MONASH UNIVERSITY

ESTIMATES OF THE ELASTICITY OF SUBSTITUTION BETWEEN IMPORTED AND DOMESTICALLY PRODUCED GOODS IN NEW ZEALAND

Andrew Comber

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Andrew Comber
Monash University

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* A preliminary draft. Comments and criticism are welcome.

1. Introduction

1.1 *Estimates of the Elasticities of Substitution for New Zealand*

The idea of elasticity of substitution has developed into one of the mainstays in the measurement of price responsiveness, not only in production theory, but also in the study of international trade. It has been applied, for example, in the context of the world demand for exports from two competing sources, to estimate one country's relative demand for imports from competing foreign sources, and to estimate one country's demand for imports relative to domestic substitution.

Elasticities of substitution between imported and domestically produced goods have been estimated in several countries in past years[1], but there has been no study focussing primarily on the elasticities of substitution in New Zealand.. Because there are no estimates of import / domestic substitution elasticities for New Zealand, economists have had to fall back on using Australian estimates as derived at the Impact Project in general equilibrium modelling work. Factors such as the lack of proper empirical data and data measurement problems may be a partial explanation as to why elasticities of substitution between imported and domestically produced goods have not been estimated for New Zealand before.

The aim of this paper is to provide some preliminary estimates of the elasticities of substitution between imports and domestically produced goods for New Zealand using data disaggregated at an industry level, based on a constant elasticity of substitution specification derived from Armington (1969).

Elasticities of substitution are of interest to economists because the elasticity of substitution can be taken as a measure of the responsiveness of imports to changes in their prices and the prices of domestic substitutes. A substitution elasticity indicates the percentage change in the share of the domestic market of an import per percentage change in the ratio of the price of the import to the price of the domestic substitute i.e. measures the sensitivity of the imported good's competitive position in the domestic market. The elasticity measures are likely to be of use in economic discussions focussing on the sectoral distribution of the impact of commercial policy changes because of the disaggregation used here. Accordingly knowledge of the elasticities of substitution is important in policy decisions in response to, for example, the effects of differing domestic and foreign inflation rates, exchange rate changes, changes in domestic indirect taxes and, of course, changes in the levels of tariffs and other trade barriers. Assessing the effects of changing various policy instruments on employment and production in particular sectors or industries is important because it is assumed that individual sectors or industries are unlikely to respond uniformly to the changes. Also disaggregation of the data enables estimation to be more accurate as some sectors have been affected as a result of liberalisation and not others. Additionally, as a result,

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[1] Recent studies which have done so are Alaouze (1976,1977) and Alaouze, Marsden and Zeitsch (1977) for Australia, Lachler (1985) for West Germany, and Shiells, Stern and Deardoff (1986) and Reinert and Roland-Holst (1990) for the United States of America.

the estimates of the elasticities of substitution may be used to re-estimate existing general equilibrium models, for example, the *Joanna* model (the New Zealand equivalent of the Australian *Orani* model), instead of falling back on the Australian estimates or using 'best guess' estimates.

New Zealand was once a protected economy with a tradeables sector largely insulated from foreign competition. Throughout the mid to late 1980s liberalisation occurred transforming the economy from a closed economy to an open economy. The result of this has been a large increase in the import penetration ratio. Changes in import penetration can have a significant impact on the tradeables sector of the economy as well as the balance of payments position, and therefore understanding the effects of changes in relative prices on the division of expenditure between imports and domestically produced goods is important both for policy makers and forecasters.

Apart from this papers contribution to the New Zealand policy debate, the re-estimation of the elasticities of substitution is important because of the large structural changes to the New Zealand economy since the mid 1980s, making the use of elasticities from *Orani* estimated using Australian data from the 1970s even less appropriate.

The remainder of the paper is organised as follows. Some basic facts about New Zealand imports and economic liberalisation are reviewed in Section 2. The theory of substitution is discussed in Section 3. Section 4 discusses the specification of the model, the data base and the econometric procedure. An analysis of the results is presented in Section 5, with conclusions in the final section.

2. New Zealand Trade: A Background

2.1 *Imports: An Overview*

Because of its small population and limited mineral resources, New Zealand has to import goods that it does not have or cannot manufacture efficiently itself. Demand for imports had continually exceeded export receipts and regulations on foreign exchange transactions, tariffs, and import licensing have been the significant techniques used to reduce the excess demand for import products, especially of finished goods. Local industries have developed behind the protection barriers and use many imported intermediate goods to produce final goods within New Zealand. As a result, even with trade liberalisation, imports of manufactured goods have remained the principal component of total imports. They comprised over sixty percent of New Zealand's total imports in 1993 and had been at even higher levels earlier. Table 1 shows the other major imports have been mineral fuels and plastics (6.8 percent and 4.7 percent respectively of 1993 imports), which are items for which New Zealand does not have sufficient domestic production capacity.

It is often very difficult for New Zealand to substitute the kinds of products and services that it imports. Several are high productivity items such as automobiles, aircraft or telecommunications equipment. Several involve high levels of technological sophistication and significant economies of scale in production. They require large investments in research and development, production facilities, marketing and distribution. As a result these industries have very high barriers to entry.[2]

Table 1
Composition of major commodities imported, 1993

Commodity	Value of imports (cif) $(millions)	Percentage of total imports(cif)
Mechanical machinery	2506.7	14.5
Vehicles	1797.6	10.4
Electrical machinery	1663.0	9.6
Mineral fuels	1176.1	6.8
Plastics	807.4	4.7
Aircraft	618.5	3.6
Optical and photographic	568.4	3.3
Paper	548.3	3.2
Pharmaceutical products	500.8	2.9
Inorganic chemicals	363.5	2.1
Iron and steel	325.8	1.9
Printed products	316.5	1.8
Organic chemicals	252.0	1.5
Rubber and articles	245.6	1.4
Iron or steel articles	243.9	1.4
Chemical products	233.6	1.3
Toys, games, etc.	183.8	1.1
Aluminium and articles	179.8	1.0
Apparel; not knitted	175.8	1.0
Apparel; knitted	169.0	1.0
Others	4457.7	25.7
Total imports	17332.7	100.0

Source: The New Zealand Official Yearbook 1994

The change in the source of imports, shown in Table 2, has been a significant factor in the country's import structure. In 1950, sixty percent of imports by value came from United Kingdom, twelve percent from Australia, seven percent from United States and the remaining twenty one percent from a wide range of countries. In 1992, the import source pattern was six percent from United Kingdom, twenty two percent Australia, eighteen percent from the United States and fifteen percent from Japan, with the remaining thirty nine percent from a wide range of sources.

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[2] See Crocombe, Enright and Porter (1991) for further detail discussing New Zealand imports.

Table 2
Origin of imports by value (percent)

Country	1950	1982	1992
United Kingdom	60	9	6
Australia	12	19	22
United States	7	17	18
Japan	-	17	15
Other countries	21	38	39
Total	100	100	100

Source: Various issues of The New Zealand Official Yearbook

2.2 *Economic Liberalisation in New Zealand*

Economic policy in New Zealand has been marked by a sharp change of direction during the 1980s. The period prior to June 1984 had been marked by an increasing reliance on administrative controls culminating in the freeze on wages, prices, interest rates and the exchange rates from 1982-84. Faced with a legacy of low growth rates, rapidly increasing foreign debt and fiscal deficits, the incoming Labour government initiated a dramatic shift towards economic liberalisation.[3]

A series of policy decisions were then made which implied a rapid process of deregulation with primary emphasis on financial markets, removal of interventions in trade goods production, and withdrawal of the state from areas of commercial activity. A twenty per cent devaluation of the New Zealand dollar was implemented in July 1984 to secure the relative price change prerequisite to removal of the large range of export incentives and a more rapid removal of import licensing and reduction of tariffs. Interest rate controls on financial institutions were removed in December 1984, and the New Zealand dollar was floated by March 1985. All compulsory ratios on financial institutions (including the reserve asset ratio) were abolished in February 1985, and a policy admitting new banks was announced in November 1985.[4] Wages, prices, interest rates and the exchange rate were all freed from direct government control.

Reform of the tax system took place on a number of fronts. On the first, the tax base has been broadened. For example, a number of personal tax concessions were removed, a business fringe benefit tax was introduced and a valued added tax (Goods and Services Tax) was implemented. Associated with a broadening of the tax base, the personal tax schedule was flattened. Also, change in policy concerning public expenditure with focus on efficiency of resource use and to a lesser extent income distribution effects, rather than the focus on short-run stabilisation which characterised the period prior to 1984. This included efficiency of resource use in publicly owned assets used for trading activities. Bad debts were written off, a number of the major

[3] For a detailed decussion, see Bollard and Buckle (1987).
[4] See Leung (1989) for a discussion of financial liberalisation in New Zealand.

state-owned trading enterprises were restructured in a stand-alone framework, and this, because the fact that the government was the owner removed an important performance incentive for management, led to the sale of many government enterprises.

And as the removal of barriers to product market competition took place, there were increased opportunities for market access for most countries into New Zealand. Indeed, negotiations for reciprocal trade arrangements, such as the CER agreement with Australia, resulted in the large increase of imports. Table 3 shows, for example, that the volume of imports from Australia increased one hundred and fifty percent between 1982 and 1994.

Table 3
Change in volume of imports by source (percent)

Country	82-84	84-87	87-90	90-94	82-94
United Kingdom	1.16	5.72	-18.20	6.35	-6.58
Australia	25.35	34.59	-7.47	37.56	150.00
United States	-5.14	54.28	36.49	11.48	122.70
Japan	27.2	-8.96	-12.69	1.48	2.60
Total	22.76	21.81	12.44	38.61	133.06

Source: Statistics New Zealand

The radical reform program has imposed a series of regulatory shocks to which the economy is still adjusting.

Therefore, the rationale for this effort stems from the need for more accurate modelling of the effects of changes in relative prices on the division of expenditure between imports and domestic substitutes in New Zealand, given the many fundamental changes in the international and national economic setting in the 1980s.

These measures may in turn lead to improved estimates of the employment and other effects of changes in trade for New Zealand.

3. Theory

3.1 *The Theory of Elasticity of Substitution*

The elasticity of a given country's relative exports with respect to relative prices is the normal definition of the elasticity of substitution in international trade. The elasticity of substitution assumes a functional relation between relative exports (or an export share) and relative prices, as in the constant elasticity equation

(1) $X_1/X_2 = f(P_1/P_2)^{\sigma}$

where X represents exports, P represents prices, 1 and 2 denote exporting countries, and σ the elasticity of substitution.

The elasticity of substitution has been popular as a direct measure of the sensitivity of a country's competitive position in world trade (as measured by share) to price and exchange rates, and used more specifically, to estimate one country's relative demand for imports from competing foreign sources, and to estimate one country's demand for imports relative to domestic substitutes.

The elasticity of substitution concept is borrowed from production theory, and seems to have been first applied to international trade flows by Tinbergen (1946) as an alternative to straightforward estimation of conventional demand equations.

In terms of utility analysis, the elasticity is rigorously defined with respect to movement along single consumer indifference curve.[5] The value of this elasticity will depend on the particular indifference curve that is selected, as well as on the relative prices. Therefore it is necessary to impose the assumption that there be equal proportional responses of the quantities of each good to changes in the levels of all other variables, mainly income and the prices of other goods. At the same time this assumes that the two goods are not identical, since if they were, the indifference curves would be straight lines and the analysis would be insignificant. The two goods are dissimilar enough to induce the purchase of some of both.

In terms of a conventional demand analysis framework, consider the elasticity of substitution in the context of one country's demand for imports relative to domestic substitutes. The demands for imports and domestic substitutes can be represented by the following log-linear estimation

(2) $\ln M = \alpha_0 + \alpha_1 \ln Y + \alpha_2 \ln P_M + \alpha_3 \ln P_D + \alpha_4 \ln P$

(3) $\ln D = \beta_0 + \beta_1 \ln Y + \beta_2 \ln P_M + \beta_3 \ln P_D + \beta_4 \ln P$

where M and D refer to the quantity of imports and quantity of competing domestic production sold in New Zealand. Their respective prices are given by the variables P_M and P_D. Y is money income and P is the price of all other goods.[6] Orcutt (1950) has cautioned against estimating (2) and (3) directly in view of the strong possibility of simultaneity bias.

In relative form, the demand relationships can be represented by

(4) $\ln(M/D) = a_0 + a_1 \ln Y + a_2 \ln P_M + a_3 \ln P_D + a_4 \ln P$

[5] See Leamer and Stern (1970).

[6] This procedure, which has been widely used in previous research, implies that imports from all sources can be treated as aggregate, and that the exchange rate and the foreign goods price (jointly captured by P_M) have the same effects on demand.

where $a_j = \alpha_j - \beta_j$.

The assumption frequently made in consumer demand theory is that consumers exhibit no money illusion. This leads to the homogeneity condition: $\alpha_1 + \alpha_2 + \alpha_3 + \alpha_4 = 0$ and $\beta_1 + \beta_2 + \beta_3 + \beta_4 = 0$. [7] Under this condition equation (4), by the assumption that : $a_1 + a_2 + a_3 + a_4 = 0$, reduces to:

(5) $\ln(M/D) = a_0 + a_1\ln(Y/P) + a_2\ln(P_M/P) + a_3\ln(P_D/P)$

A separate restriction is the assumption of constant elasticity of substitution (CES) between similar goods categories. This implies the joint condition that $\alpha_2 = -\alpha_3$ and $\beta_2 = -\beta_3$. In terms of (4), $a_2 = -a_3$, the specification is

(6) $\ln(M/D) = a_0 + a_1\ln Y + a_3\ln(P_D/P_M) + a_4\ln P$

where a_3 becomes the elasticity of substitution, anticipated to be positive.
When both the homogeneity condition and the CES assumption are applied simultaneously, (4) reduces to

(7) $\ln(M/D) = a_0 + a_1\ln Y + a_3\ln(P_D/P_M)$

The most popular way of estimating the elasticity of substitution involves the additional restriction, that income expansion paths for both imports and domestic substitutes are identical. With reference to (7), $a_1 = 0$ (or $\alpha_1 = \beta_1$), this yields

(8) $\ln(M/D) = a_0 + a_3\ln(P_D/P_M)$

This is very restrictive, especially in the context of international trade, for it implies that importers' shares of particular markets would not change except through price changes. Intuitively, this restriction is probably the most likely to be violated, especially for consumer goods. Athukorala and Menon (1995) found, however, that the homotheticity assumption on the activity (income) elasticity is met for the majority of imports, as well as for total manufactured imports, which vindicates the use of equation (8), and suggests that Armington elasticities can be used in applied general equilibrium models.

Over the years the concept of elasticity of substitution has been subject to a large number of theoretical criticisms, the most powerful being the constraints on conventional demand functions which must be assumed to arrive at equation (8). This objection has been confronted by directly testing the validity of the constraints imposed on more general demand specifications in several papers including Mutti (1977), Richardson (1973) and Lachler (1985). The results do not lend strong support to fears that the CES constraint might be unduly restrictive, and it is concluded that despite the rigidity of the theoretical assumptions underlying the conceptual validity of the elasticity of substitution, these assumptions do in fact come close to being borne out.

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[7] This makes the demand function homogenous of degree zero so that doubling all prices and money income will not change the quantities demanded.

Another objection is the relevance of the 'elasticities' approach based on imperfect substitutability between imports and domestic substitutes. It is argued that national origin should not be a significant argument in preference functions. If domestic and foreign goods were perfect substitutes, either the domestic or foreign good would swallow up the whole market and each country would be an exporter or importer of a traded good both not both. However there is the coexistence of imports and domestic output, and two-way trade.

Also there are significant price differences for the 'same' product in different countries, as well as between the domestic and export prices of a given product in the same country. The 'law of one price' does not hold across or within countries, except maybe for standard commodities that are sold on international commodity exchanges.[8] Perfect arbitrage is rejected by several papers, including Richardson (1978) and Lachler (1985), and this implies that domestically produced commodity bundles and the corresponding imports as aggregated are regarded as imperfect substitutes even though they are classified under the same heading.

An additional strong criticism is that supply relations are ignored. The bulk of the time-series work on import and export equations has addressed the supply side only by assumption. It is assumed that supply is infinitely elastic. This permits the estimation of demand equations by single equation methods. Leamer and Stern (1970) argue that the problem is less serious for estimates of the elasticity of substitution than it is for estimates of direct price elasticities, because shifts in the importer's demand function are likely to affect both the numerator and denominator of the price variable (P_1/P_2) in the same direction, making it unclear that the ratio is substantially affected. As well as this assumption, the small country assumption is applied in this paper i.e. the world price is not affected by New Zealand import demand; the import price is assumed to be exogenous.

In recent years, some related work has been done in this area which is based on dynamic theoretical foundations, focusing on short run behaviour e.g. Alaouze (1976,1977). In this paper, the long run elasticities of substitution are derived. This appears preferable for the model used here, as it relies on a more traditional, static conceptualisation and in any case are intended primarily for use in comparative static simulation work.[9] Also, because quarterly data are being used, it may be desirable to employ dummy variables to reflect the seasonal variation in the relationship.

3.2 *The Armington Model*

Elasticity of substitution features as an important parameter in Armington's (1969) trade model. His formulation is an advance over models in which the elasticity of substitution is implicitly assumed to be either zero or infinity as it permits imperfect substitution.

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[8] See Goldstein and Khan (1985).

[9] For a detailed discussion on time dimension, see Leamer and Stern (1970).

This model explains international trade flows more elaborately than other models, as imports are disaggregated by type of commodity and by country of origin and destination. The Armington model assumes all commodities are distinguished by kind and by place of production.[10] Types of commodities (called 'goods') correspond to rather broad commodity classifications, such as non tradeables, manufactures, raw materials, etc. Goods produced by different countries are called 'products'. So for the tradeable goods a purchaser distinguishes among sources of supply so that, for example, German and Japanese manufactures are the same goods but are different products. Products are assumed to be imperfect substitutes.

The import demand for a product is determined by two stage budgeting. In the first stage, the consumer determines his demand for the goods family to which a product belongs on the basis of his income, the good's price and the price of other goods. In the second stage, he determines his demand for that product on the basis of his overall demand for that good and the ratio of the product's price to the weighted average of the prices of other products in that same goods family. By assuming that the elasticities of substitution between all pairs of products in the same goods family are identical and constant in any market, Armington is able to write the following function as

$$(9) \quad I_{1ij}/I_{1j} = b_{ij}^{\sigma_{ij}} (P_{1ij}/P_{1i})^{-\sigma_{ij}}$$

where I_{1ij} is the quantity of imports demanded in a country I of good 1 exported by country j (that is of product ij), I_{1j} is the quantity of good 1 demanded in country I from all sources of supply, b_{ij} is the base period quantity share of country j in total imports of good 1 by country I, P_{ij} is the price of product ij, P_{1i} is the price of good 1 in country I (equal to a weighted average of product prices within good 1), and σ_{ij} is the elasticity of substitution for product ij. Equation (9) expresses the market share as the dependent variable.

The Armington methodology is appealing because it is an extremely economical and consistent method for estimation and the methodology itself is quite flexible. It is clear, however, that the Armington model is not without problems. Armington initially assumed demand to be separable over goods but not over suppliers. Then, requiring a precise justification of two stage budgeting and also a tractable allocation model, he made his groups homothetic, but by adopting a CES specification, he also made them separable over all pairs of sources. Hence, the separability of domestic and foreign suppliers essentially slipped in by the back door, the consequence of a particular simplifying assumption in the specification of the group 'sub-utility' functions, rather than as a necessary consequence of two-stage budgeting. Therefore choosing the right level of aggregation for the goods categories is very important, because if they are too narrowly defined, the separability assumption is likely to be violated. In this paper it is assumed that the mixture of goods in consumption are weakly separable. Also if the aggregation for the goods categories are very broadly defined, the assumptions

[10] The desription of the Armington model follows Armington (1969), Branson (1972) and Goldstein and Khan (1985).

governing estimates of the elasticity of substitution (i.e. identical income elasticities) are likely to be violated.[11]

The modelling approach in this paper is a variation on Armington (1969), Shiells, Stern and Deardorff (1986) and Reinert and Roland-Holst (1990). Consumers are assumed to maximise utility subject to their budget constraint. The utility function is assumed to be weakly separable between goods in different industry groups so the allocation of expenditure to goods within an industry group is made conditional upon the level of spending on this group.

Assuming continuous possibilities between imported and domestic goods in comparable industry groups, the consumer derives utility from a mixture (Z) of imported (M) and domestic (D) goods. Assuming the consumers subutility function for an industry group takes a CES functional form the specification is

$$(10) \quad Z = \alpha[\beta M^{(\sigma-1)/\sigma} + (1-\beta)D^{(\sigma-1)/\sigma}]^{\sigma/(\sigma-1)}$$

where α and β are calibrated parameters and σ is the elasticity of substitution between imports and domestic goods. The solution to the consumers' optimisation problem will then be to choose imports and domestic goods whose ratio satisfies the first-order condition

$$(11) \quad M/D = [(\beta/(1-\beta))\,(P_D/P_M)]^{\sigma}$$

which is the familiar equivalence between rates of substitution and relative prices. Armington elasticities can then be estimated for disaggregated commodity categories.

4. Specification and Estimation of the Model

4.1 *Model*

The demand for imports relative to domestic substitutes in each category is hypothesised to depend upon its own price relative to the price of the domestically produced good. The general form of the demand function is:

$$(12) \quad RM_t = f(RP_t) \qquad f_1 > 0$$

where RM = (M/D) - relative imports - derived by dividing the imports in real terms (M) by the domestic sales of domestic goods in real terms; and RP = (P_D/P_M) - relative price - derived by dividing the price of the domestically produced good (P_D) by the import price (P_M). The sign indicated for the partial derivative is that customarily assumed in the literature.[12]

[11] See Winters (1984) for a decussion on separability.

[12] See Goldstein and Khan (1985) for a survey of the related literature.

The constant elasticity of substitution (CES) specification, a log-linear functional form, is used because it results in estimated elasticities that are constant and therefore allows direct estimation of the desired elasticities. Assuming a CES functional form and the restrictions from the previous section, the demand relationship can be represented by:

$$(13) \quad log(\mathrm{RM})_{it} = b_0 + b_1 log(\mathrm{RP})_{it} + u_{it}$$

where b_0 is the constant term, b_1 (= σ) is the elasticity of substitution (the Armington elasticity), *log* denotes the variables measured in natural logarithms, u_{it} is the stochastic disturbance term, and the subscript *I* and *t* refer to commodity category and time, respectively. It is assumed that the elasticity of substitution will be positive as this means the two goods, the imported good and the domestically produced good, are competing or substitute products.

The relative price will identify the demand effects on imports and domestically produced goods. An increase (decrease) in RP, either through a rise (fall) in domestic prices or a fall (rise) in import prices, will result in an increase (decrease) in the import share of the domestic market as the imports become relatively less (more) expensive. As such, RP is expected to carry a positive coefficient, the elasticity of substitution.

Since unadjusted quarterly data are used, it is appropriate to include dummy variables to reflect seasonal movements not captured by the explanatory variable, RP. The seasonal variables have been defined in such a way that they sum to zero over each full year.

$$D_1 = \begin{bmatrix} 1 \\ 0 \\ 0 \\ -1 \\ . \\ . \end{bmatrix} D_2 = \begin{bmatrix} 0 \\ 1 \\ 0 \\ -1 \\ . \\ . \end{bmatrix} D_3 = \begin{bmatrix} 0 \\ 0 \\ 1 \\ -1 \\ . \\ . \end{bmatrix}$$

The restriction is imposed on the coefficients of the dummy variables to avoid the dummy trap. Caution has to be taken using dummy variables as the regression may remove too much variation from the original series, attributing some of it incorrectly to variation in the seasonal dummy variables. If the seasonal pattern has been constant over time, so that three seasonal dummies adequately account for the effects of seasonality, this approach should be appropriate. Secondly, if there is an upward trend in the series being adjusted, the regression will incorrectly attribute some of the trend to the seasonal dummies. If a trend is present, this can be interpreted as representing a certain definite factor or factors that influence the coefficients but are not measurable. For example, there may be quality changes due to technical progress. One obvious solution is to add a trend term to the regression as it may provide a good approximation of some actual pattern of changing trend. But trend analysis is only a crude attempt to summarise a general movement, and when included in this model, the trend term did not improve the estimates. The term 'trend' is an indirect way of accounting for factors that change over time, and it would certainly be preferable if these factors could be identified and measured.

Over the data period, certain commodities were subject to quantitative restrictions. Under certain conditions these can lead to biases in econometric estimates of demand functions i.e. if quotas are binding, then significant variation in prices but not quantities could be expected, causing downward bias in the elasticity of substitution. Dummies were not required for the quantitative restrictions as tariffs and quotas were not included in the import indexes and, therefore, only had an indirect influence on the import price indexes.[13]

As this is a static model in which there are no lagged endogenous variables, the only modification is that the model is supplemented with quarterly dummy variables to reflect the seasonal variation in the relationship. With this change, the estimating equation is given by:

$$(14) \quad \log(RM)_{it} = b_0 + b_1\log(RP)_{it} + b_2D_1 + b_3D_2 + b_4D_3 + u_{it}$$

where D_1, D_2 and D_3 are the dummy variables for quarters 1,2 and 3 respectively.

4.2 *Data*

The estimation of the elasticities of substitution requires data on both import prices and the prices of the corresponding domestic goods, and both real imports and real domestic sales of domestic goods. The choice of disaggregation and the starting point of the sample period is dictated by the availability of comparable data on all relevant variables. Choosing the right level of aggregation for the goods categories, as mentioned previously, is very important, and, therefore, the original aim of this paper was to estimate elasticities of substitution between imported and domestically produced goods at a level of disaggregation similar to that used in the *Orani* model i.e. 112 sectors. Disaggregation at this fine level would have been preferred, but a number of problems arose concerning the quality and availability of data. The presentation of the New Zealand trade statistics (export and import data) was in the Standard International Trade Classification (SITC) format, but this was changed on 1 January 1988, where the Harmonised System (HS) was adopted for classifying trade statistics. For a price, trade statistics data are available in a 10 digit HS format, but the range of published index series available free was revised. They were limited to approximately 50 index groupings which included Broad Economic Categories (BEC). As well, several data series do not exist, and therefore data on prices of domestic goods and real domestic sales of domestic goods was limited to proxies obtainable from published sources. The cost of obtaining data elsewhere was prohibitive.

The import price and volume indexes, and the export price, value and volume indexes are all at the same level of disaggregation. The data used for the domestic price indexes and domestic sales of domestic goods have a slightly different classification, however, the majority of the sectors were similar enough to allow some comparability

[13] As quantitative restrictions are not included in the prices and there is no variable representing quantitative restrictions, the effect of removing them due to liberalisation will not show up in the estimated results. See Section 4 which discusses data problems.

and were matched up accordingly. This situation is far from ideal, but data series were assembled for 12 sectors at the industry level, the majority of which were manufacturing industries. Included are the manufacture of food and beverages, textiles, clothing and footwear, wood and manufacture of wood products, paper, manufacture of paper products and printing, manufacture of chemicals, plastics and rubber, manufacture of non metallic mineral products, basic metals industries, manufacture of machinery and other metal products, other manufacturing, communication, financing and insurance services, and all manufacturing groups. Using quarterly data for the period 1982Q3 to 1994Q2, the series are expressed on base: September quarter 1982 (=100).

Indexes of the price of imports, appropriated from the range of published index series provided by *Statistics New Zealand* on request, are used in calculating the variable, RP. One of the statistical difficulties associated with the use of a relative price measure revolves around the way in which import prices are usually calculated in practice. The data used in the import indexes are not obtained by directly surveying prices from importers. What is available are import unit value type indexes which are based on estimates of import prices obtained by dividing the value of a particular class of imports by a corresponding measure of the quantity imported. As seen from the work of Kravis and Lipsey (1971,1974) in particular, unit values are a poor proxy for prices. Where there is a mix of goods imported under an HS item code, and the mix differs from quarter to quarter, this change in mix can have an effect on the derived unit value. Even if the mix does not change, and prices of competitive items remain constant, the overall index can change if the importance or 'weights' of one or more component items change. Also, components of recorded unit value movements due to quality changes cannot be generally identified, or separated, from those due to 'pure' price changes, and while a true price index refers to prices prevailing at time of contract, unit values are not calculated until the goods have actually been delivered. The import indexes use NZ dollar cost, insurance and freight (c.i.f.) values. Import c.i.f. values represent the costs of importers buying goods and bringing them to NZ ports of entry. Import price indexes are not directly affected by changes in the rates of duty payable on imported goods, as c.i.f. values do not include duty. Therefore, the phased reduction in tariffs and quotas that has occurred in recent years has not had a direct downward influence on the import price indexes. To bring the P_M series and the P_D series on to a comparable basis, it would be ideal to multiply the P_M series by $(1 + \theta)$ where θ is the nominal protection coefficient which incorporates the quantitative restrictions, however data was not available for nominal protection rates.[14] There are also costs associated with middlemen (wholesalers and retailers), indirect taxes, and further processing, all of which may affect final retail prices. For purposes of estimation, actual import prices which incorporated associated charges and costs would have been preferred, but such data are not available. The indexes of the price of imports are converted from base: June quarter 1989 (=1000) to base: September quarter 1982 (=100).

[14] See Menon (1995) for example of this method. Data for nominal protection rates was not available from *Statistics New Zealand* or *The Reserve Bank of New Zealand*, and because of time and bureaucratic constraints data could not be obtained from other sources. This data is available, however, and when the model is re-estimated, nominal protection rates will be included in the P_M series.

The quantity and price variables are not raw observations but rather index numbers made necessary by the aggregation over commodities.[15] Indexes of the quantity of imports obtained from *Statistics New Zealand* are chained indexes based on the Fisher formula and derived from the quantity of imports entering New Zealand rather than the usual value terms. The indexes of the quantity of imports are converted from base: June quarter 1989 (=1000) to base: September quarter 1982 (=100). These indexes are used in calculating the variable RM.

The variable P_D in this model has no observable counterpart. As an estimate, producer price indexes were used as a proxy for the prices of domestic goods. These were obtained from *Statistics New Zealand* at the industry level which were derived from prices of outputs by industry groups. It is assumed that these prices do not include discounts, rebates or indirect taxes, and, therefore, do not reflect the level of prices at retail level. The producer price indexes are converted from base: December quarter 1982 (=1000) to base: September quarter 1982 (=100).

According to both *Statistics New Zealand* and *The Reserve Bank of New Zealand*, there are no domestic output series for New Zealand, not even an index of industrial production.[16] On account of this, a proxy was required for the domestic sales of domestic goods. The core data for the development of a domestic output series are *Statistic New Zealand's* Gross Domestic Product by industry group at constant 1982-83 prices. The contribution of each producer to gross domestic product is measured by the value which it adds in producing goods and services. It is calculated as the gross output of goods and services less the value of goods and services used up in production. This data provides a base for a series of domestic production. However to estimate the equation, data on domestic sales of domestic goods is required, that is, domestic production less exports. To do this, the export price indexes were converted from base: June quarter 1989 (=1000) to base: September quarter 1982 (=1). Next the export values where divided by this new price index to acquire exports at constant prices. Finally this new export series was subtracted from the gross domestic product to obtain a proxy for series of real domestic sales.

As there are improvements being made to the data available from *Statistics New Zealand*, it is hoped that early next year, import and export values, volumes and prices, manufacturing production and producer price series will be available on a more comparable basis.

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[15] See Leamer and Stern (1970) for a detailed discussion on index numbers and the problem of aggregation.

[16] After this notice was recieved, contrary to expectations, a domestic output index series was to be made available by *Statistics New Zealand* at a reduced cost, but this offer was subsequently withdrawn for no apparent reason.

4.3 *Estimation Procedure*

The estimation process was begun by estimating equation (14) using Ordinary Least Squares (OLS). The initial regression runs indicated the presence of first order autocorrelation in six of the twelve equations. The presence of autocorrelation in half of the equations suggests that a problem or several problems may exist. Autocorrelation may have occurred because of either a specification error in the model, an omission of relevant explanatory variables, interpolation in the statistical observations, lagged effects of temporary shocks distributed over a number of periods, or that the data does not satisfy the restrictions imposed by the functional form. Given that the CES equation imposes severe restrictions on the data, the latter explanation seems more plausible. If autocorrelation is found, it is suggested that it be corrected by appropriately transforming the model so that in the transformed model there is no autocorrelation. It was decided, however, in the view of recent advances in time series econometrics, to test the time series of the data first. It is common for time series variables to demonstrate signs of non-stationarity, i.e. the mean and the covariances are time-dependent. This means that both the conditional mean and variances of macroeconomic variables trend upwards over time. It is useful to test explicitly for manifestations of non-stationarity, both as a first step in exploring the characteristics of the data, and because the presence of such non-stationarity has important econometric implications. When a non-stationary economic time series is regressed on another one, spurious regressions can result, i.e. the least squares regression can produce artificial and misleading results.[17] To determine if a time series is stationary or not, a simple 'unit root' test is performed. A root that is equal to one in absolute terms is called a unit root. When a process has a unit root, it is said to be integrated of order one or $I(1)$. A series that is $I(1)$ must be differenced once to make it stationary. The simplest and most widely used tests for unit roots were developed by Fuller (1976) and Dickey and Fuller (1979). Testing the order of integration using Augmented Dickey-Fuller (ADF)[18] and the Phillips and Perron (PP)[19] tests the hypothesis of a unit root for any of the variables under analysis could not be rejected. The test results indicated that RM and RP are non-stationary.

The foregoing results would seem to suggest analysis of the differences to obtain estimates of the parameters. However, to study the long-run relationships between variables it is important to consider their levels rather than their differences. The link between nonstationary processes and the concept of long-run equilibrium is called cointegration and was introduced by Granger (1981). If two or more variables are cointegrated, they must obey an equilibrium relationship in the long run, although they may diverge substantially from equilibrium in the short run. It is possible for two or more variables to be $I(1)$ and yet for certain linear combinations of those variables to be $I(0)$. This means the error term is stationary with mean 0. In this case, it is said that the least squares estimator works better, in that it converges to the true parameter value faster than usual i.e. 'superconsistent'.

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[17] See Granger and Newbold (1974) for a detailed discussion.

[18] See Dickey and Fuller (1981). As the error terms display serial correlation, ADF tests are used because they are (asymptotically) valid in the presence of serial correlation.

[19] See Phillips and Perron (1988)

To test for long-run equilibrium relationship between RM and RP, a modified Dickey-Fuller unit root test suggested by Engle and Granger (1987) is used to test whether or not the residuals are stationary. The results indicate cointegrating relationships between non-stationary series are formed for only six of the twelve sectors - the same six sectors in which no autocorrelation was found.[20] This is the first step of the Engle-Granger two-step method originally suggested by Engle and Granger (1987), in which equation (14) is estimated by OLS and tested for stationary of the residuals. The long run equilibrium relationship has been modelled by a straightforward regression involving the levels of the variables, dynamics ignored, and yields an OLS estimator which is 'superconsistent'. However there is a good deal of evidence that it often does not work very well in finite samples. The problem is that b_1 seems to be severely biased. This bias then causes the parameters to be biased as well. Therefore, t statistics cannot be used to draw inference about the significance of parameters on the non-stationary terms in a regression; standard t statistics are not valid asymptotically. Because the Engle -Granger test procedure suffers from a number of problems, employing one of the numerous cointegration tests might achieve better results. References include Johansen (1988,1991), Johansen and Juselius (1990), Stock and Watson (1988) and Phillips and Ouliaris (1990). Campbell and Perron (1991) provide an overview of several of these tests, which are harder to estimate than the residual based ones. In small samples, however, the bias in the cointegration tests can be substantial because the long-run properties of the data may only be weakly reflected, despite long-run relations being embodied in the level variables.[21]

Rather than simply ignore the long run relations embodied in the level variables in the six equations that did not form cointegrating vectors, a general to specific modeling procedure was employed to estimate relationships for all twelve categories. This approach does not have universal support, however, it minimises the possibility of estimating spurious relationships while retaining long run information. The estimating equation is in the form of an error correction model (ECM) which has both static and stable equilibrium solutions.[22] This modelling approach in this paper is a variation on Athukorala and Menon (1995). The demand relationship can be represented by

$$(15) \quad log(\mathrm{RM})_t = \alpha + \sum \beta_j \, log(\mathrm{RP})_{t-j} + \sum \gamma_j \, log(\mathrm{RM})_{t-j} + u_t$$

where α is the constant, u is the error term and the variables are measured in natural logarithms. This unrestricted equation was estimated using OLS and then progressively simplified by restricting statistically insignificant coefficients to zero and transforming the lag patterns in terms of levels and differences. The length of the lags is set at four periods to allow for seasonality in the data series. The long run elasticity of substitution is derived by dividing the rp level coefficient by the rm level coefficient and a simple t test is performed to see whether the elasticity is statistically significant.[23] Given the amount of 'data mining' taking place, the final 'preferred' equation was

[20] A good sign that cointegrating vectors exist is if the DW statistics are greater than one, Sargan and Bhargava (1983). Also,as this test is a residual based cointegration test, asymptotic critical values may be seriously misleading.

[21] See Harvey (1990), p.256.

[22] See Cuthbertson, Hall and Taylor (1992) for a detailed discussion.

[23] See Charemza and Deadman (1993) for more details.

subjected to a number of diagnostic checks to obtain some idea of the general adequacy of the specification.

5. Results

5.1 *Analysis and Interpretation*

The results of the unit root tests for the twelve industry categories are presented in Table 4. These results clearly indicate that all of the series are nonstationary. Unit root tests on first differences were also performed and the results indicate that most of the economic time series in first differences are stationary. Those integrated variables that were not stationary after first differences had to be differenced again to make them stationary. The results indicate, that at the $I(2)$ level of integration, those variables that were not stationary after first differences, are stationary.

Table 4
Results of Unit Root Tests

Category	Levels (ADF)		Differences (ADF)	
Food and Beverages	RM	-0.50317	ΔRM	-3.4559***
	RP	-1.01416	ΔRP	-5.2330***
Textiles, Clothing and Footwear	RM	-0.86980	ΔRM	-3.4732***
	RP	-1.65301	ΔRP	-4.1804***
Wood and Wood Products	RM	-1.82542	Δ^2RP	-3.5174***
	RP	-1.37905	ΔRM	-3.4281**
Paper and Paper Products	RM	-0.27594	ΔRM	-3.6040***
	RP	-0.72235	ΔRP	-5.3542***
Chemicals and Plastics	RM	-0.93997	ΔRM	-3.4688***
	RP	-0.52646	ΔRP	-3.0187**
Non Metallic Mineral Products	RP	-1.05774	Δ^2RM	-2.8903**
	RM	-2.38499	ΔRP	-4.7025***
Basic Metals	RM	-1.34678	ΔRM	-3.3138**
	RP	-1.94974	ΔRP	-4.0280***
Machinery and Metal Products	RM	-1.20668	ΔRM	-4.0707***
	RP	-0.01295	ΔRP	-3.4678***
Other Manufacturing	RM	-0.53617	Δ^2RM	-3.4172***
	RP	-1.37296	Δ^2RP	-4.2167***
Communication	RM	-1.54053	ΔRM	-3.0145**
	RP	-2.18042	ΔRP	-2.8412*
Insurance and Finance	RM	-0.92141	Δ^2RM	-5.6219***
	RP	-1.83918	Δ^2RP	-2.9348**
All Manufacturing Groups	RM	-0.50979	Δ^2RM	-3.6493***
	RP	-0.84991	Δ^2RP	-2.7836*

Notes:
Δ is the first difference operator and Δ^2 is the second difference operator. The significance levels for ADF tests were determined using the critical values reported in Mackinnon (1991). Critical values are: 10% = -2.57 (*), 5% = -2.86 (**) and 1% = -3.43 (***).

The results of the cointegration tests are presented in Table 5. If the test statistic is smaller than the critical value then there is evidence of cointegration. Cointegrating vectors were found for the following six industry categories: manufacture of food and beverages, textiles, clothing and footwear, paper, manufacture of paper products and printing, manufacture of chemicals, plastics and rubber, basic metals industries, and manufacture of machinery and other metal products.

Table 5
Results of Cointegration Tests

Category	
Food and Beverages	-3.6184**
Textiles, Clothing and Footwear	-3.1214*
Wood and Wood Products	-2.7661
Paper and Paper Products	-4.4631***
Chemicals and Plastics	-3.5841**
Non Metallic Mineral Products	-2.7082
Basic Metals	-3.7661**
Machinery and Metal Products	-3.3654**
Other Manufacturing	-2.1698
Communication	-0.9214
Insurance and Finance	-1.1571
All Manufacturing Groups	-3.0232

Notes:
The significance levels for the cointegration tests were determined using the critical values reported in Greene (1993), which were obtained by methods similar to those used in Mackinnon (1991). Critical values are: 10% = -3.04 (*), 5% = -3.34 (**) and 1% = -3.90 (***).

The substitution elasticities that resulted from estimating equation (14) are presented in Table 6. The full regression results for equation (14) are listed in Appendix 1. The model was estimated using OLS, and each of the equations was estimated with and without seasonal dummies, and with and without a trend term. The results listed in Appendix 1 are from those equations with seasonal dummies and without a trend term. These are the six equations which formed cointegrating vectors, and had a favourable combination of explanatory power, Durbin-Watson (DW) statistic and significant parameters. The expected sign of the estimated parameter, elasticity of substitution, was known, so only one tail of the t-distribution was used in testing their significance. The two tailed test was used in testing the significance of the seasonal dummies.

The results in Table 6 show that the six categories of imports have substitution elasticity estimates that are greater than one and are statistically significant (at the 1% level) with the expected signs. The elasticity estimates range from a high value of 3.5340 for textiles, clothing and footwear to a low value of 1.6496 for food and beverages. This implies, among other things, that commodities at this level of aggregation are far from perfect substitutes. For example, the elasticity of substitution for food and beverages means that if the relative price increases by 1%, the import share of the domestic market will increase by 1.64% as imports become relatively less expensive. The results show that the above industries in the domestic market are reasonably sensitive to imported goods. Even though the industry categories are defined at a low level of disaggregation, the results do show there is some variation between industries in their sensitivity to import competition. The Durbin Watson statistics indicate there is significant first order autocorrelation at the 5% level for food and beverages, but lies in the inconclusive range at the 1% level, and that both textiles, clothing and footwear, and chemicals and plastics fall into the inconclusive zone at the 5% level. There is no significant first order autocorrelation for paper and paper products, basic metals or machinery and metal products.[24]

Table 6
Estimates of Elasticity of Substitution (equation 14)

Category	σ
Food and Beverages	1.6496 (16.15)***
Textiles, Clothing and Footwear	3.5340 (14.52)***
Paper and Paper Products	1.8635 (5.105)***
Chemicals and Plastics	2.4889 (13.08)***
Basic Metals	2.5322 (7.191)***
Machinery and Metal Products	2.4194 (0.214)***

Notes:
σ (= b_1) is the elasticity of substitution. The figures in the parentheses are the estimated t values. Critical values (DOF = 43, one tailed test) for elasticity of substitution are: 10% = 1.303 (*), 5% = 1.684 (**) and 1% = 2.423 (***).

A certain degree of caution needs to be exercised in interpreting these results, for several reasons.. Firstly, it is very hard to draw conclusions from the estimated parameters as commodities with dissimilar economic production and retailing characteristics are aggregated. Secondly, as mentioned above, it is clear that regressing the levels of a series which is $I(1)$ on the levels of one or more other series which are also $I(1)$ is generally not a good thing to do. At best, the elements of some cointegrating vector maybe consistently estimated, but standard asymptotic theory will not apply to the estimates, and incorrect inferences about the parameters may be made.

The long run elasticities derived from the estimated ECM are summarised in Table 7. The ECM regression results for the twelve industry categories together with a set of commonly used diagnostic statistics for each equation are listed in Appendix 2. The first four observations of each series were lost because of lags in equation (15). The specification search therefore took place using data for 1983Q3 to 1994Q2, a total of 44 observations. OLS was used for estimation purposes.

[24] The industry categories basic metals and machinery and metal products did not have statistically significant seasonal dummy variable estimates, and one seasonal dummy variable was insignificant for food. In most cases the addition of seasonal dummies was warranted.

The results in Table 7 show that all categories as well as all manufacturing groups have substitution elasticity estimates that are statistically significant (at the one percent level) with the expected sign. The statistically significant substitution elasticity estimates range from a high value of 3.8236 for basic metal industries to a low of 1.6767 for wood and wood products.

Table 7
Estimates of Elasticity of Substitution (ECM)

Category	σ
Food and Beverages	1.9111 (7.258)
Textiles, Clothing and Footwear	3.2463 (5.445)
Wood and Wood Products	1.6767 (2.391)
Paper and Paper Products	2.1412 (2.280)
Chemicals and Plastics	2.3874 (3.555)
Non Metallic Mineral Products	2.4528 (3.911)
Basic Metals	3.8236 (2.088)
Machinery and Metal Products	2.4563 (3.665)
Other Manufacturing	1.8233 (3.110)
Communication	2.3345 (3.067)
Insurance and Finance	1.4643 (1.903)
All Manufacturing Groups	2.8854 (3.899)

Notes:
σ (= b_1) is the elasticity of substitution. The figures in the parentheses are the estimated t values.

Even though industries such as food and beverages and wood and wood products are expected to have relatively undifferentiated commodities, the lower elasticity estimates suggest that only a small amount of imported commodities in these industries are competitive. Most of the commodities that are produced domestically are sufficiently differentiated and therefore less sensitive to imports.

The results show that industries such as machinery and metal products, and non metallic minerals have reasonably high elasticities of substitution even though the overwhelming share of imports in these categories are inputs to domestic production for which there are no close substitutes.

How competitive each import is in each industry would have to be known before a thorough analysis can be made of the results. Even though the data is limited, this is an area for further work. Even though commodities with dissimilar economic production and retailing characteristics are aggregated, it can be seen that all industries are sensitive to imports, some more than others.

Also, as there has been wide scale liberalisation since 1984, it is likely that the currently equations are strongly influenced by the distortionary measures of the post 1984 period. The extension of the data period back to 1970 would allow the use of more observations obtained from the previously protected environment. This would significantly improve the forecasting performance of the equation and structural breaks in the behavioural relationships would be able to be identified much more easily.[25]

As regard market share dynamics, a comparison of long run substitution elasticities with respective short run elasticities (coefficients attached to the difference terms in Appendix 2) suggests that most of the relative price adjustments take place within a one year period.

Table 8
Comparison of Substitution Elasticities between Australia and New Zealand

New Zealand Category	σ equ.(14)	σ ECM	Australia Category	σ
Food and Beverages	1.6496	1.9111	Food Products	0.5
			Soft Drinks and Cordials	2.0
			Alcoholic Drinks	2.1
Textiles, Clothing and Footwear	3.5340	3.2463	Clothing	3.4
			Footwear	6.8
			Textile Products	2.4
Wood and Wood Products		1.6767	Sawmill Products	2.0
			Joinery and Wood Products	2.0
Paper and Paper Products	1.8635	2.1412	Paper Products	1.1
Chemicals and Plastics	2.4889	2.3874	Chemical Products	2.0
			Plastic Products	1.3
			Rubber Products	1.3
Non Metallic Mineral Products		2.4528	Non Metallic Minerals	1.3
Basic Metals	2.5322	3.8236	Basic Iron and Steel	0.5
			Other Basic Metals	0.5
Machinery and Metal Products	2.4194	2.4563	Machinery	0.5
			Metal Products	2.0
Other Manufacturing		1.8233	Other Manufacturing	1.2
Communication		2.3345	Communication	2.0
Insurance and Finance		1.4643	Finance and Life Insurance	2.0
All Manufacturing Groups		2.8854		

Notes:
σ is the elasticity of substitution. Domestic-import substitution elasticities for Australia obtained from Dixon, P.B. et al (1982), *ORANI: A Multi-Sectoral Model of the Australian Economy*, p. 185, Table 29.2.

[25] From the models estimated by Scott (1993), it was evident that a structural break occurred around 1984.

Given the various differences between the ORANI study and this study with regard to aspects such as model specification, level of disaggregation, and the data base, a tentative comparison is made between the elasticity of substitution estimates in Table 8. The estimates from equation (14) are very similar to the estimates from equation (15), which help to support the results from the ECM. Overall, compared with the *Orani* estimates for Australia, the New Zealand elasticity estimates were higher.

6. Conclusion

Estimates of the elasticity of substitution between imported and domestically produced goods classified at the industry level in New Zealand are presented in this paper.

The demand for imports and domestically produced goods was estimated using two procedures. The first of the estimating equations is based on the Engle-Granger two-step procedure, and the second estimating equation is based on the general to specific modelling procedure. The data used are quarterly and span the period 1982Q to 1994Q2. The estimating equations were fitted to the data using OLS methods.

The elasticity estimates for individual categories ranged from 1.6767 to 3.8236.The results indicate that the ratio of the consumption of imported to domestically produced goods is sensitive to changes in the ratio of domestic to import prices for a range of industries, with estimated elasticities of substitution clustering around two for most industries. The results also suggest that most of the relative price adjustments occur within a one year period. Overall, compared to the *Orani* estimates of substitution elasticities for Australia, the New Zealand elasticity estimates were higher.

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Appendix 1

Regession Results for Equation(14)

Food and Beverages

$$\log(RM)_k = \underset{\substack{(0.019)\\(-7.984)^{***}}}{-0.1589} + \underset{\substack{(0.102)\\(16.15)^{***}}}{1.6496\log(RP)_k} + \underset{\substack{(0.026)\\(8.948)^{***}}}{0.2391 D_1} + \underset{\substack{(0.026)\\(0.788)}}{0.0210 D_2} - \underset{\substack{(0.026)\\(-7.984)^{***}}}{0.1883 D_3}$$

$R^2 = 0.89$, DW = 1.2394

Textiles, Clothing and Footwear

$$\log(RM)_k = \underset{\substack{(0.234)\\(1.267)}}{0.2973} + \underset{\substack{(0.230)\\(14.52)^{***}}}{3.5340\log(RP)_k} + \underset{\substack{(0.013)\\(5.814)^{***}}}{0.0786 D_1} - \underset{\substack{(0.013)\\(-7.809)^{***}}}{0.1018 D_2} + \underset{\substack{(0.012)\\(2.980)^{***}}}{0.0386 D_3}$$

$R^2 = 0.93$, DW = 1.7180

Paper and Paper Products

$$\log(RM)_k = \underset{\substack{(0.038)\\(10.76)^{***}}}{0.4163} + \underset{\substack{(0.365)\\(5.105)^{***}}}{1.8635\log(RP)_k} + \underset{\substack{(0.023)\\(3.080)^{***}}}{0.0735 D_1} + \underset{\substack{(0.023)\\(1.947)^{*}}}{0.0458 D_2} - \underset{\substack{(0.023)\\(-3.212)^{***}}}{0.0758 D_3}$$

$R^2 = 0.78$, DW = 1.9888

Chemicals and Plastics

$$\log(RM)_k = \underset{\substack{(0.127)\\(1.600)}}{0.2033} + \underset{\substack{(0.190)\\(13.08)^{***}}}{2.4889\log(RP)_k} + \underset{\substack{(0.013)\\(5.582)^{***}}}{0.0728 D_1} - \underset{\substack{(0.012)\\(-4.441)^{***}}}{0.0576 D_2} - \underset{\substack{(0.012)\\(-3.833)^{***}}}{0.0493 D_3}$$

$R^2 = 0.60$, DW = 1.6765

Basic Metals

$$
\begin{array}{lllllllll}
\log(RM)_t & = & -0.3166 & + & 2.5322 \log(RP)_t & + & 0.0960\,D_1 & - & 0.1511\,D_2 & + & 0.0648\,D_3 \\
 & & (0.068) & & (0.352) & & (0.101) & & (0.101) & & (0.101) \\
 & & (-4.590)^{***} & & (7.191)^{***} & & (0.948) & & (-1.492) & & (0.6406)
\end{array}
$$

$R^2 = 0.46$, DW = 1.9765

Machinery and Metal Products

$$
\begin{array}{lllllllll}
\log(RM)_t & = & 0.2914 & + & 2.4194 \log(RP)_t & - & 0.0132\,D_1 & + & 0.0208\,D_2 & - & 0.0470\,D_3 \\
 & & (0.022) & & (0.214) & & (0.038) & & (0.038) & & (0.038) \\
 & & (12.74)^{***} & & (11.30)^{***} & & (-0.3464) & & (0.5432) & & (1.227)
\end{array}
$$

$R^2 = 0.75$, DW = 2.3069

Notes:
R^2 is the adjusted coefficient of determination and DW is the Durbin Watson statistic. Critical values (DOF = 43, one tailed test) for elasticity of substitution are: 10% = 1.303 (*), 5% = 1.684 (**) and 1% = 2.423 (***). Critical values (DOF = 43, two tailed test) for the coefficients of the seasonal dummy variables and the constant variable are: 10% = 1.684 (*), 5% = 2.021 (**) and 1% = 2.704 (***). The figures in the first set of parentheses are the estimated standard errors (se) of the regression coefficients and those in the second set of parentheses are the estimated t values. Durbin Watson critical values (n = 48, k' = 5) are: 5% level - d_L = 1.287 and d_U = 1.776, 1% level - d_L = 1.111 and d_U = 1.584.

Appendix 2

Regression Results for Equation (15)

Food and Beverages

$\Delta_4 rm_t$	=	-0.7552	+	$0.8900\ \Delta_2 rp_t$	+	$0.717\ rm_{t-4}$	+	$1.3712\ rp_{t-2}$	-	$0.1176\ \Delta rp_{t-1}$
		(0.261)		(0.218)		(0.109)		(0.188)		(0.033)
		$(-2.888)^{***}$		$(4.078)^{***}$		$(6.550)^{***}$		$(7.258)^{***}$		$(-3.534)^{***}$

R^2 = 0.7905, DW = 1.4146, ADF = -13.3057, RESET(4,32) = 0.69, LM(1,34) = 2.81, LM(4,31) = 2.68, ARCH(1) = 1.71, BP(4) = 8.14

Textiles, Clothing and Footwear

$\Delta_4 rm_t$	=	0.1081	+	$0.2923\ \Delta_2 rp_t$	+	$0.6771\ rm_{t-4}$	+	$2.1983\ rp_{t-2}$
		(0.024)		(0.163)		(0.218)		(0.403)
		$(4.356)^{***}$		$(1.789)^{*}$		$(3.093)^{***}$		$(5.445)^{***}$

R^2 = 0.8342, DW = 1.9382, ADF = -8.1179, RESET(4,33) = 2.68, LM(1,35) = 1.58, LM(4,32) = 0.75, ARCH(1) = 0.59, BP(4) = 2.86

Wood and Wood Products

$\Delta_4 rm_t$	=	0.1202	+	$0.9990\ \Delta_2 rp_t$	+	$0.4171\ rm_{t-4}$	+	$0.6994\ rp_{t-2}$
		(0.031)		(0.255)		(0.160)		(0.292)
		$(3.852)^{***}$		$(3.915)^{***}$		$(2.596)^{**}$		$(2.391)^{**}$

R^2 = 0.6409, DW = 1.0595, ADF = -7.6112, RESET(4,33) = 1.97, LM(1,35) = 2.97, LM(4,32) = 1.03, ARCH(1) = 0.17, BP(3) = 5.37

Paper and Paper Products

$\Delta_4 rm_t$	=	0.1239	+	$0.1288\ \Delta_2 rp_t$	+	$0.5580\ rm_{t-4}$	+	$1.1948\ rp_{t-3}$
		(0.053)		(0.035)		(0.132)		(0.523)
		$(2.309)^{**}$		$(3.649)^{***}$		$(4.223)^{***}$		$(2.280)^{**}$

R^2 = 0.8237, DW = 1.7611, ADF = -11.1581, RESET(4,33) = 1.92, LM(1,35) = 3.32, LM(4,32) = 1.67, ARCH(1) = 0.48, BP(3) = 2.13

Chemicals and Plastics

$$
\begin{array}{llllllllll}
\Delta_4 rm_t & = & 0.1423 & + & 0.6020\,\Delta rp_t & + & 0.3679\,rm_{t-4} & + & 0.8785\,rp_{t-1} & - & 0.1265\,\Delta rp_{t-1} \\
 & & (0.079) & & (0.223) & & (0.1604) & & (0.2471) & & (0.030) \\
 & & (1.797)^{*} & & (2.691)^{**} & & (2.294)^{**} & & (3.555)^{***} & & (-4.195)^{***}
\end{array}
$$

$R^2 = 0.4315$, DW = 1.4606, ADF = - 23.8742, RESET(4,32) = 0.33, LM(1,34) = 1.54, LM(4,31) = 0.52, ARCH(1) = 1.61, BP(4) = 6.78

Non Metallic Mineral Products

$$
\begin{array}{llllllll}
\Delta_4 rm_t & = & 0.2017 & + & 1.3257\,\Delta_2 rp_t & + & 0.5736\,rm_{t-4} & + & 1.4136\,rp_{t-2} \\
 & & (0.041) & & (0.354) & & (0.126) & & (0.361) \\
 & & (4.831)^{***} & & (3.738)^{***} & & (4.528)^{***} & & (3.911)^{***}
\end{array}
$$

$R^2 = 0.5915$, DW = 1.6989, ADF = -7.8208 RESET(4,33) = 1.54, LM(1,35) = 2.42, LM(4,32) = 1.83, ARCH(1) = 2.21, BP(3) = 4.11

Basic Metals

$$
\begin{array}{llllllll}
\Delta_4 rm_t & = & 1.7064 & + & 0.3266\,\Delta_2 rp_t & + & 0.3791\,rm_{t-4} & + & 1.4497\,rp_{t-2} \\
 & & (0.433) & & (0.113) & & (0.162) & & (0.694) \\
 & & (3.941)^{***} & & (2.867)^{***} & & (2.334)^{**} & & (2.088)^{**}
\end{array}
$$

$R^2 = 0.5766$, DW = 1.6401, ADF = -5.3729, RESET(4,33) = 1.11, LM(1,35) = 1.65, LM(4,32) = 2.13, ARCH(1) = 0.22, BP(3) = 5.66

Machinery and Metal Products

$$
\begin{array}{llllllll}
\Delta_4 rm_t & = & 0.2083 & + & 1.2909\,\Delta_2 rp_t & + & 0.5603\,rm_{t-4} & + & 1.376\,rp_{t-3} \\
 & & (0.038) & & (0.375) & & (0.131) & & (0.375) \\
 & & (5.440)^{***} & & (3.665)^{***} & & (4.252)^{***} & & (3.665)^{***}
\end{array}
$$

$R^2 = 0.8441$, DW = 1.6603, ADF = -6.0385, RESET(4,33) = 1.49, LM(1,35) = 2.36, LM(4,32) = 1.58, ARCH(1) = 1.37, BP(3) = 1.82

Other Manufacturing

$$
\begin{array}{llllll}
\Delta_4 rm_t & = & 0.4268 & + & 0.4534\,rm_{t-4} & + & 0.8268\,rp_{t-4} \\
 & & (0.172) & & (0.1171) & & (0.265) \\
 & & (2.470)^{**} & & (3.873)^{***} & & (3.110)^{***}
\end{array}
$$

$R^2 = 0.9457$, DW = 1.4882, ADF = -18.7561, RESET(4,34) = 1.36, LM(1,36) = 1.45, LM(4,33) = 1.61, ARCH(1) = 0.64, BP(2) = 3.44

Communication

$\Delta_4 rm_t$	=	-0.6128	+	$0.6641\ \Delta_2 rp_t$	+	$0.9603\ rm_{t-4}$	+	$2.2419\ rp_{t-2}$
		(0.120)		(0.1172)		(0.454)		(0.731)
		$(-5.071)^{***}$		$(5.666)^{***}$		$(2.111)^{**}$		$(3.067)^{***}$

R^2 = 0.7688, DW = 1.7850, ADF = -10.9176, RESET(4,33) = 1.84, LM(1,35) = 1.14, LM(4,32) = 1.63, ARCH(1) = 1.58, BP(3) = 5.05

Insurance and Finance

$\Delta_4 rm_t$	=	0.7748	+	$0.6130\ rm_{t-3}$	+	$0.8976\ rp_{t-4}$
		(0.3135)		(0.2194)		(0.4716)
		$(2.4720)^{**}$		$(2.793)^{***}$		$(1.903)^{*}$

R^2 = 0.6530, DW = 1.8007, ADF = -9.5708, RESET(4,34) = 1.96, LM(1,36) = 2.65, LM(4,33) = 1.01, ARCH(1) = 0.35, BP(3) = 3.23

All Manufacturing Groups

$\Delta_4 rm_t$	=	0.1823	+	$0.1983\ \Delta rp_t$	+	$0.9379\ rm_{t-4}$	+	$2.706\ rp_{t-2}$
		(0.066)		(0.094)		(0.2721)		(0.694)
		$(2.732)^{**}$		$(2.095)^{**}$		$(3.447)^{***}$		$(3.899)^{***}$

R^2 = 0.4965, DW = 1.3873, ADF = -11.0389, RESET(4,33) = 0.43, LM(1,35) = 3.42, LM(4,32) = 0.67, ARCH(1) = 0.23, BP(3) = 4.59

Notes:
The figures in the first set of parentheses are the estimated standard errors (se) of the regression coefficients and those in the second set of parentheses are the estimated t values, with the significance levels denoted as; *** = 1%, ** = 5%, * = 10%. R^2 is the adjusted coefficient of determination, DW is the Durbin Watson statistic, ADF is the Augmented Dickey-Fuller test for integration, RESET is Ramsey's Regression Specification Error Test for functional form misspecification using the square of the fitted values, LM is the Langrange Multiplier test for first and fourth order serial correlation, ARCH is the Langrange multiplier test for first-order autoregressive conditional heteroscedasticity, BP is the Breusch-Pagan heteroscedasticity test of residuals. Test statistics with two figures in brackets should be referred to the F distribution with indicated degrees of freedom, while those appearing with one figure should be referred to the chi-square distribution with the indicated degree of freedom.

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