

**Commerce Division
Discussion Paper No. 68**

**MEASUREMENT OF ASIAN INCOME
ELASTICITIES FOR NEW ZEALAND
EXPORTS:
A COINTEGRATION APPROACH**

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September 1999

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ISSN 1174-5045
ISBN 1-877176-45-1

Abstract

This paper estimates short and long run income elasticities of demand for New Zealand exports to several Asian countries. Export demand is modelled as a function of spending power using cointegration analysis. The results show that short run income elasticities for New Zealand exports vary from 0.7 (Singapore) to 3.3 (Japan). Long run income elasticities vary from 1.4 (Singapore) to 8.64 (Indonesia). In addition, the error-correction terms range from -0.32 (Indonesia) to -0.86 (Japan).

Contents

List of Tables	i
1. Introduction	1
2. Background	1
3. Error Correction Model	3
4. Data Description	4
5. Cointegration Analysis	4
6. Results of the Error-Correction Model	7
7. Implications of the Results	9
8. Conclusion	9
References	11
Appendix	12

List of Tables

1.	New Zealand Exports to Asia Year Ended June 1997 (Million NZ\$)	2
2.	ADF Unit Root Tests of Individual Variables	5
3.	Engle and Granger Cointegration Test Results	6
4.	Error Correction Models for Asian Countries	7

1. Introduction

Exports provide a large proportion of New Zealand's national income. Nearly a third of New Zealand's exports (\$21 billion) went to Asia in 1997. Asia is New Zealand's largest overseas market for aluminium, wood and wood products, and fish. Japan is New Zealand's largest export market in Asia, earning \$3,137 million in 1997.

The objective of this paper is to estimate the income elasticity of demand for New Zealand exports to Asia. The importance of income elasticities is they measure the response to changes in demand from changes in income or spending power. Export demand is modelled using cointegration analysis which links long run relationships between export demand and spending power into a short-run dynamic equation, known as an error-correction model (ECM). The ECM measures how the rate of growth of exports responds to its short run deviation from long run equilibrium and changes in the rates of growth of spending power.

The paper is arranged as follows. The next section describes the product mix of New Zealand goods imported by Asian countries. Section 3 describes the ECM export demand model and data. Section 4 describes and presents the unit root and cointegration tests. Results of the estimated error-correction models and long run income elasticities and their implications are reported in section 5. Section 6 concludes the paper.

2. Background

Before estimating income elasticities of export demand it is useful to study what commodities are being purchased by each country. This is important because the product mix will invariably be a major determinant of the magnitude of income elasticity. Table 1 shows the value of New Zealand exports to Asia split by commodity and country for the year ended June 1997.

Japan is the largest Asian importer of New Zealand meat, dairy, fish, fruit, wood and aluminium products. China is the largest Asian importer of New Zealand wool. Singapore is the largest Asian importer of New Zealand oil and petroleum, while Hong Kong is the largest

Asian importer of New Zealand paper and paper products. Wood is New Zealand's largest export earner in Asia, followed closely by dairy products.

The definition for meat includes sheepmeat and beef. Dairy is defined as the sum of butter, casein, cheese and curd and milk and cream products. Fruit is defined as the aggregation of vegetables, kiwifruit, fruit and apples. Wood consists of wood and wood products combined. Oil is oil and petroleum exports, and paper is made up of paper and paper products.

Table 1
New Zealand Exports to Asia Year Ended June 1997 (Million NZ\$)

	Meat	Dairy	Fish	Fruit	Wool	Wood	Aluminium	Oil	Paper
China	6	49	40	3	217	17	2	0.06	12
Hong Kong	34	61	87	69	57	27	6	0	30
Indonesia	29	89	2	10	3	87	19	0	4
Japan	152	339	306	349	54	769	424	0.003	2
Korea	45	42	47	25	6	359	135	2	0
Malaysia	37	243	10	27	3	17	3	0	19
Philippines	7	146	1	4	2	44	11	0	7
Singapore	24	30	9	39	0.2	7	8	8	12
Taiwan	68	161	44	54	37	90	13	0.0	1
Thailand	2	113	14	13	12	27	13	0.02	6
Total	404	1273	560	593	391	1444	634	10	93

Source: Ministry of Foreign Affairs and Trade

The majority of China's spending on New Zealand products is on wool. Although China's income elasticity is not estimated in this paper, it is expected that China would have a high income elasticity, as the demand for wool is a derived demand. Hong Kong on the other hand imports a lot of fish, dairy and fruit, relative to other commodities. These goods can be considered to be necessities in Hong Kong. As a result Hong Kong's income elasticity for New Zealand exports is expected to have be inelastic.

Dairy and wood products make up the bulk of Indonesia's imports of New Zealand goods. As the demand for wood is derived and dairy products are luxuries in Indonesia, the income elasticity for Indonesia is expected to be elastic. Although Japan imports food staples such as fish and fruit and vegetables, it also is importing products that are traditionally western such as dairy products. Consequently, Japan's income elasticity is expected to be elastic. The same can be said for Korea. The majority of Malaysia's imports are made up of dairy products. The demand from the Philippines is similar to Malaysia except that the Philippines import more wood products. It is expected that the Philippines demand for New Zealand products would be more elastic than Malaysia. Singapore mainly imports necessities such as

fish and fruit. In addition, Singapore is New Zealand's largest purchaser of oil and petroleum products in Asia. These goods can probably be considered necessities, therefore we would expect that the income elasticity for Singapore to be inelastic. Although the income elasticity for Taiwan is not estimated it is likely that its income elasticity is elastic due to the nature of its imports of dairy products. Thailand purchases a product mix similar to Taiwan's. Therefore it is expected that Thailand also has an elastic income elasticity of demand for New Zealand products.

3. Error Correction Model

The demand function of New Zealand exports to Asian markets can be expressed as:

Model

$$EX_{it} = f(INC_{it}) \quad (1)$$

where:

EX_{it} is the total exports from New Zealand's to the i th Asian country in year t

INC_{it} is the total demand of the i th Asian country. Defined as $GDP+imports-exports$ ¹ in year t

If export demand and spending power are cointegrated the ECM can be derived from the following ADL(1,1) model in equation 2. Lower case variables denote natural logarithms.

$$ex_{it} = \alpha_0 + b_1 inc_{it} + b_2 inc_{it-1} + b_3 ex_{it-1} + \varepsilon_{it} \quad \varepsilon_{it} \sim IID(0, \sigma^2) \quad (2)$$

Equation 2 can be reparametised to a first order error-correction model:

$$\Delta ex_{it} = b_1 \Delta inc_{it} - \lambda [ex_{it-1} - \beta_0 - \beta_1 inc_{it-1}] + \varepsilon_{it} \quad (3)$$

where: $\beta_1 = (b_1 + b_2)/\lambda$, $\beta_0 = \alpha_0/\lambda$ and $\lambda = (1 - b_3)$ with $b_3 < 1$

¹ This definition is adopted from Joumard and Reisen (1992)

The parameters from equation 3 can be interpreted as follows. The term in square brackets can be regarded as the disequilibrium error from period $t-1$ which can be interpreted as stating that this period's change in exports depends on the change in total demand and on the extent of the disequilibrium in the previous period. In other words, λ is an adjustment parameter called error-correction term. b_1 is the short-run income elasticity of demand for New Zealand exports. β_0 and β_1 are the long-run equilibrium parameters.

4. Data Description

The data are annual observations for the period 1972 - 1996². New Zealand exports to the Asian countries are in thousands of dollars f.o.b deflated using the export price index 1990=100. Export statistics are taken from Overseas Trade Statistics as published by Statistics New Zealand. Total demand for New Zealand exports by selected Asian countries is defined as GDP+imports-exports in own currency, deflated using the IMF GDP deflator 1990=100. Total demand statistics are taken from the IMF's International Finance Statistics, IMF. Real GDP figures for Hong Kong 1972 - 1975 are sourced from Hong Kong Census Statistics Department (1986) and from 1976 - 1996 Asian Development Bank. Import and export statistics for Hong Kong were not readily available. Subsequently, Hong Kong's total demand is defined as real GDP.

5. Cointegration Analysis

A necessary and sufficient condition for representing series as an error-correction model (ECM) is for the series to be cointegrated (Engle and Granger, 1987). Before cointegration can be tested for, univariate stationarity tests must be carried out to determine the integrating properties of the model. This is required because each variable involved in estimating the ECM must be stationary of the same order. In this paper the Augmented Dickey-Fuller (1979) test, based on the following regression, is used to test for order of integration.

$$\Delta y_t = \alpha_0 + \alpha_1 y_{t-1} + \alpha_2 t + \sum_{j=1}^p \gamma_j \Delta y_{t-j} + \omega_t \quad \omega_t \sim IID(0, \sigma^2) \quad (4)$$

where Δ is the first-difference operator and ω_t is a stationary white noise error term. Akaike's Information Criterion was used to determine the appropriate lag length for each series. All series are expressed as logs. Table 1 presents the results of the ADF unit root tests for export demand and spending power for each Asian country. The null hypothesis of non-stationarity ($\alpha_1 = 0$) is tested using a t test. The null hypothesis is rejected if the estimate of α_1 is negative and statistically significant, based on critical values provided by Dickey and Fuller (1979). The ADF test results suggests that all variables are non-stationary in levels but stationary in first differences.

Table 2
ADF Unit Root Tests of Individual Variables

Critical value at 5% level is -3.14 for constant and trend, -2.57 for constant, no trend..

Variables	t-Statistic	t-Statistic	Constant	Trend
	ADF levels	ADF First Differences		
<i>Singapore</i>				
NZ Exports to Singapore	-1.48	-4.20*	Yes	Yes
Total Demand	-2.92	-6.63*	Yes	Yes
<i>Japan</i>				
NZ Exports to Japan	-1.50	-6.85*	Yes	Yes
Total Demand	-1.71	-4.18*	Yes	Yes
<i>Korea</i>				
NZ Exports to Korea	-2.16	-5.91*	Yes	Yes
Total Demand	-1.92	-7.32*	Yes	Yes
<i>Hong Kong</i>				
NZ Exports to Hong Kong	-2.80	-6.43*	Yes	Yes
Total Demand	-1.53	-5.13*	Yes	Yes
<i>Thailand</i>				
NZ Exports to Thailand	-1.83	-4.08*	Yes	Yes
Total Demand	-1.11	-3.30*	Yes	Yes
<i>Indonesia</i>				
NZ Exports to Indonesia	-2.56	-5.29*	Yes	Yes
Total Demand	-2.51	-4.11*	Yes	Yes
<i>Malaysia</i>				
NZ Exports to Malaysia	-.278	-4.96*	Yes	Yes
Total Demand	-1.27	-3.01*	Yes	No
<i>Philippines</i>				
NZ Exports to Philippines	-1.95	-3.92*	Yes	Yes
Total Demand	-2.85	-3.14*	Yes	Yes

² Period for Thailand 1972 - 1995.

Because the series for each country are integrated of the same order, it is possible that they are cointegrated. There are several approaches that can be used to test for cointegration. This paper uses Engle and Granger's (1987) procedure.

The Engle and Granger test is based on the stationarity of residuals of the cointegrating equation. X and Y are cointegrated if residuals from regressing X and Y are stationary. The relationship between exports and total demand can be expressed in the following equation (equation 5). Estimation of which will give an estimate of the long run equilibrium relationship between the variables.

$$ex_{it} = \beta inc_{it} + \varepsilon_t \quad (5)$$

Engle and Granger (1987) propose a test whether ex_{it} and inc_{it} are not cointegrated by testing whether the residuals are stationary using augmented Dickey-Fuller (1979) unit root tests (equation 6).

$$\Delta \varepsilon_t = \alpha_0 + \alpha_1 \varepsilon_{t-1} + \alpha_2 t + \sum_{j=1}^p \gamma_j \Delta \varepsilon_{t-j} + \omega_t \quad \omega_t \sim IID(0, \sigma^2) \quad (6)$$

If ε_t is stationary then ex_{it} and inc_{it} are cointegrated. Table 2 presents the results of the Engle-Granger cointegration test using the ADF unit root test for stationarity of the variables. The null hypothesis of non-stationarity of the residuals ($\alpha_1=0$) is rejected at 10%. For all countries we can conclude that export demand and spending power are cointegrated and a long run equilibrium relationship between export demand and spending power for each country exists.

Table 3
Engle and Granger Cointegration Test Results

Results of the cointegration tests (constant, no trend). Critical value at 10% level is -2.57

Country	t-Statistic
Singapore	-3.58*
Japan	-4.90*
Korea	-3.54*
Hong Kong	-3.62*
Thailand	-3.64*
Indonesia	-3.28*
Malaysia	-3.43*
Philippines	-2.89*

6. Results of the Error-Correction Model

Given that the variables for each country are cointegrated, the demand for New Zealand exports to Asia can be characterised as an error-correction model (equation 3). In this simple model the growth rate of New Zealand exports depends on the error-correction term and the growth rates of spending power. The advantage of the error-correction model is that it can be used to estimate both short-run and long-run elasticities. This is important because the response of export demand to a change in spending power may be dispersed over more than one year and therefore the estimates of short-run and long-run elasticities may be different. Table 3 reports the results of the estimated error-correction models.

Table 4
Error Correction Models for Asian Countries

(t-values in Parentheses)

	Hong Kong	Indonesia	Japan	Malaysia	Philippines	Singapore	South Korea	Thailand
β_0	-7.175*** (-3.786)	-0.950 (-0.277)	-3.641** (-2.348)	-0.229 (-0.192)	-1.729 (-0.789)	1.445 (0.841)	-6.705*** (-4.818)	-5.073 (-1.301)
SR Income Elasticity	0.750 (0.973)	2.798** (2.334)	3.321*** (3.079)	1.067*** (85.828)	2.884*** (5.24)	0.733* (1.342)	2.109*** (3.248)	1.665* (1.602)
β_1	1.299*** (8.463)	1.043*** (3.543)	1.414*** (11.684)	1.090*** (10.265)	0.9335** (2.943)	1.009*** (6.267)	1.638*** (13.711)	1.359*** (4.171)
Error-correction Term	-0.505*** (-2.771)	-0.324*** (-2.938)	-0.857*** (-4.529)	-0.614*** (-3.591)	-0.451*** (-3.5689)	-0.714*** (-3.531)	-0.970*** (-6.334)	-0.303** (-2.229)
D	-0.701** (-1.801)	-	-	-	-	-	-0.764*** (-4.203)	-
LR Income Elasticity	1.48	8.64	3.87	1.74	6.27	1.41	2.17	5.50
R ²	0.3625	0.4349	0.5780	0.4383	0.5974	0.3486	0.6755	0.3438
LM (χ^2_1) ⁱ Test	1.724	1.687	4.691	3.093	1.590	2.210	2.402	1.528
JB test for normality (χ^2_2) ⁱⁱ	1.049	0.529	1.666	0.0675	2.761	1.756	0.831	0.904

Critical values at the 5% and 10% level respectively:

i Autocorrelation (χ^2_1) 3.841 and 6.635

ii Normality (χ^2_2) 5.99 and 9.210

*, **, and *** indicate significance at 10%, 5% and 1% levels respectively

The ECM models for Hong Kong and South Korea include a dummy variable to account for outliers. All coefficients have the expected signs. All short-run income elasticities are

statistically significant except for Hong Kong. The Lagrange Multiplier test for autocorrelation suggests that serial dependence is not present in the models at the 10% level of significance. The Jarque-Bera normality tests provide evidence that the residuals are normally distributed. The R^2 are respectable for first difference equations, ranging from 0.3438 to 0.6755.

The error-correction term for each model is negative and statistically significant. The negative coefficient of the error-correction term ensures that the long-run equilibrium is achieved. However, adjustments towards long run equilibrium are not instantaneous. The error-correction terms vary from as low as 0.31 for Thailand to as high as 0.97 for South Korea. This means that for Thailand thirty one percent of any years deviation from the long run equilibrium is corrected in the next years growth of exports to Thailand. The negative and statistically significant coefficient of the error-correction term confirms the cointegration relationship found earlier and the validity of the error-correction representation.

The constant for all models except Hong Kong, Japan and South Korea is not statistically significantly different from zero. Theory suggests that the constant should equal zero in the long run (Harris, 1995). The positive short-run income elasticities suggest that New Zealand exports to Asia are normal goods. But there are significant differences of individual country elasticities. Income elasticities are inelastic for Hong Kong and Singapore, and elastic for the remaining counties. More specifically, Singapore has an elasticity of 0.7, which by convention would suggest that Singapore's imports from New Zealand are necessities, while at the other end of the scale Japan's income elasticity is 3.2, which would suggest that Japan's exports include a lot of luxury items. The differences in elasticities show that Asian countries do not have homogenous tastes for New Zealand exports.

The long run elasticities in Table 3 have been derived from the ECM model (see appendix). As expected, the long-run elasticities are larger than the short-run elasticities with all long run elasticities being greater than one. Indonesia, the Philippines and Thailand have the largest long-run income elasticities. The least elastic long-run elasticities are Hong Kong and Singapore and Malaysia.

7. Implications of the Results

The results presented in Table 3 show that stable long-run relationships exist between New Zealand exports to Asian countries and the spending power of those Asian countries. Although the model is very simple it still provides satisfactory results.

Although Asia is often referred to as a homogenous group of countries this research has shown that income elasticity of demand for New Zealand exports by Asian countries differs between Asian countries. Both Hong Kong and Singapore have inelastic short run income elasticities of demand for New Zealand exports. Malaysia has a unitary short run income elasticity of demand for New Zealand exports, whereas the remaining countries have elastic short run income elasticities of demand. The importance of income elasticities is they measure the response to changes in demand from changes in income or spending power. New Zealand exporters are less likely to be affected from economic downturns in countries that have inelastic income elasticities, such as Hong Kong and Singapore. In contrast, New Zealand's exports to Japan would be affected to a larger extent if Japan's economy collapsed or went into recession.

From the point of view of a New Zealand exporter to Asia, the error-correction terms (Table 3) give an indication of how long each country will take to recover from an economic growth shock, such as the present Asian crisis. Countries with large error-correction terms, like Japan and South Korea, will recover from these shocks, at a faster rate than countries with small error-correction terms, such as Indonesia and Thailand.

8. Conclusion

This paper has shown that demand for New Zealand exports by selected Asian countries is cointegrated with the spending power of the countries. The presence of cointegration allowed an error-correction model to be estimated to capture the long run equilibrium and short dynamics of export demand and spending power. This implies that there is a long run relationship to which the variables for each country have a tendency to return to in the long run. The error-correction models were used to generate income elasticities of demand for New Zealand exports to Asia.

The results of the ECM model found that the short-run income elasticities of demand for New Zealand exports by Asians varied widely, ranging from 0.7 to 3.3. The long-run elasticities ranged from 1.4 to 8.6.

The model was simply specified as lack of data only allowed 25 observations. Demand for New Zealand exports by Asian countries was only being explained by spending power. For a better understanding of the pattern of demand for New Zealand exports, all relevant demand factors, such as prices and exchange rates need to be included. In addition, the model could be improved by using quarterly data which would pick up any seasonality that is present. However, as a first step, it appears that this model was successful in estimating the income elasticities of demand for New Zealand for by Asian countries. Further improvements to model specification could be made by disaggregating total exports into separate commodities. This would allow own-price elasticities to be calculated providing a fuller analysis.

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APPENDIX

Derivation of Long-Run Elasticities

The long-run steady state relationship can be expressed as:

$$X_i = KY_i^v \quad (A1)$$

Where X_i is a vector of New Zealand exports to i th Asian country and Y is the spending power of the i th Asian country. The above equation can be linearised by taking logarithms of the variables:

$$x = k_i + vy \quad (A2)$$

where x is the logarithm of New Zealand exports to the i th Asian country, k_i is the logarithm of the intercept, K , in the equation above, y is the logarithm of the spending power of the i th Asian country and v is the long run income elasticity.

For convergence to the long run equilibrium to occur, some short run adjustment is needed. As an illustration the case of a AR(1) type process is assumed.

$$x_t = \alpha x_{t-1} + \mu + y_t \theta + \varepsilon_t \quad (A3)$$

where $|\alpha| < 1$, μ is the intercept, θ is the column vector of short-run elasticities and ε_t is a 'white noise' error term. The steady state can be derived from the above equation as long as the long-run dynamic steady state in which all equilibrium values grow at a constant rate. Equation A3 can be reparameterised by subtracting x_{t-1} from both sides, and adding and subtracting y_{t-1} from the right hand side to obtain:

$$\Delta x_t = \mu + \Delta y_t \theta + (\alpha - 1) [x_{t-1} - (1 - \alpha)^{-1} y_{t-1} \theta] + \varepsilon_t \quad (A4)$$

where Δx_t is the rate of export growth and Δy_t is the rate of spending power growth. The term inside the brackets is the error correction term. If exports to Asia rise above the long-run equilibrium level at time $t-1$, the term in the brackets becomes positive

The long-run elasticities can be derived from estimating the error-correction model (Equation A4) by multiplying the absolute value of the inverse of the error-correction term by the short-run elasticity.

$$v = (1-\alpha)^{-1} \theta \tag{A5}$$