

The next step is to apply the Johansen multivariate cointegration procedure to test for the presence of a cointegrating vector or vectors among the non-stationary series. Table 2 reports the estimated λ_{max} and trace test statistics and their respective critical values. Both test statistics confirm that there exists a stable long-run relationship between export demand for electronic products (at SITC level) and relative prices and foreign income.

Table 2. Results of Johansen cointegration tests

$Q_{\text{SITC 752}}$ equation

λ_{max} test				**Trace test**			
H_0	**H_a**	**Statistic**	**95%**	**H_0**	**H_a**	**Statistic**	**95%**
r = 0	r = 1	43.78**	20.97	r = 0	r ≥ 1	54.31**	29.68
r ≤ 1	r = 2	9.36	14.07	r ≤ 1	r ≥ 2	10.53	15.41
r ≤ 2	r = 3	1.17	3.76	r ≤ 2	r ≥ 3	1.17	3.76

$Q_{SITC\ 762}$ **equation**

	λ_{max} test				Trace test		
H$_0$	**H$_a$**	**Statistic**	**95%**	**H$_0$**	**H$_a$**	**Statistic**	**95%**
r = 0	r = 1	30.34**	20.97	r = 0	r ≥ 1	43.15**	29.68
r ≤ 1	r = 2	10.84	14.07	r ≤ 1	r ≥ 2	12.81	15.41
r ≤ 2	r = 3	1.97	3.76	r ≤ 2	r ≥ 3	1.97	3.7

$Q_{SITC\ 763}$ **equation**

	λ_{max} test				Trace test		
H$_0$	**H$_a$**	**Statistic**	**95%**	**H$_0$**	**H$_a$**	**Statistic**	**95%**
r = 0	r = 1	37.94**	20.97	r = 0	r ≥ 1	48.00**	29.68
r ≤ 1	r = 2	6.38	14.07	r ≤ 1	r ≥ 2	10.06	15.41
r ≤ 2	r = 3	3.68	3.76	r ≤ 2	r ≥ 3	3.68	3.76

$Q_{SITC\ 764}$ **equation**

	λ_{max} test				Trace test		
H$_0$	**H$_a$**	**Statistic**	**95%**	**H$_0$**	**H$_a$**	**Statistic**	**95%**
r = 0	r = 1	26.10**	20.97	r = 0	r ≥ 1	30.41**	29.68
r ≤ 1	r = 2	3.47	14.07	r ≤ 1	r ≥ 2	4.31	15.41
r ≤ 2	r = 3	0.84	3.76	r ≤ 2	r ≥ 3	0.84	3.76

$Q_{SITC\ 776}$ **equation**

	λ_{max} test				Trace test		
H$_0$	**H$_a$**	**Statistic**	**95%**	**H$_0$**	**H$_a$**	**Statistic**	**95%**
r = 0	r = 1	69.15**	20.97	r = 0	r ≥ 1	79.67**	29.68
r ≤ 1	r = 2	8.70	14.07	r ≤ 1	r ≥ 2	10.52	15.41
r ≤ 2	r = 3	1.82	3.76	r ≤ 2	r ≥ 3	1.82	3.76

The estimated long-run elasticity parameters are reported in Table 3. They were calculated initially by setting the coefficients on export quantity (Q_t) equal to -1 and subsequently dividing the estimated cointegrating vectors by the negative of the estimated Q_t coefficients. Both estimated price and income elasticities have the expected sign - negative and positive respectively, but their magnitudes differ within the electronics product group. Among the estimated values for long-run price elasticities, only the export demand for semiconductors (i.e. $Q_{\text{SITC 776}}$) is price inelastic with a magnitude equals -0.23 implying non-price competitive factors have a positive effect on $Q_{\text{SITC 776}}$.

Table 3. Normalized cointegrating vectors: one cointegrating equation – demand for electronics exports

Equation		Normalized Cointegrating Vector
<u>Demand for electronics exports</u>		
Automatic data processing equipment	$Q_{\text{SITC 752}t}$ =	$27.09 - 0.97P_t + 13.53Y_t$ $(-3.76)^{***}$ $(21.85)^{***}$
Radio-broadcast receivers with sound recorders & reproducers	$Q_{\text{SITC 762}t}$ =	$10.47 - 1.27P_t + 4.93Y_t$ $(-17.03)^{***}$ $(13.53)^{***}$
Sound recorders or reproducers; television image & sound recorders reproducers	$Q_{\text{SITC 763}t}$ =	$15.31 - 1.64P_t + 6.97Y_t$ $(-3.39)^{***}$ $(3.62)^{***}$
Telecommunication equipment, parts & accessories	$Q_{\text{SITC 764}t}$ =	$13.25 - 1.03P_t + 6.60Y_t$ $(-6.03)^{***}$ $(5.49)^{***}$
Thermionic valves & tubes; photocells etc.	$Q_{\text{SITC 776}}$ $_t$ =	$5.85 - 0.23P_t + 3.69Y_t$ $(-2.45)^{**}$ $(10.98)^{***}$

Notes: (i) t-statistics are in parentheses.
(ii) *** denotes 1% significance level; ** denotes 5% significance level; * denotes 10% significance level.
(iii) The estimation output from Eviews did not report the standard errors for the constant terms, therefore, the t-statistics are not shown.

The semiconductor industry is continually evolving because of ongoing R&D activities that can lead to new and improved products. Therefore, the core activities of semiconductor manufacturing such as silicon ingot growing, cutting and polishing of silicon wafers, chip design and wafer fabrication become important non-price competitive activities. Currently, Malaysia is attempting to promote these activities in order to obtain a non-price competitive advantage in the manufacture of semiconductors.

The long-run estimates of foreign income elasticities of electronics export quantities corroborate the "consensus view" that they are highly elastic (see Goldstein and Khan, 1985;

Marques and McNeilly, 1988; Feenstra, 1994). Values are greater than unity imply that electronics exports are highly responsive to changes in foreign income in the long run. In particular, the processing equipment industry has the largest estimated income elasticity of 13.53. This evidence could be justified by an argument obtained from Krugman (1979, 1980, 1989), who adapted the monopolistic model of Dixit and Stiglitz (1977), that the income elasticity of demand for a country's exports would be larger when there was disproportionately rapid growth in its productive capacity relative to the world capacity. Given that the high income elasticity of export demand for electronics, the adoption of outward-oriented policy can lead to rapid growth in electronics exports that can raise long-run economic growth for Malaysia subject to business cycles abroad. This evidence is consistent with the theoretical argument for a developing country that export trade can promote growth.

The estimation results of the ECM are shown in Table 4. The lagged explanatory variables were chosen based on Hendry's general-to-specific modeling approach. A maximum of 4 lags was imposed initially and then the most parsimonious model was tested down from the general model with the exclusion of one lag at a time, using the *t* statistic on the estimated coefficients. For valid statistical inference, it is necessary to test the assumptions underlying the Ordinary Least Squares (OLS) method. First, the Durbin-Watson test statistic is used to determine whether the residuals are serially correlated. In addition, the Breusch-Godfrey Lagrange Multiplier (LM) test statistic is also used to detect the presence first- and fourth-order serial correlation. Second, the Jarque-Bera test statistic is used to check the normality in the OLS residuals. Third, the ARCH (i.e. an abbreviation for autoregressive conditional heteroscedasticity) LM test statistic is used to test the validity of homoscedasticity. Fourth, Ramsey's RESET (regression specification error test) is used to examine whether the regression displays any specification error in its functional form, omitted variables and correlation between the residuals. Fifth, the Chow test is used to examine the structural stability of the estimated regression. All the regressions behave well in terms of diagnostic tests for ordinary least squares assumptions relating to error processes such as absence of serial correlation, normality and homoscedasticity. The RESET statistics indicate no evidence of incorrect functional form, and the Chow tests suggest regressions are stable at 5 per cent significance level.

Table 4. Regression results for error-correction models – demand for electronics exports

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Demand for exports of automatic data processing equipment ($\Delta Q_{\text{SITC 752}}$):

$$\Delta Q_t = \underset{(1.22)}{0.05} - \underset{(-11.40)^{***}}{2.43\Delta P_t} - \underset{(-2.12)^{**}}{0.52\Delta P_{t-1}} - \underset{(-2.10)^{**}}{6.96\Delta Y_{t-2}} + \underset{(1.69)^{*}}{0.22 D1_t} - \underset{(-1.90)^{*}}{0.26 EC_{t-1}} + \varepsilon_t$$

$R^2 = 0.813$
Adjusted $R^2 = 0.789$
F-statistic = 33.13
Durbin-Watson statistic = 1.80
Breusch-Godfrey LM [1] test = 0.01 (0.919)

Breusch-Godfrey LM [4] test = 2.61 (0.626)
Jarque-Bera test of normality = 7.05 (0.531)
ARCH [4] test = 3.73 (0.444)
Ramsey's RESET [2] test = 0.92 (0.408)
Chow test: F(6, 38) = 0.70

Demand for exports of radio-broadcast receivers with sound recorders or reproducers ($\Delta Q_{SITC\ 762}$):

$$\Delta Q_t = -0.008 + 0.19\Delta Q_{t-1} + 0.74\Delta Q_{t-4} - 0.87\Delta P_t + 0.62\Delta P_{t-4} + 0.11D1_t - 0.28EC_{t-1} + \varepsilon_t$$

(-0.86) (1.74)* (6.94)*** (-7.09)*** (5.31)*** (3.24)*** (-1.82)**

$R^2 = 0.795$
Adjusted $R^2 = 0.761$
F-statistic = 23.23
Durbin-Watson statistic = 1.72
Breusch-Godfrey LM [1] test = 1.10 (0.294)
Breusch-Godfrey LM [4] test = 3.73 (0.444)
Jarque-Bera test of normality = 0.71 (0.703)
ARCH [4] test = 2.95 (0.566)
Ramsey's RESET [2] test = 0.31 (0.732)
Chow test: F(7, 36) = 0.28

Demand for exports of sound recorders or reproducers; television image and sound recorders or reproducers ($\Delta Q_{SITC\ 763}$):

$$\Delta Q_t = 0.003 + 0.64\Delta Q_{t-1} - 0.17\Delta Q_{t-2} + 0.41\Delta Q_{t-4} - 0.80\Delta P_t - 0.16\Delta P_{t-1} - 0.24\Delta P_{t-2}$$

(0.33) (2.63)** (-1.75)* (4.12)*** (-6.11)*** (-1.78)* (-2.78)***

$$+ 0.38\Delta P_{t-4} + 1.38\Delta Y_{t-1} + 0.07D1_t - 0.82EC_{t-1} + \varepsilon_t$$

(4.38)*** (1.69)* (2.08)** (-3.02)***

$R^2 = 0.745$
Adjusted $R^2 = 0.665$
F-statistic = 9.33
Durbin-Watson statistic = 1.90
Breusch-Godfrey LM [1] test = 0.08 (0.776)
Breusch-Godfrey LM [4] test = 0.40 (0.983)
Jarque-Bera test of normality = 1.24 (0.539)
ARCH [4] test = 2.83 (0.587)
Ramsey's RESET [2] test = 0.86 (0.434)
Chow test: F(11, 32) = 2.03

Demand for exports of telecommunication equipment, parts and accessories ($\Delta Q_{SITC\ 764}$):

$$\Delta Q_t = 0.003 - 0.54\Delta P_t - 0.45 EC_{t-1} + \varepsilon_t$$
$$\quad (0.13) \quad (-4.07)^{***} \quad (-3.27)^{***}$$

R^2 = 0.466
Adjusted R^2 = 0.441
F-statistic = 18.33
Durbin-Watson statistic = 2.00
Breusch-Godfrey LM [1] test = 0.00 (0.990)
Breusch-Godfrey LM [4] test = 7.17 (0.127)
Jarque-Bera test of normality = 1.99 (0.369)
ARCH [4] test = 3.13 (0.537)
Ramsey's RESET [2] test = 1.59 (0.217)
Chow test: F(3, 42) = 0.10

Demand for exports of thermionic valves and tubes; photocells etc. ($\Delta Q_{SITC776}$):

$$\Delta Q_t = -0.01 + 0.43\Delta Q_{t-1} + 0.16\Delta Q_{t-4} - 0.72\Delta P_t - 0.20\Delta P_{t-1} - 0.26\Delta P_{t-2} + 2.09\Delta Y_t$$
$$\quad (-1.05) \quad (3.10)^{***} \quad (2.09)^{**} \quad (-7.38)^{***} \quad (-2.17)^{**} \quad (-2.46)^{**} \quad (2.56)^{**}$$

$$+ 2.78\Delta Y_{t-1} + 0.10 D1_t - 0.90 EC_{t-1} + \varepsilon_t$$
$$\quad (3.26)^{***} \quad (3.33)^{***} \quad (-3.80)^{***}$$

R^2 = 0.803
Adjusted R^2 = 0.749
F-statistic = 14.92
Durbin-Watson statistic = 2.01
Breusch-Godfrey LM [1] test = 0.01 (0.918)
Breusch-Godfrey LM [4] test = 1.96 (0.744)
Jarque-Bera test of normality = 0.33 (0.846)
ARCH [4] test = 3.18 (0.529)
Ramsey's RESET [2] test = 1.72 (0.197)
Chow test: F(10, 33) = 1.41

Notes: (i) t-statistics are in parentheses.
(ii) *** denotes 1% significance level; ** denotes 5% significance level;
* denotes 10% significance level.
(iii) [ ] refers to number of lags or fitted terms.
(iv) ( ) refers to probability value.

The estimated coefficients on the relative price and foreign income variables show how the average speed of export adjustment in response to shocks of relative prices and foreign income. In most cases, foreign income has a larger estimated coefficient value than relative prices. Moreover, these two variables are only jointly significant in the following regressions: $\Delta Q_{\text{SITC 752}}$, $\Delta Q_{\text{SITC 763}}$ and $\Delta Q_{\text{SITC 776}}$.

The estimated coefficient of the dummy variable *D1*, which was used to capture the sharp depreciation of the ringgit during the Asian currency crisis, is positive and significantly different from zero except for $\Delta Q_{\text{SITC 764}}$ regression. The coefficient estimate for *D1* suggests that the slide of the ringgit against the US dollar (and most of major currencies during the crisis period) may have been quite instrumental in raising the external demand for Malaysia's electronic products despite the uncertain outlook in the currency markets.

The one-lagged error-correction term (EC_{t-1}) measures the disequilibrium between the actual and equilibrium export quantity. Table 4 shows that the estimated coefficients for EC_{t-1} have the correct sign with considerable variation in the speed of adjustment (given by the time it takes the export quantity to restore long-run equilibrium after some short-run changes in its regressors) among the different electronics products. For example, $\Delta Q_{\text{SITC 776}}$ takes about one quarter (one divided by the estimated coefficient of EC_{t-1}) to restore long-run equilibrium while $\Delta Q_{\text{SITC 752}}$ requires about four quarters to converge to long-run steady state. These econometric results also support the earlier findings (see Arize, 1996; Arize *et al*, 2000) on long-run cointegration on the grounds that an equilibrium relationship is present among the variables in each of the error-correction regressions.

5. Conclusions

This paper provides new empirical evidence on the demand for Malaysia's electronics exports at the 3-digit SITC level. The cointegration results suggest strong evidence of a unique long-run relationship between export quantity and its key determinants, viz. relative prices and foreign income, for Malaysia's largest five electronics export product groups. The average absolute long-run price elasticity of demand for electronic exports is greater than [1], implying that the improvement of price competitiveness is an appropriate strategy if Malaysia wants to increase export growth for the electronics. However, the export demand for semiconductors is found to be price inelastic in the long run. In order to sustain the growth momentum in semiconductor exports, non-price factors such as chip design and wafer fabrication must continually improve. To this end, the government should promote domestic technological capabilities in integrated circuit design and wafer fabrication.

The increase in the use of technology and move the semiconductor industry further up the value chain are in line with the policies and strategies recently recommended by Ninth Malaysia Plan (Malaysia, 2006). At the present stage, the government has been effective in providing important infrastructure and the necessary support system for industrial development. However, the skills of the workforce are inadequate to meet the technological needs for higher value added activities. Thus, manpower training programs for high-end industrial development should be implemented.

With reference to high long-run income elasticities of export demand for electronics products, they imply that Malaysia's electronics exports have a high degree of exposure to these traditional export markets such as the U.S., Japan and Singapore. In fact, they are also the major sources of FDI in the country. Dependence on them for electronics exports may affect the sector adversely if they experience a recession or there is a change in foreign consumer or producer preferences for Malaysian electronics products. To mitigate these adverse effects, there should be attempts to increase the diversification of electronics products apart from diversifying into new export markets through trade promotion strategy.

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Appendix

All the time-series data are quarterly from 1990 to 2001. Before they are expressed in quarterly growth in logarithmic terms for the estimation regressions, the raw data are transformed into indices at 1995 prices (i.e.1995 = 100) to ensure all variables are unit free.

Q_{SITC} = Volume of electronic export at 3-digit SITC level.

P^j_{SITC} = Unit price of electronic export at 3-digit SITC level, which is constructed based on the followings:

$$\text{Unit price of SITC 762 export} = \frac{\text{Current FOB value (RM) of SITC 762 export}}{\text{Quantity of SITC 762 export}}$$

where FOB is the abbreviation for free on board, and the export quantity of each SITC product group is measured in common unit.

$$PW_t = \sum_{n=1}^{3} w^n P^n_t$$

where $w^n = x^n / \sum_{n=1}^{3} x^n$, trade share of Malaysia's n^{th} major trading partners i.e. U.S. Japan and Singapore.

x^n = Malaysia's electronic exports to the n^{th} trading partners, and
P^n_t = wholesale price index of Malaysia's n^{th} major trading partners.

$$YF_t = \sum_{n=1}^{3} w^n YF^n_t$$

where YF^n_t = real gross domestic product of Malaysia's n^{th} trading partner, and the weights used for constructing foreign income variables are similar to those used in the construction of the relative price variables.