MODELLING MANUFACTURED EXPORTS: EVIDENCE FOR ASIAN NEWLY INDUSTRIALISED ECONOMIES

This paper examines the determinants of export growth for four of the Asian newly industrialising economies (NIEs): Hong Kong, Korea, Singapore and Taiwan. Using the framework of cointegration and error correction modelling, it is found that, in the case of Singapore, income effects, competitiveness (relative price effects) and exchange rate effects are the dominant sources of export growth while in Korea's case, these same variables are less significant in explaining export growth. In the case of Taiwan, income effects and exchange rate effect are more dominant than relative price effects and domestic factors such as exchange rate, and export prices have more significantly affected export growth in Hong Kong. Overall, the most significant variable in explaining export growth in the NIEs is the exchange rate. The empirical evidence indicates that the J-curve does exist for these NIE exports.

Introduction

One of the most widely discussed growth strategies in economic development literature is the promotion of exports to achieve faster growth. It has been suggested that growth in real exports causes growth in real gross national product (Bhagwati 1978; Krueger 1978; and Xu 1996). This view has been used to explain the growth performance of both less developed countries (LDCs) and newly industrialising economies (NIEs).¹ The main argument is that the growth of exports leads to better resource allocation and production efficiency which, in turn, leads to faster growth. Given the importance of this factor, this paper first develops an export growth model and then analyses both the time-series properties of such export growth and its key determinants for Korea, Hong Kong, Taiwan and Singapore. Earlier studies of export growth and its determinants are few (Dalamagas 1995; Muscatelli et al. 1995). Our study differs from previous works in three ways. First, our dynamic modelling of export demand behaviour does not follow the restrictive simple-stock adjustment mechanism used in several studies (Dalamagas 1995; Moreno 1991). Instead, a less stringent and more general process is used, based on an error correction procedure. Second, unlike the previous models that study export growth, our model is derived from the maximisation of objective functions by rational agents. Third, the level of specification used in previous studies does not recognise that real exports and some of their proposed determinants such as world
income are, a priori, potentially non-stationary integrated variables. Failure to consider the non-stationary nature of these variables could in part lead to the inclusion of modelling variables and errors in determining the effects of the exchange rate, income and relative prices. In this paper we establish the properties of the time series prior to testing for cointegration. We then use the framework of error correction modelling in the analysis to determine the factors influencing export growth in Hong Kong, Korea, Singapore and Taiwan.

Export modelling

The model consists of two countries, the domestic economy (NIE) and the foreign economy (rest of the world [ROW]). Each country produces manufactured goods. The representative household in each country is assumed to maximise an intertemporal objective function. Households maximise their total life-time utility subject to budget constraints. Households maximise utility, defined as the current and future consumption of goods and leisure. More specifically, the variables entering the utility function are: leisure (H); domestic manufactured goods \(C_m\); and imported manufactured goods \(C_m^*\). Since all the arguments of the utility functions are measured in real terms, a constant rate of discount(s) is assumed. The intertemporal utility function can be stated as:

\[
v = \int_{-\infty}^{\infty} e^{-st} u(H, C_m, C_m^*) \, dt
\]  

The utility maximisation behaviour of domestic households is constrained by the source of wage income. So, the budget constraint can be stated as:

\[
P_m C_m + \tilde{e} P_m^* C_m^* = W \cdot L
\]  

Income \((W \cdot L)\) is allocated among expenditure on manufactured goods at given domestic prices \(P_m\) and foreign world price \(P_m^*\). \(\tilde{e}\) is the exchange rate defined as units of the NIE’s currency per unit of foreign currency. Similarly, the foreign household objective function can be defined as:

\[
\tilde{v} = \int_{-\infty}^{\infty} e^{-st} \tilde{u}(H, C_m, C_m^*) \, dt
\]
Where * relates to foreign production, while the bar indicates foreign consumption. For example, $C_m$ is foreign consumption of the manufactured goods produced by the NIE country (domestic country) while $C^*_m$ indicates foreign consumption of manufactured goods produced by the foreign country. Demand for domestic (NIE) manufactured exports is derived from the intertemporal utility function of a representative household in the ROW (see Appendix A for a complete derivation). By solving this maximisation problem, the demand for NIEs’ manufactured exports can be expressed as a function of the domestic export prices of manufactured goods, world export prices of manufactured goods, the exchange rate and the total expenditure of the ROW (world GDP). For the purpose of empirical modelling for NIE exports, the demand for NIEs’ manufactured exports takes the following linear form by taking the logarithm of equation (A-5) (see Appendix A).

$$EX_t = a_0 + a_1 Y_{wt} + a_2 P_{wt} + a_3 P_t + a_4 ER_t + z_t$$

(4)

where, $EX_t$ denotes the logarithm of exports, $Y_{wt}$ is the logarithm of total expenditure of the ROW (world GDP), $P_t$ is the logarithm of export prices, $P_{wt}$ is the logarithm of world export prices, $ER_t$ is the logarithm of the exchange rate and $z_t$ is an error term. To establish the long-run equilibrium relationship among the variables, we assume that equation (4) is the cointegrating equation. To identify the short-run dynamic specification, we employ the ‘general-to-specific’ paradigm (see Hendry 1989; Hendry et al. 1988).

$$\Delta EX_t = \alpha(L) \Delta EX_{t-1} + \beta(L) \Delta X^*_t + \sum_{i=1}^{4} \Phi_i Z_{t-1}^i$$

(5)

where $Z_t = EX_t - \eta' X_t; \quad X_t = (Y_{wt}, P_{wt}, P_t, ER_t)$; $X^*_t = (Y_{wt}, P_{wt}, P_t, ER_t)$.

$\alpha(L)$ and $\beta(L)$ are lag polynomials and the vector $\eta$ is the cointegrating vector estimated from equation (4). The parameter $\Phi$ is the error-correction coefficient. If the variables employed in equation (4) have a single unit root but are cointegrated, the error correction form in equation (5) exists, that is $\Phi_i \neq 0$. 


Empirical results

The empirical analysis is carried out using quarterly seasonally adjusted data on six variables. The data span the first quarter of 1973 through to the second quarter of 1995 and all variables are in logarithmic form (see Appendix B for details of data definitions). We estimated the long-run demand equation for exports directly using the well-known concept of cointegration, having first established that all the individual series are integrated of degree one using a standard unit root test. Parsimonious dynamic models for exports ($\Delta EX$) for Korea, Hong Kong, Taiwan and Singapore were obtained by engaging in a general–specific modelling exercise. In this exercise, we used equation (5). The independent variables were four lags of $\Delta EX$, the current and four lags of $\Delta ER$, $\Delta Y_w$, $\Delta P$, $\Delta P_w$. To avoid the loss of power and nuisance parameter problems, the error correction term was generated following a canonical cointegrating regression (CCR) estimation procedure (Park 1992). Final parsimonious ECM equations for Korean export demand and Singaporean export demand are reported in Table 1.

Considering that the dependent variable is cast in first-difference, overall, the empirical result suggests that the statistical fit of the model to the data is satisfactory (as indicated by the values of adjusted $R^2$) and most of the independent variables are statistically significant at the 5 or 10 per cent level. The price elasticities (both export prices and world export prices) in the export demand equations for all NIE countries are correctly signed. For example, if export prices rise, the demand for NIE exports will fall. On the other hand, if world export prices rise, the demand for NIE exports will rise. The income variables (world GDP) for all NIEs were also correctly signed and significant at the 5 per cent level. The estimated income elasticities imply a fairly large response of manufactured exports to a change in world income (3.51 for Korea and 3.48 for Singapore, 2.3 for Taiwan and 1.32 for Hong Kong). The significance of world income (scale variable) is also in contrast to the Riedel (1988) hypothesis that world income is irrelevant in NIE export growth.

However, our estimates are consistent with the previous empirical findings of Muscatelli et al. (1995) and In and Sgro (1998). Both have implemented system methods such as FIML and SUCCR. They tend to find very significant income elasticities of export demand for all the NIEs.

Table 1 Final parsimonious ECM equations for Korean and Singaporean exports

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>Standard Error</th>
<th>t-value</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\Delta EX$</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\Delta ER$</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>$\Delta Y_w$</td>
<td></td>
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<tr>
<td>$\Delta P$</td>
<td></td>
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<tr>
<td>$\Delta P_w$</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>$\Delta M$</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\Delta F$</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>$\Delta I$</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\Delta W$</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

4
Korea

\[
\Delta EX_t = -2.93 + 0.70\Delta EX_{t-4} + 0.55\Delta ER_{t-4} + 3.51\Delta Y_{wt} \\
(-3.44) \quad (9.44) \quad (2.26) \quad (1.98)
\]

\[
-0.66\Delta P_{t-4} + 0.003\Delta P_{wt-4} - 0.16ECM_{t-1} \\
(-1.95) \quad (0.005) \quad (-3.43)
\]

\[
R^2 = 0.64 \quad D-W = 2.44 \quad BG(5) = 6.16 \quad BPG(5) = 6.25 \quad CHOW = 6.65 \quad RESET = 1.3
\]

Singapore

\[
\Delta EX_t = -1.17 + 0.52\Delta EX_{t-4} + 0.64\Delta ER_{t-1} + 3.48\Delta Y_{wt} \\
(-2.43) \quad (5.91) \quad (2.51) \quad (3.38)
\]

\[
-0.71\Delta P_{t-4} + 0.82\Delta P_{wt-1} - 0.12ECM_{t-1} \\
(-4.46) \quad (2.34) \quad (-2.42)
\]

\[
R^2 = 0.47 \quad D-W = 2.03 \quad BG(5) = 1.28 \quad BPG(5) = 6.11 \quad CHOW = 2.53 \quad RESET = 0.66
\]

Notes:

a. BG(5) is the Breusch-Godfrey test for up to 5th order serial correlation and is asymptotically distributed as \(\chi^2(5)\). Since observed values (6.16 for Korea and 1.28 for Singapore) are less than the critical chi-square value (\(\chi^2(5) = 11.07\)) at the 5% significance level, we accept the null hypothesis of no serial correlation for both countries.

b. BPG(5) is a test for heteroskedasticity developed by Breusch-Pagan-Godfrey and is asymptotically distributed as \(\chi^2(5)\). Since computed values (6.25 for Korea and 6.11 for Singapore) are less than the critical chi-square value, 11.07 at the 5% significance level, we accept the null hypothesis of homoscedasticity.

c. CHOW is a test for structural stability and follows the F-distribution. Since computed value (F = 6.65 for Korea) exceeds the critical F-value, F(7, 76) = 2.15 at the 5% significance level, we reject the hypothesis of structural stability.

d. RESET is a regression specification error test. Ramsey's RESET test follows the F-distribution. Since computed values (1.3 for Korea and 0.66 for Singapore) are less than the critical F-value F(2,81) = 3.12, at the 5% significance level, we conclude that this model is not mis-specified.
Table 2  Final parsimonious ECM equations for Hong Kong and Taiwanese exports

<table>
<thead>
<tr>
<th>Hong Kong</th>
<th>$\Delta EX_t = -2.58 + 0.193\Delta EX_{t-1} + 0.61\Delta ER_{t-4} + 1.32\Delta Y_{wt}$</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>($-3.97, 1.88, 3.25, 1.93$)</td>
</tr>
<tr>
<td></td>
<td>$-0.42\Delta P_{t-2} + 0.64\Delta P_{wt-1} - 0.12ECM_{t-1}$</td>
</tr>
<tr>
<td></td>
<td>($-1.16, 1.95, -4.00$)</td>
</tr>
<tr>
<td>$R^2 = 0.35$</td>
<td>D-W = 2.02                                     BG(5) = 3.77    BPG(5) = 7.01    CHOW = 2.98    RESET = 0.98</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Taiwan</th>
<th>$\Delta EX_t = -2.53 + 0.23\Delta EX_{t-2} + 0.13\Delta ER_{t-2} + 2.30\Delta Y_{wt}$</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>($-3.29, 2.44, 0.40, 2.35$)</td>
</tr>
<tr>
<td></td>
<td>$-1.001\Delta P_{t-3} + 0.21\Delta P_{wt} - 0.286ECM_{t-2}$</td>
</tr>
<tr>
<td></td>
<td>($-4.37, 0.46, -3.31$)</td>
</tr>
<tr>
<td>$R^2 = 0.35$</td>
<td>D-W = 1.97                                     BG(5) = 5.49    BPG(5) = 3.27    CHOW = 3.68    RESET = 5.53</td>
</tr>
</tbody>
</table>

Notes: a Note that observed values of the Breusch–Godfrey test (3.77 for Hong Kong and 5.39 for Taiwan) are less than the critical chi-square value ($\chi^2(5) = 11.07$) at the 5% significance level. Therefore, we accept the null hypothesis of no serial correlation for both countries.

b Using the Breusch–Pagan–Godfrey test for heteroskedasticity, we accept the null hypothesis of homoscedasticity since computed values (7.01 for Hong Kong and 3.27 for Taiwan) are less than the critical chi-square value, 11.07 at the 5% significance level.

c In case of the structural stability test (CHOW test), the computed values (F = 2.89 for Hong Kong and F = 3.68 for Taiwan) exceed the critical F-value, F(3.64) = 2.75 (Hong Kong) and F(3.65) = 2.75 (Taiwan), respectively, at the 5% significance level, so we reject the hypothesis of structural stability.

d The model mis-specification test (Ramsay’s RESET test) is supported for Hong Kong but not for Taiwan (that is the computed value 0.98 for Hong Kong is less than the critical F-value, F[2] = 3.12 but the computed value [5.53 for Taiwan] is bigger than the critical value).

The significance of the exchange rate is worth noting in that a relatively long-lagged exchange rate term ($\Delta ER_{t-4}$) is adjusted to explain Korea and Hong Kong’s export growth but a short-lagged exchange rate term is adjusted to explain Singapore’s export growth ($\Delta ER_{t-1}$) and
Taiwan's export growth (ΔERt). All of the diagnostic tests support the statistical appropriateness of the equations. Statistically, the equations perform well, exhibiting no problems of functional form mis-specification (Ramsey's Reset test), residual autocorrelation (Breusch-Godfrey's test for general serial correlation) and heteroskedasticity (LM test). The stability test result (Chow test) for the Korean export demand equation is conducted using a structural break period (1979:4) (change of exchange rate regime, from fixed to a flexible rate). Finally, note that the error correction term appears with a statistically significant coefficient and displays the appropriate (negative) sign, a finding that accords well with the validity of an equilibrium relationship among the variables in the cointegrating equation. This implies that overlooking the cointegration of the variables would have introduced mis-specification in the underlying dynamic structure.

To analyse the major determinants of the change in exports in NIEs, we conducted a forecast error decomposition analysis (FEDA). A five year ahead dynamic decomposition of the forecasting error variance of the change in exports is reported in Table 3. Variance decomposition results suggest that the change in exports can be explained largely by the forecast error variance of exports itself in Korea, Taiwan and Hong Kong and, to a lesser extent, in Singapore. Overall, in Singapore's case, the exchange rate, export prices, world export prices and world GDP are the dominant sources of variation in both the short and long term.

Table 3  Forecast error variance decomposition of NIE manufactured exports

<table>
<thead>
<tr>
<th>Period</th>
<th>Exports</th>
<th>World GDP</th>
<th>Exchange Rate</th>
<th>Export Prices</th>
<th>World Export Prices</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>K</td>
<td>S</td>
<td>K</td>
<td>S</td>
<td>K</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>88.7</td>
<td>67.0</td>
<td>2.1</td>
<td>3.0</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>84.8</td>
<td>53.4</td>
<td>3.2</td>
<td>7.5</td>
</tr>
<tr>
<td></td>
<td>10</td>
<td>84.3</td>
<td>53.2</td>
<td>3.2</td>
<td>7.5</td>
</tr>
<tr>
<td></td>
<td>20</td>
<td>84.3</td>
<td>53.2</td>
<td>3.2</td>
<td>7.5</td>
</tr>
<tr>
<td>H</td>
<td>T</td>
<td>H</td>
<td>H</td>
<td>H</td>
<td>T</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>81.2</td>
<td>76.7</td>
<td>1.8</td>
<td>7.8</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>63.7</td>
<td>64.5</td>
<td>2.0</td>
<td>12.6</td>
</tr>
<tr>
<td></td>
<td>10</td>
<td>62.4</td>
<td>64.4</td>
<td>2.0</td>
<td>12.6</td>
</tr>
<tr>
<td></td>
<td>20</td>
<td>62.4</td>
<td>64.4</td>
<td>2.0</td>
<td>12.6</td>
</tr>
</tbody>
</table>
Note: a K indicates Korea, S indicates Singapore, H indicates Hong Kong and T indicates Taiwan.

This suggests that changes in the exchange rate, export prices, world export prices and world GDP have significant effects on exports growth. The contribution of the exchange rate, export prices, world export prices and world GDP, after five years, contributed 16.5 per cent, 15.2 per cent, 7.5 per cent and 7.5 per cent, respectively, to the variance in the export growth. In contrast, the forecast error variance of exports accounted for by the exchange rate, export prices, world export prices and world GDP are relatively small in Korea's case, contributing 3.6 per cent, 3.9 per cent, 4.9 per cent and 3.2 per cent, respectively. This suggests that external shocks have smaller effects on export growth in Korea than Singapore.

In Taiwan's case, the world income (WGDP) (12.6 per cent), exchange rate (13.3 per cent), and to a lesser extent export prices (5 per cent) and world export prices (4.8 per cent) are the dominant sources of variation in the long run. Our estimate finds strong evidence that exchange rate and income effects significantly affect export behaviour in Taiwan, but no evidence of a strong effect on competitiveness (relative-price effect). By contrast, in Hong Kong's case, the forecast error variance of exports accounted for by export prices and exchange rate are relatively strong, contributing 17.4 per cent and 17.6 per cent, respectively. In the case of Hong Kong, domestic factors (export prices and exchange rates) were found to have quite a significant influence on the growth of exports.

In conclusion, the main empirical finding from the forecast error variance of exports is that overall, the exchange rate generally has a significantly affect and contributes to the variations of export growth for all NIEs. Second, it is found that, in the case of Singapore, income effects (world GDP), competitiveness (relative price effects) and exchange rate effects are the dominant sources of export growth while in Korea's case, these same variables are less significant in explaining export growth. Third, the exchange rate and export prices are more important than other variables as the domestic factors in influencing the sources of export growth in Hong Kong's case, while the contribution of exchange rate and world GDP to export growth was consistently substantial in Taiwan's case.

To investigate the determinants of the export growth, Figures 1–16 display the impulse response functions (IRA). The IRA analysis helps to identify the direction of the dynamic response of export growth to the shocks from world income, the exchange rate, domestic export prices and world export prices. Since the variables in the model are converted to log differences prior to estimation, the IRA results indicate the effect of a shock from growth rate of world GDP (Figures 1, 5, 9 and 13), world export prices (Figures 2, 6, 10...
and 14), exchange rate (Figures 3, 7, 11 and 15) and export prices (Figures 4, 8, 12 and 16) on the growth rate of exports. Because the contemporaneous correlation causes the error covariance matrix to be non-diagonal, the errors need to be generalised. This was carried out using the Cholesky decomposition. The IRA was carried out for several orderings of the variables. The results reported here are based on the ordering world GDP, exchange rate, export prices and world export prices. Though not reported, the impulse response analysis with different orderings yielded quite similar results and did not change any qualitative aspect of the subsequent results. Overall, the responses are consistent with the predictions of our parsimonious ECM equation. For example, the world income shock has a strong positive effect on all NIE exports in the 5-10 quarters. The response is quite dramatic in both the short and the long run. The world export prices shock apparently has a positive significant effect on Singapore and Hong Kong but a mixed effect on Korean exports and a diminishing effect on Taiwan over the 10 quarters. As the forecast error decomposition analysis of Hong Kong indicates, in terms of magnitude, the external factors (world income and world prices) are less significant in influencing export growth in Hong Kong. The shock of export prices, as our theory predicted, shows the negative effect on exports, hitting the maximum effect around 5 quarters and tapering off around 10 quarters. Overall, the empirical finding of the IRA analysis closely parallels the forecast error decomposition results of the NIEs. One of the most important empirical findings is that the IRA response of exports to the shock of exchange rate portrays the initial stage of the 'J-curve', which shows the change in the export trade induced by a given devaluation plotted against time. Interestingly, the curves illustrate the initial worsening of the exports in response to a devaluation, and the subsequent swing toward a long-run equilibrium path over time. In short, the impulse response analysis provides empirical evidence indicating that the first segment of the J-curve does exist for all NIE exports.

Concluding remarks
This paper deals with the modelling of manufactured exports in the NIEs. Through optimisation of the behaviour of agents in the foreign economy (ROW), an optimal export demand function for the domestic economy (NIE) is derived.

The long-run relationship between export growth and domestic factors (exchange rate and export prices) and external factors (world income and world export prices) in the export
demand equation are tested and supported by the J_1 test and are estimated using CCR estimation.

On the basis of the ECM modelling, the evidence of this preliminary evaluation gives support to a contention of short-run dynamic influence of exchange rate, export prices, world export prices and world income on export growth in the NIEs. The results of the FEDA and IRA analysis consistently support the proposition that in both relative cyclical income effects and the exchange rate, world export prices and export prices (relative price effects) are dominant and have played an influential role in explaining export growth in Singapore. These same variables have played a less significant role in the case of Korea. Domestic factors (exchange rates and export prices) are important influences on export growth in Hong Kong, while income effects and exchange rates rather than competitiveness (relative price effects) are more dominant in Taiwan. The results are robust across the many specifications considered for all NIEs. Further, the IRA supports the proposition that the J-curve pattern does exist for all NIE exports.

Overall, the most important variable (regardless of the country) in explaining export growth in NIEs is the exchange rate. As a policy implication of this empirical evidence, stabilisation of domestic factors such as exchange rates, whose 80 per cent volatility is transmitted into domestic prices in the Asia Pacific region (Garnaut 1991), should be given serious thought. This volatility distorts price mechanisms which will ultimately affect the producers’ incentive to maintain and expand export manufacturing. Finally, it is clear that joint efforts dealing with both external and domestic factors are required for continued long-run export growth in the NIEs.

Appendix A: Derivation of the demand for NIE exports

The utility function of the ROW household has as its arguments leisure and manufactured goods. The lifetime intertemporal utility function can be expressed as:

\[ \tilde{\nu} = \int_{s}^{\infty} e^{-st}u(H, \bar{C}_m, \bar{C}_m')dt \]  
(A.1)

The budget constraint for the above utility function is:

\[ \hat{c}(\hat{P}_m, \bar{C}_m) + \hat{P}_m^* \bar{C}_m^* = W^*L^* = X^* \]  
(A.2)
where $\tilde{e}$ is the exchange rate. The Hamiltonian approach is used to derive optimal equilibrium conditions for labour supply ($L^*$) and manufactured goods ($\overline{C}_m, \overline{C}_m^*$).

The Hamiltonian representation of the above equation is:

$$\max \int_0^\infty e^{-st} \tilde{\mu}(\cdot) dt + \lambda \left\{ W^*L^* - \tilde{e}(\overline{P}_m \overline{C}_m) - \overline{P}_m^* \overline{C}_m^* \right\}$$  \hspace{1cm} (A.3)

Therefore, the first order conditions for export demand are:

$$\overline{C}_m: e^{st} \left( \lambda \tilde{e} \overline{P}_m - \frac{\partial U}{\partial C_m} \right) = 0 \leftrightarrow \frac{\partial U}{\partial C_m} = \lambda \tilde{e} \overline{P}_m$$  \hspace{1cm} (A.4)

Based on the separability assumption of utility, the optimal conditions for export demand for manufactured goods can be expressed as functions of price ($\overline{P}_m, \overline{P}_m^*$), exchange rate ($\tilde{e}$) and total expenditure for consumption ($X^*$).

$$\overline{C}_m = f(\tilde{e}, \overline{P}_m, \overline{P}_m^*, X^*)$$  \hspace{1cm} (A.5)

Appendix B: Data

The main source data for NIEs comes from the IMF’s international financial statistics. For example, the source of data for world GDP and exchange rates is the IMF’s international financial statistics and the data on Korea’s exports and prices were obtained from the Korea Bank’s publications (1996, various issues). Variable definitions:

1. $Y_W$: World GDP (by expenditure), approximated by OECD GDP, using a base year index 1990 = 100.
2. $P_W$: World export prices, trade-weighted index of export prices in the NIEs’ major trading partners, the United States, Japan and Germany. The weight values of the United States, Japan and Germany, computed by trade-weighted prices index are 0.56, 0.35 and 0.09, respectively.
3. $EX$: Exports of NIE manufactures, total export volume (US$ million value of exports).
(4) P: Export prices, unit value indices of total exports, using a base year index 1990 = 100.

(5) ER: Exchange rate (trade-weighted exchange rate), using Singapore dollars per US dollar for Singapore, using won per SDR (Special Drawing Rights) for Korea, Hong Kong dollars per US dollar for Hong Kong and Taiwanese yuan per US dollar for Taiwan.

Notes

1 A useful summary of the theoretical and empirical background to this view can be found in Giles et al. (1992).

2 Since manufactured goods are the major component of NIE exports, we shall be focusing solely on exports of manufactured goods: thus, we shall avoid further distinctions such as non-manufactured goods and non-tradeable goods.

3 As is usual, it is assumed that the distinction between world export prices and (domestic) export prices has to do with the existence of tariffs and subsidies.

4 Some studies of OECD exports have suggested that firms may discriminate on price between domestic and foreign markets so that we should model domestic price and export price simultaneously (see Aspe and Giavazzi 1982; Funke and Holly 1990). However, as Muscatelli and et al. (1995) point out, in the case of most of our NIEs, it is not likely to be important, given that domestic markets are minuscule relative to foreign export markets (especially for economies such as Singapore).

5 Hereafter ‘export price’ and ‘world export price’ shall be deemed to refer to ‘domestic export price of manufactured goods’ and ‘world export prices of manufactured goods’.

6 We have employed standard ADF tests (Phillips–Perron 1988) and the Park–Choi (1988) unit root test. These test results clearly suggest that they are integrated of order one. The results do not change when different truncation lags are used and do not depend on whether the trend variable is included or not. We checked for cointegration using $J_1$ test (Park 1992) and we cannot reject the null hypothesis of one cointegrating vector. The results of these tests are not reported here for reasons of space, but are available from the authors on request.

7 A central issue in studies of NIE exports is related to the question of whether the extremely rapid export growth of NIEs can be viewed primarily as a phenomenon of income-elastic export demand. Riedel (1988) in a study of Hong Kong exports of manufactures, and a subsequent study by Athukorala and Riedel (1990) which focuses on Korean exports of machine tools, found high price elasticities and insignificant income elasticities. In contrast, Dalamagas (1995) has explored the determinants of export growth and identified a significant income and demand factor as well as a supply factor (relative growth in production). Similarly, Muscatelli et al. (1995) provide evidence that high income elasticities of export demand are detected.
using a conventional simultaneous model. Given the rapid growth of NIE exports in
world trade (Korea is ranked 11th in volume of world trade), our empirical findings are
not likely to support the ‘small country assumption’.

By taking into account this structural change, the parsimonious ECM equation shows
better estimated results:

\[
\Delta EX_t = -3.39 + 0.72 \Delta EX_{t-4} + 0.52 \Delta ER_{t-4} + 4.61 \Delta Y_{wt} \\
-0.59 \Delta P_{t-4} + 0.36 \Delta P_{wt-4} - 0.19 ECM_{t-1} - 0.05 DD_t \\
\]

\[R^2 = 0.66 \quad D-W = 2.46\]

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