3 PARAMETER SETTINGS

In addition to input-output, national accounts and assistance data, the SALTER model requires estimates of a number of behavioural parameters. These parameters describe cost minimising opportunities available to producers and utility maximising opportunities available to consumers in each modelled region.

The behavioural parameters required are listed and described in Table 3.1. This chapter provides the rationale behind the choice of values for these parameters.

As seen in Chapter 1, the length of the planning period may affect the choices available to producers and consumers. To allow for this, the SALTER model can be used in either a short-term (around 2 years) or a long-term (around 10 years) mode, and behavioural parameters for these alternative planning horizons are supplied. Little information is available on the relation between long- and short-run parameters, and estimates presented here are by necessity largely the result of synthetic procedures and value judgments.

Since a whole system is being modelled, it would be desirable to estimate a consistent set of parameters. However, this is impractical due to the large number of parameters to estimate and the lack of reliable data (Mansur and Whalley 1984). Modellers have in general relied on previous research to obtain parameter values that are then calibrated to fit the initial equilibrium data set. In the remainder of this chapter, relevant econometric evidence and practices followed by general equilibrium modellers are reviewed before sets of parameter values to be used in the numerical specifications of the SALTER model are chosen. This review is based in part on a recent survey of parameter specifications in a number of general equilibrium models (Adams, Dixon, Meagher, Parmenter and Peter 1990).

3.1 Elasticities of substitution among primary factors

The SALTER model's production structure assumes producers substitute among primary factors (labour, capital and farm land) to form a value added aggregate, although farm land is assumed to be used only in the agricultural sectors. The primary factor aggregate is combined in fixed proportions with aggregate intermediate inputs to form gross output. The substitution among primary factors is ruled by a constant elasticity of substitution function in which the only parameter to be specified is the (constant) elasticity of substitution. An estimate of this parameter is required for each of the j industries in the z modelled countries.

Table 3.1: Behavioural parameters in the SALTER model

Parameter	*Description*	*Range*
η^z_{2j}	Elasticity of substitution between primary factors in industry j	$j = 1,...,J$ $z = 1,...,S$
η^z_i	Elasticity of substitution in production between domestic commodity i and imported aggregate commodity i	$i = 1,...,J$ $z = 1,...,S$
β^z_i	Elasticity of substitution in household consumption between domestic commodity i and imported aggregate commodity i	$i = 1,...,J$ $z = 1,...,S$
β^z_{Gi}	Elasticity of substitution in government consumption between domestic commodity i and imported aggregate commodity i	$i = 1,...,J$ $z = 1,...,S$
β^z_{Ki}	Elasticity of substitution in investment demand between domestic commodity i and imported aggregate commodity i	$i = 1,...,J$ $z = 1,...,S$
η^{Iz}_i	Elasticity of substitution in production between commodities imported from different sources	$i = 1,...,J$ $z = 1,...,S$
β^{Iz}_i	Elasticity of substitution in household consumption between commodities imported from different sources	$i = 1,...,J$ $z = 1,...,S$
β^{Iz}_{Gi}	Elasticity of substitution in government consumption between commodities imported from different sources	$i = 1,...,J$ $z = 1,...,S$
β^{Iz}_{Ki}	Elasticity of substitution in investment demand between commodities imported from different sources	$i = 1,...,J$ $z = 1,...,S$
β_F	Elasticity of substitution between freight sources	
μ^z_i	Elasticity of demand for commodity i with respect to aggregate consumption expenditure	$i = 1,...,J$ $z = 1,...,S$
λ^z_{ih}	Price elasticity of demand for commodity i with respect to the price of commodity h	$i = 1,...,J$ $h = 1,...,J$ $z = 1,...,S$
χ^z_L	Elasticity of labour supply to real after-tax wages	$z = 1,...,S$

Econometric evidence

Caddy (1976) reviews 21 cross-section and 13 time series studies of empirical estimates of primary factor substitution elasticities covering a variety of industries. The estimates reviewed are the product of estimating a production function directly or equations derived from the first-order conditions assuming the producer maximises profits.

Estimates of substitution elasticities are found to vary dramatically depending on the level of aggregation, the particular functional form or parameter restrictions imposed, and whether the estimation is based on cross-section or time series data. There are many potential biases and little is known of their magnitude or direction.

In general, cross-section estimates tend to be larger than those obtained in time series analyses. Cross-section studies typically cover a wide variety of economic circumstances found by individual firms. The variation in these circumstances is typically larger than the year-to-year variations observed in the data used in time series studies. Because elasticities of substitution derived from cross-section studies have been estimated using data with greater variation, they are more likely to produce estimates of long-run substitution possibilities. The time series estimates provided by Caddy are thus typically lower than the cross-section estimates of primary factor substitution, reflecting relatively short-run substitution opportunities.

Quantitative restrictions such as supply management policies affect the estimates of substitutability between inputs, as they limit firms' access to specific inputs. For example, land set-aside programs in the United States are expected to reduce farmers' ability to use farm land and thus bias estimates of substitution possibilities in agriculture that would be available when such programs were not in effect (Burniaux, Delorme, Lienert, Martin and Hoeller 1988).

Rimmer (1990) has estimated elasticities of substitution between labour and capital using a cost function approach. The estimation procedure was adapted for each broad industry group to account for estimation problems or an industry's peculiarity (for example, performance in agriculture can be heavily influenced by weather conditions). The time series estimation based on Australian data from 1962 to 1985 accounts for different wage regimes. Values estimated by Rimmer for the more recent periods are compared in Table 3.2 with those synthesised by Whalley (1985) from Caddy's (1976) compilation.

The values obtained by Rimmer are similar to those used by Whalley in spite of their very different origin. They show that substitution opportunities are highest in the services industries, but lower in manufacturing and agriculture. The lower value for agriculture may reflect the relative importance of, and lack of substitutes for, farm land in agricultural production in which substitution possibilities for this factor have been largely exhausted. The low value obtained by Rimmer for manufacturing may reflect the high degree of aggregation and heterogeneity of this sector.

Previous modelling practice

In their search for parameter values, researchers have also supplemented the econometric estimates reviewed above with their own judgments about the value that parameters should have. For example, Mercenier and Waelbroeck (1986) believe efforts in estimating parameters are inconclusive and incorporate subjective estimates

Table 3.2: **Elasticities of substitution between capital and labour in various industries obtained from two studies**

	Whalley	*Rimmer*
Agriculture	0.6	0.4
Mining	0.8	0.8
Manufacturing	0.6 – 0.9	0.5
Construction	0.9	1.0
Services	1.0[a]	0.9
Electricity, gas and water	1.0[a]	0.9
Transport and communications	1.0[a]	1.2
Retail and distribution	na	0.9

a Values assumed by Whalley (1985). na Not available.
Sources: Whalley (1985), Rimmer (1990).

formulated by World Bank staff, advocating that the end user of their model might have a preferred set of parameter values.

It is typical in general equilibrium models to apply the same elasticities of substitution among primary factors for all countries involved (for example, Whalley 1985, Burniaux et al. 1990). This may seem reasonable when the countries modelled are similar, but substitution opportunities may be affected by the technologies used.

Early econometric studies suggest some differences exist in the substitution opportunities of developed and developing economies (Fuchs 1963). It is expected that the largest differences between technologies that might affect substitution elasticities will arise from differences in the degree of development of a country. While a large part of industrial and extractive production processes might be assumed to be relatively homogeneous across countries, this may not be the case for agricultural industries, as technologies in this sector may vary widely from industrialised to developing countries.

Yotopoulos and Nugent (1976) indicate that several studies (including Arrow, Chenery, Minhas and Solow 1961) find larger opportunities for substitution in agriculture than in manufacturing, but claim that modern technology tends to decrease substitution opportunities. This would point to the need to specify larger elasticities of substitution in agriculture in lesser developed countries, such as the ASEAN economies included in the SALTER model. However, the lack of reliable estimates makes it difficult to use differentiated sets of elasticities. The common practice of imposing a single set of substitution elasticities on all modelled countries is followed in specifying production parameters in the SALTER model.

Preferred parameter values

The elasticities of substitution among primary factors selected for the SALTER model are presented in Table 3.3. The short-run estimates are based on Rimmer (1990), except in manufacturing. Since the industry specification in SALTER is more disaggregated, the synthetic estimates of Whalley (1985) are used for the manufacturing industries.

In the long run, there is more opportunity to adjust the mix of primary factors in response to changes in their relative prices. To reflect this, long-run elasticities of substitution are assumed to be higher than those affecting decisions in the short run.

Caddy (1976) indicates that time series elasticities are centred around 0.5, while cross-section estimates are centred around 1.0. Dixon et al. (1982) agree that the 'cross-sectional estimates should be interpreted as applying to an adjustment period considerably longer than one or two years' (pp. 189–90). Assuming that cross-section estimates apply to a ten-year period, the long-run estimates used in the SALTER model are taken to be double those in the short run.

3.2 Trade elasticities in the SALTER model

In the SALTER model, it is assumed that domestically produced and imported commodities are imperfect substitutes for each other and that imports from different sources are likewise only partial substitutes. This applies to all categories of aggregate demand — intermediate input demands, consumer demands, government and investment demands.

Given this specification, two sets of trade elasticities are required to model international trade in the SALTER model. These are:

— elasticities of substitution between domestic and imported commodities; and

— elasticities of substitution between imports from different sources.

The numerical specification of these parameters is the object of the following sections.

Substitution between domestic and imported commodities

Import price elasticities available from the literature are usually not differentiated by use. They are estimated for aggregate commodity imports or total imports (Stern, Francis and Schumacher 1976). The builders of the ORANI model of the Australian economy point out that most of Australia's major imports are used predominantly by one end user, and thus justify using the same substitution parameter for all end uses (Dixon et al. 1982). Assuming that the share of imports in each user's demand is not too different, the substitution elasticity estimated by commodity but for all uses can be

Table 3.3: **Elasticities of substitution between primary factors assumed in the SALTER model**

No.	*SALTER commodities*	*Short run*	*Long run*[a]
	Agriculture and primary non–extractive industries		
1	Paddy rice	0.40	0.80
2	Wheat	0.40	0.80
3	Other grains	0.40	0.80
4	Non-grain crops	0.40	0.80
5	Wool	0.40	0.80
6	Livestock products	0.40	0.80
7	Forestry	0.40	0.80
8	Fishing	0.40	0.80
	Mining industries		
9	Coal	0.80	1.60
10	Oil	0.80	1.60
11	Gas	0.80	1.60
12	Other minerals	0.80	1.60
	Food processing industries		
13	Processed rice	0.80	1.60
14	Meat products	0.80	1.60
15	Milk products	0.80	1.60
16	Other food products	0.80	1.60
	Non-food manufacturing		
17	Beverages and tobacco	0.80	1.60
18	Textiles	0.90	1.80
19	Wearing apparel	0.90	1.80
20	Leather and fur	0.80	1.60
21	Lumber and wood products	0.90	1.80
22	Pulp, paper and printing	0.80	1.60
23	Petroleum and coal products	0.90	1.80
24	Chemicals, rubber and plastic	0.90	1.80
25	Non-metallic mineral products	0.90	1.80
26	Primary iron and steel	0.90	1.80
27	Non ferrous metals	0.80	1.60
28	Fabricated metal products	0.80	1.60
29	Transport industries	0.90	1.80
30	Other machinery and equipment	0.90	1.80
31	Other manufacturing	0.90	1.80
	Services		
32	Electricity, gas and water	0.90	1.80
33	Construction	1.00	2.00
34	Trade and transport	1.20	2.40
35	Private services	0.90	1.80
36	Government services	0.90	1.80
37	Ownership of dwellings	0.90	1.80

a Double the short term values.

applied uniformly across users (that is, demand for intermediate inputs, consumer, investment and government demands). These two assumptions are used in specifying the import-domestic substitution parameters for the SALTER model. If the shares of imports in each use are actually similar, this results in similar price elasticities of demand for imports and domestic products by all end users.

Econometric evidence

Common sources for assigning values to the substitution elasticity between imports and domestic products are the Stern et al. (1976) survey of about 130 estimations of import and export elasticities for a variety of countries, and the Alaouze (1977) and Alaouze, Marsden and Zeitsch (1977) studies of substitution elasticities between domestic and imported commodities in Australia. The import price elasticities reviewed by Stern et al. (1976) are either for:

— aggregate imports for a number of countries; or

— large but disaggregated commodity group imports (usually for a single country).

Burniaux et al. (1988) expect that disaggregated price elasticities are higher than estimates at more aggregated levels owing to greater substitution possibilities among homogeneous products. As a consequence, agricultural product estimates are expected to be higher than estimates for manufactures. This is not, however, borne out by empirical results. Quantitative trade restrictions are presumed to affect the estimates of import price elasticities, and therefore opportunities for substitution.

Stern et al. (1976) indicate that import price elasticities are centred around 1.0, while export price elasticities are higher, at around 1.25. However, a number of researchers (for example, Orcutt 1950, Kemp 1962) have argued that biases toward unity are inherent to the estimation procedure used in many cases.

Alaouze et al. (1977) provide estimates of substitution elasticities for 32 commodities imported into Australia. They use a 'rapid adjustment model' to estimate immediate response to price changes and a 'partial adjustment model' to account for lags in changing the relative shares of imports and domestic products as a result of a change in relative import prices. Elasticities for a number of time frames are obtained with the partial adjustment model. Alaouze (1977, p. 12) indicates:

> the infinite period elasticity obtained from the partial adjustment model is taken as an unbiased estimate of the long run elasticity of substitution and the three period elasticity as the approximate estimate of the annual response.

The difference between the two estimates varies from nearly zero for beer and soap (small value consumables) to about 150 per cent for underwear and refrigerators. Intermediate inputs such as raw textiles have relatively low differences in substitution elasticities, while in more processed textile products (for example, apparel) the differences are larger. The smallest differences between the one-year and the infinite period estimates are found in inputs used by the construction industry, indicating that all adjustments to price changes are made by buyers of such products within the year. Simple averages of the percentage difference between long- and short-run elasticities for broad commodity groups are shown in Table 3.4, indicating significant differences among groups in their ability to adjust to changing conditions.

Table 3.4: **Average long-run and short-run elasticities of substitution between domestic and imported products for broad commodity groups**

Commodity group	*ASIC*[a]	*Short-run elasticity*	*Long-run elasticity*
Food	2132, 2140	1.4	1.4
Beverages	2192	2.2	2.2
Textiles	2314, 2315, 2317, 2318, 2331	1.1	1.4
Apparel	2411, 2423, 2424, 2425, 2426	2.2	4.0
Pulp and paper	2611	0.8	1.1
Chemicals	2711, 2713, 3432	1.2	1.2
Construction	3324, 2821, 2831, 2835, 2914	1.2	1.2
Vehicles	3211, 3212	3.2	5.5
Manufactured products	2927, 2725, 2522, 3322, 3323, 3325	1.4	1.9

a Australian Standard Industrial Classification.
Source: Adapted from Alaouze et al. (1977).

Previous modelling practice

Modellers have often used the link between compensated price elasticities and substitution elasticities to specify the latter. Mansur and Whalley (1984) detail the assumptions and approximations involved. Basically, expansion effects are assumed to be small, and imports are assumed to be a relatively small proportion of total use. In this case, substitution elasticities can be approximated by uncompensated price elasticities. Models may require the specification of import price elasticities and expansion (income) elasticities, or a set of substitution elasticities from which price elasticities can be derived.

Using the Stern et al. (1976) review, Whalley (1985) indicates that estimates of price elasticities of import demand for aggregate commodity groups and aggregate imports have a central tendency around unity for a number of countries. Whalley specifically uses import price elasticities to specify substitution elasticities between domestic and imported commodities in both his four-region and seven-region models. This practice results in relatively low substitution elasticities, centred around unity.

Burniaux et al. (1988) argue that 'implicit estimates of import elasticities derived from domestic demand and supply elasticities give much higher values than direct estimates based on time series analysis', and consequently in the WALRAS model price elasticities are increased substantially to reflect long-run substitution opportunities among disaggregated commodity groups. The values used in specifying the WALRAS model are significantly higher than the price elasticities of aggregate imports used in Whalley's (1985) models. Values range between 5 and 7, and are different by country although no justification is given to support this pattern.

Rejecting the low results found in direct econometric estimation is a common practice. Abbott (1988) lists a number of potential sources of bias which include the standard problems encountered in econometrics (for example, specification error, identification error, aggregation, and so on). He advocates a synthetic approach to 'estimate' parameters based on previous research and the use of components in the behaviour of trade patterns. That is, rather than estimating a relatively simple econometric trade model, behavioural parameter estimates are derived from the trade behaviour of different components resulting in the net trade flows (that is, adjustments in domestic production and use, price transmissions, and stocks). Abbott shows that such synthetic estimates for wheat and coarse grains tend to provide larger estimates than those directly estimated econometrically. The synthetic estimates of substitution elasticities reported in this study range between 1.0 and 4.7, depending on the importing country. These are significantly higher than the values obtained through direct estimation that Abbott cites (all are less than 1.0) and other econometric estimates reviewed above.

This example illustrates that evidence other than from strict econometric estimation may prove useful in setting parameter values. This approach based on heterogeneous sources is used in the next section to choose the elasticities of substitution between imported and domestic commodities for the SALTER model.

Preferred parameter values

Because of the intercountry linkages in the SALTER model, the import substitution elasticities in each region of the model help to determine not only the elasticity of demand for imports by the region, but also the elasticity of demand for exports by other regions.

For a small country supplying only a small share of its trading partners' imports of any particular commodity, the export demand elasticity for this commodity is approximately equal to the elasticity of substitution between imports from different sources in the importing regions. This is because the expansion effects in importing countries of changes in a small country's export price are negligible, while the elasticity of a small country's market share is approximately equal to the substitution elasticity among imports (Box 3.1). Furthermore, as described below, we have chosen

Box 3.1: **Relation between import substitution and export demand elasticities**

This box provides an explanation of the relation between import substitution elasticities and export demand elasticities in the SALTER model.

Consider a range of countries s exporting a commodity to a range of countries z for a particular purpose k ($k = 1$ intermediate usage, 2 investment, 3 government consumption, 4 household consumption). Let p_s^{Iz} denote the (percentage change in) the price of imports from a particular source. Then we may define an import price index in a particular destination country z for purpose k as

$$p^{Iz}(k) = \sum_s S_s^{Iz}(k) p_s^{Iz}$$

where $S_s^{Iz}(k)$ denotes the share of source s in the total value of imports for purpose k. Let p^{Dz} denote the price of domestically produced goods of the same description. Then we may define a price index for all goods of this description

$$p^z(k) = S^{Dz}(k) p^{Dz} + S^{Iz}(k) p^{Iz}(k)$$

where $S^{Dz}(k)$ denotes the share of domestic products and $S^{Iz}(k)$ the share of imports in total purchases of goods of this description in destination country z for purpose k.

For the first three purposes (intermediate usage, investment, government consumption) the demand in country z for imports from a particular source s has the form

$$x_s^{Iz}(k) = x^{Iz}(k) - \eta^{Iz}\left[p_s^{Iz} - p^{Iz}(k)\right]$$

$$x^{Iz}(k) = \textit{scale variable} - \eta^z\left[p^{Iz}(k) - p^z(k)\right]$$

where $x^{Iz}(k)$ denotes demand for the composite imported variety for purpose k, η^{Iz} is the elasticity of substitution between imports from different sources and η^z is the elasticity of substitution between the domestically produced and the composite imported variety. Combining all these relations, we obtain demand in county z for imports from a particular source s for purpose k ($k = 1, 2, 3$) as

$$x_s^{Iz}(k) = \textit{scale variable} - \eta^z\left[p^{Iz}(k) - p^z(k)\right] - \eta^{Iz}\left[p_s^{Iz} - p^{Iz}(k)\right]$$

$$= -\left[\eta^z S^{Dz}(k) S_s^{Iz}(k) + \eta^{Iz}\left(1 - S_s^{Iz}(k)\right)\right] p_s^{Iz} - \sum_{s' \neq s}\left[\eta^z S^{Dz}(k) S_{s'}^{Iz}(k) - \eta^{Iz} S_{s'}^{Iz}(k)\right] p_{s'}^{Iz}$$

$$+ \eta^z S^{Dz}(k) p^{Dz} + \textit{scale variable}$$

For the last purpose (household consumption) the demand in country z for imports from a particular source s has the form

$$x_s^{Iz}(k) = x^{Iz}(k) - \eta^{Iz}\left[p_s^{Iz} - p^{Iz}(k)\right]$$

$$x^{Iz}(k) = x^z(k) - \eta^z\left[p^{Iz}(k) - p^z(k)\right]$$

$$x^z(k) = \textit{scale variable} - \lambda^z p^z(k) - \textit{terms involving prices of other goods}$$

(Continued on next page)

Box 3.1 *(continued)*

where $x^z(k)$ is household demand for goods of this variety and λ^z is the absolute magnitude of the own-price elasticity of household demand for these goods. Combining these relations, we obtain demand in country z for imports from a particular source s for household demand ($k = 4$) as

$$x_s^{Iz}(k) = -\lambda^z p^z(k) - \eta^z\left[p^{Iz}(k) - p^z(k)\right] - \eta^{Iz}\left[p_s^{Iz} - p^{Iz}(k)\right] + \text{other terms}$$

$$= -\left[\lambda^z S^{Iz}(k)S_s^{Iz}(k) + \eta^z S^{Dz}(k)S_s^{Iz}(k) + \eta^{Iz}\left(1 - S_s^{Iz}(k)\right)\right]p_s^{Iz}$$

$$-\sum_{s' \neq s}\left[\lambda^z S^{Iz}(k)S_{s'}^{Iz}(k) + \eta^z S^{Dz}(k)S_{s'}^{Iz}(k) - \eta^{Iz}S_{s'}^{Iz}(k)\right]p_{s'}^{Iz}$$

$$-\left[\lambda^z S^{Dz}(k) - \eta^z S^{Dz}(k)\right]p^{Dz} + \text{other terms}$$

Total demand in country z for imports from a particular source s is given by

$$x_s^{Iz} = \sum_k S_{su}^{Iz}(k)x_s^{Iz}(k)$$

where $S_{su}^{Iz}(k)$ is the share of total imports from country s to country z accounted for by particular usage k. Inserting the expressions for demand for particular uses and collecting the terms involving the price from a particular source s gives the following expression for the own-price elasticity of import demand in country z for a particular commodity from country s.

$$\textit{Import demand elasticity} = -\sum_{k=1,2,3} S_{su}^{Iz}(k)\left[\eta^z S^{Dz}(k)S_s^{Iz}(k) + \eta^{Iz}\left(1 - S_s^{Iz}(k)\right)\right]$$

$$- S_{su}^{Iz}(k=4)\left[\lambda^z S^{Iz}(k)S_s^{Iz}(k) + \eta^z S^{Dz}(k)S_s^{Iz}(k) + \eta^{Iz}\left(1 - S_s^{Iz}(k)\right)\right]$$

If the exporting country s is small, its share of the import market in country z for any particular purpose $S_s^{Iz}(k)$ is approximately equal to zero. Then the expression for the own-price demand elasticity reduces to be equal in magnitude to the elasticity of substitution between imports from different sources η^{Iz}.

There are several reasons why this approximation may not hold exactly in the actual model. First, even for small exporters, market shares are not exactly zero. Second, when exports are sold into several markets, even if the substitution elasticity is the same in all individual markets, the true aggregate substitution elasticity is in general smaller (James and McDougall 1993b). Finally, import demand elasticities are defined with respect to purchasers' prices, but export demand elasticities with respect to fob prices. Trade and transport margins tend to make export demand elasticities lower than import demand elasticities.

Even where all these effects are present, the elasticities of substitution between imports from different sources are likely to give a good indication of the export demand elasticities facing small exporting countries.

to set elasticities of substitution between imports from different sources at twice the values of the corresponding domestic-import substitution elasticities. So the export demand elasticity for a small country is approximately twice the domestic-import substitution elasticity.

Thus, if we chose import-domestic substitution elasticities centring around unity, as proposed by Whalley (1985), then we would obtain export demand elasticities for small countries of about 2.0. In this case, even small countries would exercise a considerable degree of market power in international markets, and could greatly improve their terms of trade by taxing exports. With export demand elasticities of about 2.0, the optimal export tax rate would be about 100 per cent.

We find this account of the international trading environment facing small countries hard to believe. But if we reject it, then we must also reject the underlying import-import substitution elasticities. To do this, we must either set import-import substitution elasticities almost an order of magnitude higher than the domestic-import substitution elasticities, or set domestic-import substitution elasticities considerably higher than most econometric estimates. As explained below, we take the latter course.

Our preferred values for the domestic-import substitution elasticities represent a compromise between the econometric estimates on import substitution elasticities, and our prior beliefs about export demand elasticities.

For the econometric evidence on domestic-import substitution elasticities, we take the estimates of Alaouze et al. (1977) as representative. We accept the evidence from Corado and de Melo (1983) discussed below, that import-import substitution elasticities are typically about twice as great as domestic-import substitution elasticities — we have no evidence suggesting that they are much more than twice as great. We postulate a typical value for the export demand elasticity facing a small country of about 10, similar to the apparent aggregate export demand elasticity facing Australia in long-run ORANI simulations. By the previous argument, this implies a typical value for domestic-import substitution elasticities of about 5.0, whereas the Alaouze et al. estimates fall mostly in the range 1.0 to 2.0 (Table 3.4).

To derive our preferred values, we use a loss function minimisation approach to set the long-run elasticities between the values in Table 3.4 and the value of 5.0 implied by our prior beliefs on the elasticity of export demand. The problem consists of determining the value of a parameter based on the information found in the econometric estimate and the prior value above. The loss function is defined so as to be increasing in the difference between the preferred value of the parameter and the econometric estimate on the one hand, and the prior value of 5.0 on the other. When such a function is minimised with respect to the preferred value, we obtain a preferred

Table 3.5: **Elasticities of substitution between imported and domestic commodities assumed in the SALTER model**

No.	*SALTER commodities*	*Broad categories for correspondence with Table 3.4*	*Short-run elasticity*	*Long-run elasticity*
1	Paddy rice	Food	2.2	2.2
2	Wheat	Food	2.2	2.2
3	Other grains	Food	2.2	2.2
4	Non-grain crops	Food	2.2	2.2
5	Wool	Textiles	1.7	2.2
6	Livestock products	Manufactures	2.1	2.8
7	Forestry	Manufactures	2.1	2.8
8	Fishing	Manufactures	2.1	2.8
9	Coal	Manufactures	2.1	2.8
10	Oil	Manufactures	2.1	2.8
11	Gas	Manufactures	2.1	2.8
12	Other minerals	Manufactures	2.1	2.8
13	Processed rice	Food	2.2	2.2
14	Meat products	Food	2.2	2.2
15	Milk products	Food	2.2	2.2
16	Other food products	Food	2.2	2.2
17	Beverages and tobacco	Beverages	3.1	3.1
18	Textiles	Textiles	1.7	2.2
19	Wearing apparel	Apparel	2.4	4.4
20	Leather and fur	Apparel	2.4	4.4
21	Lumber and wood products	Manufactures	2.1	2.8
22	Pulp, paper and printing	Pulp and paper	1.3	1.8
23	Petroleum and coal products	Chemicals	1.9	1.9
24	Chemicals, rubber and plastic	Chemicals	1.9	1.9
25	Non-metallic mineral products	Manufactures	2.1	2.8
26	Primary iron and steel	Manufactures	2.1	2.8
27	Non ferrous metals	Manufactures	2.1	2.8
28	Fabricated metal products	Manufactures	2.1	2.8
29	Transport industries	Vehicles	3.0	5.2
30	Other machinery and equipment	Manufactures	2.1	2.8
31	Other manufacturing	Manufactures	2.1	2.8
32	Electricity, gas and water	Manufactures	2.1	2.8
33	Construction	Construction	1.9	1.9
34	Trade and transport	Construction	1.9	1.9
35	Private services	Construction	1.9	1.9
36	Government services	Construction	1.9	1.9
37	Ownership of dwellings	Construction	1.9	1.9

estimate which takes into account the information contained in both the econometric estimate and the prior value. For the particular loss function chosen, this approach generates preferred values equal to the harmonic mean of the econometric estimate and the prior value of 5.0. The long-run elasticities in Table 3.5 are determined according to this method.

The preferred short-run elasticities are derived from the long-run elasticities. The ratios of the preferred long-run values (from Table 3.5) to the econometric long-run estimates (from Table 3.4) are applied to the econometric short-run estimates from Table 3.4.

Following Deardorff and Stern (1986) the same elasticities of substitution are applied to all regions in the model. Differences in import sensitivity to price changes between the regions modelled are assumed to be captured by:

— regional differences in production and final demand structures, that is, the differences in share parameters; and

— regional differences in consumer demand parameters.

Similarly, assuming the proportion of imports in the use of a commodity by all users is similar, the parameters for aggregate imports of that commodity are applied to all user classes.

The elasticity of substitution among imports from different sources

The nested structure used to model imports from different sources is a common feature in trade models. This requires the specification of substitution elasticities among imports from different sources. In the SALTER model, these parameters need to be specified for each of four end users and commodity imports (*I*) in each country.

Corado and de Melo (1983) estimate elasticities of substitution between imports from the European Community and non-European Community countries for Portugal. Their estimates range from a theoretically inconsistent –0.7 for mining and petroleum products to 3.3 for metal products. In general, they observe that the elasticity of substitution estimates among imports are larger than elasticities of substitution between imports and domestic products. The simple average of their estimates of substitution between imports and domestic commodities is about 0.8, while that of substitution among imports is 1.5. The authors find their estimates to be reasonable and in broad agreement with estimates for substitution elasticities for aggregate imports found by Hickman and Lau (1973).

Wear (1990) has estimated price and substitution elasticities for New Zealand imports. In this study, import sources are divided into five groups: Australia, the European Community, North America (Canada and the United States), selected Asian countries (Japan, Malaysia, Indonesia, Thailand and Singapore) and the rest of the world. Share equations derived from a cost function were estimated for 17 of the 37 commodity classifications in the SALTER model. These estimates are given in Table 3.6, where

Table 3.6: **Import substitution elasticity estimates for New Zealand and Portugal**[a]

	New Zealand[b]	*Portugal*[c]
Non-grain crops	1.00	1.67
Other minerals	1.81	–0.66
Meat products	1.13	1.50
Other food products	2.02	0.64
Beverages and tobacco	0.46	3.02
Textiles	0.96	1.09
Wearing apparel	0.55	1.18
Leather fur and their products	1.05	1.57
Lumber and wood products	0.94	2.85
Pulp, paper and printing	2.18	0.75
Chemicals, plastics and rubber	1.44	0.99
Petroleum and coal products	3.15	0.14
Non-metallic mineral products	1.08	0.66
Primary iron and steel	1.61	1.89
Other metal and metal products	1.06	3.27
Transport equipment	0.52	2.58
Other manufacturing	0.63	1.20

a The classification used in this table is as used in Wear (1990). The commodity categories were closely matched with those used by Corado and de Melo.
b *Source*: Wear (1990).
c *Source*: Corado and de Melo (1983).

they are compared with the estimates obtained for Portuguese imports by Corado and de Melo (1983).

In general, the estimates from Wear (1990) are smaller than the Portuguese estimates. The simple average of the New Zealand estimates (1.3) represents 80 per cent of the average of the consistent (positive) estimates for Portugal (1.6) reported in Table 3.6. In both studies, the authors tend to think of these estimates as applying to the short term, reflecting the fact that existing contracts make it difficult for importers to adapt their sources for imports very quickly in response to relative price changes.

Previous modelling practice

Whalley (1985) and Harrison, Rutherford and Wooton (1989) assume a constant elasticity of substitution form in specifying the substitution between imports from different sources, allowing imports to shift in reaction to relative price changes. Whalley sets these elasticities to 1.5 and Harrison et al. set them to 2.0 for all commodities in all countries.

Preferred parameter values

The elasticities of substitution among imports specified in the SALTER model are calculated by multiplying the elasticities of substitution between domestic and imported products by a factor of 2.0, the approximate ratio of the average elasticities of substitution among imports and the average elasticities between domestic and imported commodities obtained by Corado and de Melo (1983). Two main reasons have guided this choice:

- there is a lot more information about substitution between domestic and imported products; this led to the choice of parameters in Table 3.5; and
- it is important for modelling purposes (and expected on theoretical grounds) that substitution elasticities in the lower level nests (import-import substitution) are higher than those in higher level nests (import-domestic substitution).

The resulting elasticities of substitution among import sources are found in Table 3.7. Preferred long-run values for this parameter range from 3.6 to 10.4.

As noted earlier, the export demand elasticity for a commodity is approximately equal to the elasticity of substitution between imports from different sources in the importing regions. A more general formula was derived in Box 3.1. Appendix B lists the implied long-run export demand elasticities for each commodity to each destination, calculated using this more general formula.

As expected, for most small exporters the export demand elasticities are close in value to the elasticities of substitution between imports from different sources. The export demand elasticities are noticeably smaller in magnitude than the import-import substitution elasticities where exporters are not small. For example, the long-run export demand elasticity for Australian wool is –1.4 in the US market and –3.0 in the Chinese market, whereas the long-run import-import substitution elasticity for wool in those markets is 4.4. Appendix B also presents approximate aggregate export demand elasticities for each commodity from each region, obtained as export-weighted averages of the elasticities to individual destinations. Finally, it presents aggregate export demand elasticities for four broad sectors and for each region as a whole, obtained using a similar export weighting procedure.

Elasticity of substitution among freight sources

A single elasticity of substitution guides substitution possibilities among freight sources. The value is set equal to 2.0, lower than the long-run elasticity of substitution among import sources for the trade and transport commodity. This is to capture the impact of regulations which are difficult to capture in direct measures of industry assistance, but which nevertheless restrict freight substitution possibilities (Wigle and Perroni 1991).

Table 3.7: Elasticities of substitution among imports from different sources assumed in the SALTER model

No.	*SALTER commodities*	*Broad categories for correspondence with Table 3.4*	*Short-run elasticity*	*Long-run elasticity*
1	Paddy rice	Food	4.4	4.4
2	Wheat	Food	4.4	4.4
3	Other grains	Food	4.4	4.4
4	Non-grain crops	Food	4.4	4.4
5	Wool	Textiles	3.4	4.4
6	Livestock products	Manufactures	4.2	5.6
7	Forestry	Manufactures	4.2	5.6
8	Fishing	Manufactures	4.2	5.6
9	Coal	Manufactures	4.2	5.6
10	Oil	Manufactures	4.2	5.6
11	Gas	Manufactures	4.2	5.6
12	Other minerals	Manufactures	4.2	5.6
13	Processed rice	Food	4.4	4.4
14	Meat products	Food	4.4	4.4
15	Milk products	Food	4.4	4.4
16	Other food products	Food	4.4	4.4
17	Beverages and tobacco	Beverages	6.2	6.2
18	Textiles	Textiles	3.4	4.4
19	Wearing apparel	Apparel	4.8	8.8
20	Leather and fur	Apparel	4.8	8.8
21	Lumber and wood products	Manufactures	4.2	5.6
22	Pulp, paper and printing	Pulp and paper	2.6	3.6
23	Petroleum and coal products	Chemicals	3.8	3.8
24	Chemicals, rubber and plastic	Chemicals	3.8	3.8
25	Non-metallic mineral products	Manufactures	4.2	5.6
26	Primary iron and steel	Manufactures	4.2	5.6
27	Non ferrous metals	Manufactures	4.2	5.6
28	Fabricated metal products	Manufactures	4.2	5.6
29	Transport industries	Vehicles	6.0	10.4
30	Other machinery and equipment	Manufactures	4.2	5.6
31	Other manufacturing	Manufactures	4.2	5.6
32	Electricity, gas and water	Manufactures	4.2	5.6
33	Construction	Construction	3.8	3.8
34	Trade and transport	Construction	3.8	3.8
35	Private services	Construction	3.8	3.8
36	Government services	Construction	3.8	3.8
37	Ownership of dwellings	Construction	3.8	3.8

3.3 Consumer demand parameters

In the SALTER model the demand for intermediate inputs is determined by the production structure. Government and investment demands for commodities are determined as fixed proportions of real aggregate levels of government expenditure and investment. Consumer demands are determined assuming a representative consumer maximises a separable utility function subject to a budget constraint. The consumer is assumed to allocate a fixed proportion of disposable income to consumption expenditure; this is his/her budget allowance. The allocation among different commodities is assumed to be described by a linear expenditure system.

Reducing the number of parameters to be specified

Expenditure systems are notorious for requiring a large number of parameters to characterise them. In the SALTER model, relations between expenditure and price elasticities are used to minimise the number of parameters needed to specify each region's consumer expenditure system.

The homogeneity and adding-up restrictions of the linear expenditure system imply that price and expenditure elasticities in the system are not independent. Frisch (1959) shows that if preferences are independent, the price elasticities can be obtained by:

(3.1) $$\lambda_{ij} = -S_{Cj}\mu_i\left(1+\frac{\mu_j}{\omega}\right)+\delta_{ij}\frac{\mu_i}{\omega}$$

where

λ_{ij} is the elasticity of commodity i with respect to price j;

μ_i is the expenditure elasticity of commodity i;

S_{Cj} is the average budget share of commodity j;

ω is the 'Frisch parameter', the reciprocal of the marginal utility of income, or the flexibility of the marginal utility of money; and

δ_{ij} is the Kronecker delta and is equal to zero when $i \neq j$ and unity when $i = j$.

Hence the own-price and cross-price elasticities for each country can be determined from a set of expenditure elasticities compatible with the benchmark equilibrium database share parameters obtained from the database and the Frisch parameter. This greatly reduces the number of parameters that must be specified and guarantees consistency between parameters and the database.

The SALTER commodity disaggregation is finer than the disaggregation typically used in estimating consumer demand systems. When estimating consumer demand systems, researchers typically assume preference independence. This allows them to specify a separable and additive utility function in which it is assumed that consumers' aggregate utility is the sum of the levels of utility derived from the consumption of broad commodity aggregates. But the assumption of additive preferences is only appropriate when commodity groups are broadly defined (Peter 1990). Hence, estimates of consumer demand price and expenditure elasticities are typically available for a small number of broadly defined commodity groups. When the commodity disaggregation is finer, the estimates from the more aggregate consumption studies must be allocated to the disaggregated commodity specification.

Tulpulé and Powell (1978) show how estimates for expenditure elasticities derived from a small system (eight commodities) can be expanded to a larger system (109 commodities) using external information on expenditure elasticities and the equilibrium database. Tulpulé and Powell show that the expenditure elasticity for commodity i can be obtained by:

$$\mu_i = \sum_{j=1}^{J} \frac{C_{ij}}{C_i} \mu_j^o \tag{3.2}$$

where

μ_i is the expenditure elasticity of commodity i;

C_{ij} is the level of commodity i in aggregate commodity group j;

C_i is the aggregate consumption of commodity i; and

μ_j^o is the expenditure elasticity of commodity group j.

In the SALTER model, each disaggregated commodity is assumed to be part of a single group of commodities. In this case, the consumption of commodity $i (C_i)$ is equal to the consumption of commodity i from group $j (C_{ij})$, and the share parameter equals one. The disaggregated expenditure elasticity μ_i is therefore equal to the expenditure elasticity that applied to the aggregate commodity group (μ_i^o).

Econometric evidence and previous modelling practice

In surveying the econometric literature on income elasticities for specifying the demand parameters of the WALRAS model, Burniaux et al. (1990) produced the synthetic estimates shown in Table 3.8. Using estimates from Weisskoff (1971) and Lluch, Powell and Williams (1977), Mercenier and Waelbroeck (1986) produced the expenditure elasticities reported in Table 3.9, differentiating between urban and rural consumer behaviour. Such differences are very small for most commodities and even values across regions do not seem to vary much except in the case of food for which estimates are, as expected, higher in less developed regions.

More recently, Selvanathan (1988) has produced estimates for 18 developed countries based on a ten-commodity classification, which are in broad agreement with the Lluch et al. (1977) results. In general, the tendency is for estimates for food to be lower than estimates for other items in consumers' budgets and estimates for services to be higher. Estimates less than unity indicate the commodity is a 'necessity' (for example, food,

Table 3.8: **Income elasticities used in the WALRAS model**

	Australia	*New Zealand*	*Canada*	*United States*	*Japan*	*European Community*
Grains and cereals	0.1	0.0	0.0	0.0	0.0	0.1
Meat	0.3	0.2	0.5	0.4	0.7	0.4
Milk, cheese and eggs	0.2	0.2	0.2	0.2	0.7	0.3
Other food	0.5	0.6	0.3	0.3	0.6	0.5
Alcoholic beverages	0.4	1.1	0.5	0.3	0.5	0.5
Tobacco	0.4	1.1	0.5	0.3	0.5	0.5
Clothing and footwear	0.6	0.7	0.6	0.6	0.5	0.6
Gross rents, fuel and power	1.4	1.3	1.1	1.2	1.3	1.2
Household equipment and operation	1.5	0.9	1.4	1.4	1.3	1.5
Medical use	1.7	1.4	0.6	1.1	1.2	0.6
Transport and communication	1.5	1.2	1.3	1.0	1.1	1.5
Education and recreation	0.8	1.3	1.0	1.0	1.1	1.2
Other consumer goods and services	1.2	1.3	1.2	1.4	1.2	1.4

Source: Burniaux et al. (1990).

Table 3.9: **Income elasticities used in the Varuna model**

	Agriculture		*Manufactured*		
	Food	*Non-food*	*products*	*Energy*	*Services*
Rural sector					
South Asia	0.730	0.731	0.950	1.122	1.125
East Asia	0.679	0.679	0.950	1.013	1.017
OECD	0.524	0.524	0.949	0.630	1.050
Urban sector					
South Asia	0.736	0.738	0.949	1.163	1.164
East Asia	0.684	0.685	0.950	1.046	1.049
OECD	0.499	0.500	0.949	0.599	0.999

Source: Mercenier and Waelbroeck (1986).

beverages, clothing, housing) whereas expenditure elasticities above unity make a commodity a 'luxury' (for example, durables and recreation).

Yet another more recent collection of elasticities was derived by Theil, Chung and Seal (1989). These estimates result from the International Comparisons Project currently conducted by the United Nations Statistical Office. Consumption data for 51 countries in 1980 were fitted to a Working (1943) model of consumption expenditure assuming preference independence. The estimates obtained reflect expectations about the sensitivity of 'necessity' and 'luxury' goods to income changes relative to the initial level of income. By pooling the data across countries, the estimates obtained are consistent across countries.

Consumption expenditure elasticities in the SALTER model

Instead of specifying a full set of own-price and cross-price elasticities that would be consistent with the linear expenditure system, these parameters are derived from expenditure elasticities based on values provided by Theil et al. (1989) and the flexibility of the marginal utility of money. The Theil estimates are preferred because they are internally consistent across countries and are based on relatively recent (1980) consumption information.

Of the expenditure elasticity estimates obtained by Theil et al. (1989) for 10 composite commodities, 7 of these composite commodities were applicable to the SALTER commodity classification. The estimated expenditure elasticities declined without exception as per capita income increased. The authors maintain that expenditure elasticities are much more dependent on real income than on relative prices. The set of countries in the study included 8 SALTER regions, listed in Table 3.10. Expenditure elasticities for the European Community are per capita income-weighted averages of the corresponding elasticities for Belgium, Luxembourg, Denmark, West Germany, Greece, Spain, France, the Netherlands, Italy, Portugal, United Kingdom and the Republic of Ireland.

Table 3.10: **Selected income elasticities from Theil et al. study**

	Food	*Beverages and tobacco*	*Clothing*	*Durables*	*Transport*	*Recreation*	*Miscellaneous*
Canada	0.15	1.02	0.96	1.16	1.24	1.26	1.25
United States	0.14	1.02	0.96	1.16	1.24	1.26	1.25
Japan	0.39	1.02	0.96	1.18	1.27	1.30	1.28
Korea	0.64	1.02	0.96	1.22	1.38	1.45	1.40
EC	0.32	1.02	0.96	1.17	1.26	1.29	1.27
Indonesia	0.72	1.02	0.96	1.27	1.55	1.70	1.59
Philippines	0.66	1.02	0.96	1.23	1.41	1.49	1.44
Hong Kong	0.35	1.02	0.96	1.17	1.26	1.29	1.27

Source: Adapted from Theil et al. (1989).

The remaining SALTER regions use Theil et al. estimates from countries of similar per capita income. Table 3.11 lists the 1980 per capita incomes for all SALTER regions. It also shows the countries from which Theil et al. estimates were taken to provide income elasticities for SALTER regions other than those shown in Table 3.10.

Table 3.12 then lists the full set of expenditure elasticity estimates used in the SALTER model.

Table 3.11: **Per capita incomes by SALTER region, 1980**

	Per capita income 1980 $US	*Per capita income US = 1.00*	*Country from Theil et al. study with closest per capita income*
Australia	10 282	0.90	Canada
New Zealand	7 659	0.67	Hong Kong
Canada	10 815	0.94	
United States	11 446	1.00	
Japan	8 907	0.78	
Korea	1 634	0.14	
EC	10 410	0.91	
Indonesia	495	0.04	
Malaysia	1 773	0.15	Bolivia
Philippines	733	0.06	
Singapore	4 707	0.41	Venezuela
Thailand	720	0.06	Madagascar
China	246	0.02	Tanzania
Hong Kong	5 445	0.48	
Taiwan	2 347	0.21	Ecuador
Rest of World	960	0.08	Senegal

Source: United Nations (1991), Council for Economic Planning and Development (1990).

Table 3.12: **Expenditure elasticities for the SALTER model**

	Food	*Beverages and tobacco*	*Clothing*	*Durables*	*Transport*	*Recreation*	*Miscellaneous*
Australia	0.15	1.02	0.96	1.16	1.24	1.26	1.25
New Zealand	0.35	1.02	0.96	1.17	1.26	1.29	1.27
Canada	0.15	1.02	0.96	1.16	1.24	1.26	1.25
United States	0.14	1.02	0.96	1.16	1.24	1.26	1.25
Japan	0.39	1.02	0.96	1.18	1.27	1.30	1.28
Korea	0.64	1.02	0.96	1.22	1.38	1.45	1.40
EC	0.32	1.02	0.96	1.17	1.26	1.29	1.27
Indonesia	0.72	1.02	0.96	1.27	1.55	1.70	1.59
Malaysia	0.68	1.02	0.96	1.24	1.44	1.53	1.47
Philippines	0.66	1.02	0.96	1.23	1.41	1.49	1.44
Singapore	0.51	1.02	0.96	1.19	1.30	1.34	1.31
Thailand	0.74	1.02	0.96	1.29	1.68	1.92	1.74
China	0.78	1.02	0.96	1.37	2.27	3.48	2.50
Hong Kong	0.35	1.02	0.96	1.17	1.26	1.29	1.27
Taiwan	0.64	1.02	0.96	1.22	1.38	1.45	1.40
Rest of World	0.73	1.02	0.96	1.28	1.61	1.79	1.65

Source: Adapted from Theil et al. (1989).

Table 3.13: **Classification concordance for allocating expenditure elasticities**

No.	*37-commodity classification*	*7-commodity classification*
1	Paddy rice	Food
2	Wheat	Food
3	Other grains	Food
4	Non-grain crops	Food
5	Wool	Miscellaneous
6	Livestock products	Miscellaneous
7	Forestry	Miscellaneous
8	Fishing	Miscellaneous
9	Coal	Miscellaneous
10	Oil	Miscellaneous
11	Gas	Miscellaneous
12	Other minerals	Miscellaneous
13	Processed rice	Food
14	Meat products	Food
15	Milk products	Food
16	Other food products	Food
17	Beverages and tobacco	Beverages
18	Textiles	Clothing
19	Wearing apparel	Clothing
20	Leather and fur	Miscellaneous
21	Lumber and wood products	Miscellaneous
22	Pulp, paper and printing	Miscellaneous
23	Petroleum and coal products	Miscellaneous
24	Chemicals, rubber and plastic	Miscellaneous
25	Non-metallic mineral products	Miscellaneous
26	Primary iron and steel	Miscellaneous
27	Non ferrous metals	Miscellaneous
28	Fabricated metal products	Miscellaneous
29	Transport equipment	Durables
30	Other machinery and equipment	Durables
31	Other manufacturing	Durables
32	Electricity, gas and water	Miscellaneous
33	Construction	Miscellaneous
34	Trade and transport	Transport
35	Private services	Recreation
36	Government services	Miscellaneous
37	Ownership of dwellings	Miscellaneous

The 37 SALTER commodities are allocated among the 7 commodity groups in Table 3.12 for which expenditure elasticities are available. The concordance between the 7-commodity and 37-commodity classifications is shown in Table 3.13. Through the Tulpulé and Powell (1978) argument presented earlier, the expenditure elasticities in the 37-commodity classification correspond directly to those in the 7-commodity classification. Thus, for each modelled region, there is a set of 37 expenditure

elasticities. These elasticities are further normalised using the benchmark data set so that they satisfy the property of Engle aggregation. The final values used in the SALTER model are found in Appendix B.

Consumption price elasticities of demand in the SALTER model

Once normalised, the expenditure elasticities are used with the Frisch parameter to generate the own-price and cross-price elasticities of demand in consumption using the method shown above. A complete set of demand parameters is therefore determined for each region modelled.

The ORANI model of the Australian economy uses a Frisch parameter value of –1.82 (Dixon et al. 1982), a weighted average of values obtained by Williams (1978) for different Australian consumer groups. Frisch (1959) had originally conjectured that higher (absolute) values of this parameter would be characteristic of lower income consumers and that the parameter would decrease as a function of consumers' incomes. In testing this conjecture, Selvanathan (1988) concludes that:

- the Frisch parameter is not related to real income; and
- estimates of the marginal utility of income for 18 countries are centred around –0.5, which results in an estimate for the Frisch parameter of –2, close to the value used in the ORANI model.

In these conclusions, based on consumption patterns in a variety of developed countries, Selvanathan joins Theil (1987) who concludes on the basis of consumption patterns in 30 developed and developing countries that evidence in favour of the Frisch conjecture is not sufficient to support it.

However, this evidence is based largely on the estimation of demand systems using data from developed affluent countries. There may not be sufficient variation in the data in this respect to obtain significantly different estimates of the Frisch parameter. Peter (1990) cites Frisch parameters derived by Lluch et al. (1977) for several SALTER regions, along with the following relationship between Frisch parameters and per capita incomes also derived by Lluch et al. (1977).

(3.3) $$-\omega \approx 36X^{-0.36}$$

where ω is the Frisch parameter and X is GNP per capita in 1970 US dollars.

The final set of Frisch parameters used in the SALTER model is shown in Table 3.14. Lluch et al. (1977) provide estimates of Frisch parameters for some SALTER regions and Peter (1990) provides an estimate of the Frisch parameter for Australia. The remaining Frisch estimates are calculated using equation (3.3) and 1970 per capita income in US dollars. The exception is Taiwan, which is given the same Frisch parameter estimate as Korea for want of better data. Note that the Lluch estimate of the Frisch parameter for Korea was discarded in favour of the estimate shown in Table 3.14. The Lluch estimate, $\omega = -10.34$, was considered to be too high in absolute value relative to the other estimates.

Table 3.14: **Frisch parameters for the SALTER model**

	Per capita income 1970 $US	*Estimates using equation (3.3)*	*Frisch parameters used in SALTER*	*Source of parameters used*
Australia	3133	-1.98	-1.46	Peter (1990)
New Zealand	2233	-2.24	-2.24	Equation (3.3)
Canada	3973	-1.82	-1.82	Equation (3.3)
United States	4922	-1.69	-1.85	Lluch et al. (1977)
Japan	1953	-2.35	-2.35	Equation (3.3)
Korea	279	-4.74	-4.74	Equation (3.3)
EC	2278	-2.23	-2.07	Lluch et al. (1977)
Indonesia	79	-7.47	-7.88	Lluch et al. (1977)
Malaysia	319	-4.52	-4.24	Lluch et al. (1977)
Philippines	182	-5.53	-5.76	Lluch et al. (1977)
Singapore	914	-3.09	-3.10	Lluch et al. (1977)
Thailand	198	-5.36	-2.14	Lluch et al. (1977)
China	96	-6.96	-6.96	Equation (3.3)
Hong Kong	916	-3.09	-3.09	Equation (3.3)
Taiwan	same as Korea		-4.74	Equation (3.3)
Rest of World	860	-3.16	-3.16	Equation (3.3)

Source: Per capita income data is from United Nations (1991).

From these values of the Frisch parameter and the earlier values of expenditure elasticities, a complete set of consumer demand elasticities is generated relatively economically. This system tends to generate low cross-price effects. The resulting own-price elasticities are found in Appendix B.

3.4 The elasticity of labour supply

Changes in labour supply are specified as linear functions of changes in the real after-tax wage rate in the SALTER model. This requires the specification of an elasticity of labour supply with respect to the real after-tax wage for each region modelled. The SALTER model includes Western developed economies, developed economies such as Japan where a different work ethic has been observed, middle income countries such as Korea and Taiwan (presumably with an oriental work ethic) and ASEAN members who in large part are developing, mainly agricultural economies. It is expected that labour supply elasticities would vary in these different types of region.

Recent studies of labour supply in developed countries have attempted to separate income from substitution effects and concentrate on either male or female labour supply (Pencavel 1986). Most studies of male labour supply measure the response of the male working force to wage changes and do not account for labour participation rates. Studies of female labour supply are also available, but tend to concentrate on the labour supply of particular groups.

Econometric evidence

In his recent review of econometric evidence in Anglo–Saxon countries, Pencavel (1986) places the elasticity of male labour supply to wage increases at about –0.1. This means that as wages increase by 10 per cent, the labour supply of working males *decreases* by 1 per cent. This points to the existence of a backward bending supply curve in which large income effects reduce male workers' incentives to work as they devote more time to leisure.

In analysing women's decision to work and supply labour, Luskin (1990) suggests with Mroz (1987) that estimates are very low, centred around zero. The low estimates for women's labour obtained by Mroz are based on married white US women aged 30–60.

In both cases, income effects are argued to have a strong depressing effect on the amount of labour supplied. This income effect is expected to affect elasticity estimates at the relatively high levels of income and economic development observed in the United States and the United Kingdom. These studies exclude the participation decision and groups such as young women and the decision by elderly people to work or not. Mansur and Whalley (1984) indicate that 'estimates on this elasticity vary sharply by the group involved, with prime-age males having low if not negative elasticities and secondary and older workers having higher elasticities (around 0.5)'.

Labour supply in agricultural developing economies

Due to the lower income levels prevailing in some SALTER regions, labour supply is expected not to be affected by the negative income effect observed in more developed countries. In China and a large part of the ASEAN region, a significant part of the labour force is found in agriculture. A significant part of this force is expected to work in a semi-subsistence setting in which consumption and production decisions are made simultaneously. Household models have been used to analyse farmers' allocation decisions. Singh, Squire and Strauss (1986) provide a review of these models.

By taking into account the effects of price changes on total farm income, household models yield elasticities that are significantly different from those obtained from demand and supply studies that are not integrated. In the case of labour supply elasticities, estimates obtained with the household model tend to be larger. Elasticities assuming constant profits simulate results from a non-integrated model. Such low estimates reflect the negative income effects usually observed in labour supply studies. However, farm income is composed of labour income, income from management and profits. The effect of higher labour income (wages) is to *decrease* profits. This negative effect on profits and aggregate farm income results in a higher supply of labour than was estimated assuming constant profits. Thus the elasticity of labour supply in this framework is positive and of the order of 0.1 to 0.3, as shown in Table 3.15.

Table 3.15: **Elasticities of labour supply to wages assuming constant and varying profits**

	Taiwan	*Malaysia*	*Korea*	*Thailand*
Constant profits	–0.12	–0.07	0.00	0.08
Varying profits	0.17	0.11	0.11	0.26

Source: Singh et al. (1986).

Previous modelling practice

Labour supply elasticities are found mostly in tax models to capture labour taxation effects. Fullerton, Shoven and Whalley (1980) and Ballard, Fullerton, Shoven and Whalley (1985) use an elasticity of 0.15 for the supply of labour by the whole workforce in the United States. This value is obtained as an average of male and female labour supply elasticities, weighted by the respective wage bill of each group. In an extension of the ORANI model of the Australian economy, the influence of wages on labour force participation is specified as slightly positive, and tempered by negative effects of non-labour income and unemployment (Dee 1989).

Preferred parameter values.

Based on the evidence mentioned above, Luskin (1990) suggests that a weighted average of male and female elasticities be used in the SALTER model. Assuming 60 per cent of the labour force is male, an elasticity of labour supply of –0.1 for men and 0.0 for women, this yields a value of –0.06 for the wage elasticity of aggregate labour supply.

Luskin (1990) suggests that only pure wage effects should be reflected in the SALTER model parameterisation. Thus, based on estimates of the elasticity of labour supply to off-farm wages in Thailand and Malaysia, he suggests a value of zero, making the supply of labour effectively exogenous.

In the light of the low estimates of aggregate labour supply elasticities, this parameter is set to zero for all regions in most simulations conducted with the SALTER model. The possibility of specifying a non-zero elasticity is, however, left to the user.