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A General Equilibrium Model of the World Economy

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Model Structure, Database and Parameters

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on behalf of the Department of Foreign Affairs and Trade

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PREFACE

In December 1988 the Department of Foreign Affairs and Trade approached the then Industries Assistance Commission to conduct an analysis of the economic effects of alternative trade liberalisation scenarios. The analysis was to be based on a version of the WALRAS world trade model developed by the Organisation for Economic Co-operation and Development (OECD).

While the WALRAS model could provide valuable insights into the effects of trade liberalisation, to be of maximum policy relevance the country coverage and commodity detail contained in the original WALRAS model needed to be extended. In particular, given the Prime Minister's initiative to enhance the interchange of views between Australia and its near trading partners through the Asia-Pacific Economic Cooperation (APEC) Group, it was considered essential that any analysis of trade liberalisation also include the ASEAN region and the Republic of Korea. It was also considered necessary that the model identify commodities such as wheat and wool that are of special concern to Australia, and commodities such as rice and textiles that are important to Australia's regional partners.

The Department of Foreign Affairs and Trade commissioned the Industries Assistance Commission to develop a model which covered eight countries or groups of countries and up to 34 industries and commodities. The model was named SALTER (Sectoral Analysis of Liberalising Trade in the East Asian Region) after the distinguished Australian Economist Wilfred Salter.

This volume documents the theoretical structure of the SALTER model, its database and parameters. It is being provided to enable scrutiny of the work undertaken so far. It is hoped that this process will enable the model to be refined as more information is incorporated in the database and the model's structure is improved.

The SALTER model has the potential to significantly affect trade debates. It can highlight the economic and social effects of continued protection policies in the world economy. Having such a tool available at the present time is most opportune.

John Zeitsch

Project Leader

ACKNOWLEDGEMENTS

The development of the SALTER model was made possible by substantial contributions from a number of specialists. The cooperation and encouragement provided by John Martin and his team at the OECD's Growth Studies Division has been greatly appreciated.

Several consultants were employed to assist in developing the model. Dr Ken Pearson at Melbourne University extended the GEMPACK modelling software to enable the model's database to be updated and to obtain large change solutions of the model. Dr Cillian Ryan of the University of North Wales constructed the database for the European Community component of the model. The Institute of Applied Economic and Social Research provided a review of existing multicountry models. Drs Marinos Tsigas and Thomas Hertel provided crucial research skills in the estimation of international trade margins.

Top class clerical support for the project was provided by Roberta Wise, Christine Hryhoriak and Malcolm Fisher.

WILFRED EDWARD GRAHAM SALTER

Wilfred Salter was born in Western Australia in 1929. He graduated with first-class honours from the University of Western Australia in 1952, and gained his PhD from Clare College, Cambridge, in 1955 for his thesis *A Consideration of Technological Change with Special Reference to Labour Productivity*. His research continued at John Hopkins and the Australian National University, culminating in the publication in 1960 of his most important work, *Productivity and Technical Change* — 'one of the finest — and earliest — examples of the embodiment hypothesis' (Harcourt 1972). Also while at the Australian National University, he developed with T.W. Swan the dependent economy (small country) model of stabilisation policy, indicating the role played by changes in the real exchange rate (Salter 1959). In 1960 he left the University to become Assistant Secretary in the Economic Section of the Prime Minister's Department. Taking leave from the public service in 1962, he joined the Harvard Advisory Group as Economic Adviser to the Government of West Pakistan. He died in Lahore in 1963.

> The activities of the last four years of his life show Salter's view of what an economist should be. Not content with even the most thorough academic training, with spinning theories, or with analysing cold statistics, he believed that an economist should learn his trade by responsible experience in varied fields. His decisions to join the Commonwealth Service and to work in Pakistan were part of a deliberate plan to fit himself for an economist's job, whether his future might lie in academic or in government service. (Swan 1963)

> Salter's work [on productivity and technical change] is a model which all aspiring (and established) economists could profitably have before them. Its characteristics are a flair for formulating relevant theory which, clearly, neatly and excitingly expressed, is carried no further than the requirements of the problem in hand — and is immediately tested against the facts. (Harcourt 1972)

The world trade model developed for the Department of Foreign Affairs and Trade has been given the acronym SALTER (Sectoral Analysis of Liberalising Trade in the East Asian Region) in his honour.

CONTENTS

BOXES

FIGURES

TABLES

1 THE SALTER MODEL STRUCTURE

The SALTER (Sectoral Analysis of Liberalising Trade in the East Asian Region) model is a computable general equilibrium model in the tradition of Whalley's (1985) models of world trade. Other models of this type include the WALRAS (World Agricultural Liberalisation Study) model used to analyse the economic implications of reducing agricultural assistance in member countries of the Organisation for Economic Co-operation and Development (Burniaux, Delorme, Lienert and Martin 1990), and the Michigan model of North–South trade relations between developed and developing countries (Deardorff and Stern 1986).

Like these models, the SALTER model is composed of regional submodels that describe in varying degrees of detail the economic activities of firms, households and governments. The regional submodels are linked through international trade flows to form a general equilibrium model in which prices and quantities supplied and demanded are determined simultaneously in all primary factor markets and domestic and international commodity markets.

A simulation reflects the reactions of households, firms and governments to a change in the policies or economic conditions facing them. The underlying functions used to specify the behaviour of households, firms and governments are nonlinear. However, following Johansen (1974) the SALTER model is specified in terms of percentage changes in quantities and prices. This results in a model in which behaviour is described by linear relationships. As in the original Johansen linearised model, the variables specified in the SALTER model are therefore the percentage changes in quantities and prices that occur in reaction to the changes in conditions facing households, firms and governments in their allocation decisions.

Specifying the model in linear terms enables the model to be solved using matrix inversion techniques and can assist in interpreting more complex simulations. But solving the model in this form gives rise to linearisation errors. Dixon, Parmenter, Sutton and Vincent (1982, pp. 206–7) describe a procedure by which a nonlinear solution to the underlying problem can be obtained from a problem specified in linear terms. This process is based on an extrapolation of solutions obtained with a Euler solution procedure and is the default solution procedure used for the SALTER model.

Regions and commodities

The SALTER model consists of eight countries or groups of countries (box 1.1), which together accounted for about 80 per cent of world gross domestic product in 1987. The world's major market oriented economies — Japan, the United States and the European Community — are explicitly modelled. The rapidly growing regions of Asia are represented through the inclusion of the ASEAN region as an aggregate and the Republic of Korea. The close economic ties Australia has with New Zealand are captured through the inclusion of these two economies.

Countries not explicitly modelled are included in a 'rest of the world' aggregate which is treated as a single trading entity. The rest of the world component of the model does not include explicit equations to describe producer and consumer behaviour. Rather this information is condensed into a set of trade elasticities which describe how trade in the rest of the world responds to movements in the prices it faces from its trading partners relative to its own trade prices.

In each country in the model, 34 commodities and industries are distinguished (box 1.2). This amount of detail was considered necessary to model issues of concern to Australia and its trading partners. The model thus explicitly recognises the production of key agricultural commodities of importance to the ASEAN region such as paddy rice and non-grain crops but still includes Australia's major resource based exports — wool, wheat and coal. Labour-intensive manufacturing industries, such as spinning, dying and made-up textiles, wearing apparel, leather, fur and their products, are identified separately as are the resource based industries of lumber and wood products and pulp, paper and printing. The heavy

Box 1.1: **Regions in the SALTER model**

1	Australia	
2	New Zealand	
3	Canada	
4	United States	
5	Japan	
6	Republic of Korea	
7	European Community	(United Kingdom, France, Federal Republic of Germany, Italy, Belgium, Netherlands, Luxemburg, Denmark, Ireland, Greece, Spain, Portugal)
8	ASEAN members	(Indonesia, Thailand, Singapore, Malaysia, the Philippines, Brunei)
9	Rest of the world	

Box 1.2: **Industries and commodities in the SALTER model**

1	Paddy rice	18	Leather, fur and their products
2	Non-grain crops	19	Lumber and wood products
3	Wheat	20	Pulp, paper and printing
4	Other grains	21	Chemicals, rubber and plastic
5	Wool	22	Petroleum and coal products
6	Other livestock products	23	Non-metallic mineral products
7	Forestry	24	Primary iron and steel
8	Fishing	25	Other metals and products
9	Coal	26	Transport industries
10	Oil and gas	27	Other machinery and equipment
11	Other minerals	28	Other manufacturing
12	Meat products	29	Electricity, gas and water
13	Milk products	30	Construction
14	Other food products	31	Trade and transport
15	Beverages and tobacco	32	Other services (private)
16	Spinning, dyeing and made-up textiles	33	Other services (government)
17	Wearing apparel	34	Other services (ownership of dwellings)

manufacturing industries which have formed the basis of the rapid growth of several European economies, Japan and Korea are also recognised.

The model recognises three primary factors of production: labour, capital and farm land. While capital and labour can be mobile across all industries, farm land is used only in agricultural industries. In contrast to commodities, primary factors are not traded between regions in the model. The aggregate quantity of farm land and capital available in each economy is fixed, but the supply of labour in each region is determined by the model.

The economic structure of the SALTER model

The SALTER model represents the behaviour of households, firms and governments in each of the regions listed in box 1.1. It is a model in which changes in equilibrium quantities and prices are determined by the specified behaviour of economic agents and the structure of international trade assumed to prevail. The rate of growth of the economies modelled is not determined in the model: simple assumptions about savings are made and real investment demand is assumed to be determined exogenously. The SALTER model is therefore not dynamic, but rather a comparative static model. Reactions to a change in the economic conditions facing economic agents are represented by the adaptations they make in order to achieve a new equilibrium. The way in which these adaptations occur is not determined by the model; rather the changes observed in a simulation are those that would result given enough time to attain a new equilibrium.

The SALTER model consists of a series of regional submodels. Each submodel is composed of different blocks:

- a macroeconomic block, which keeps track of national accounting aggregates;
- a consumer demand block, which determines how households allocate their budget among alternative consumer goods;
- a production block, which determines how firms allocate their resources to produce output; and
- a government block, which describes the fiscal activities of the government and how the government allocates its revenues among commodity purchases and transfers to households.

In addition to blocks applying to regional demands and supplies, there is a rest of the world block which describes trade among the regions that are not explicitly modelled.

Macroeconomic aggregates and behaviour

The definitions of macroeconomic aggregates and basic macroeconomic identities defined in the SALTER model are given in table 1.1. These equations describe the basic links between income and aggregate expenditures for private and public consumption and investment. A complete list of parameters and variables used to specify the SALTER model is provided in appendix 1A at the end of this chapter. The model is written in terms of percentage changes in the variables; simple rules are followed in deriving the model's linear equations from the underlying nonlinear structure (box 1.3).

Aggregate net primary factor income is defined in equation S1 for each region as the sum of net income from the three primary factors: labour, capital and farm land. Thus net factor income is the sum of income earned by labour in each industry, income earned by farm land in the agricultural industries, and income earned by capital, less depreciation. Since variables are defined in terms of percentage changes, a change in net primary factor income (y_F^z) is proportional to changes in each of its components, according to each component's share in net primary factor income.

Table 1.1: **Macroeconomic relations in the SALTER model**

No.[a]	*Equation*	*Range*
Aggregate net primary factor income		
S1	$y_F^z = \sum_{k \neq 2} S_{Yk}^z (w_k^z + f_{Dk}^z) + \sum_{j=1}^{J} S_{Y2j}^z (w_{2j}^z + f_{2j}^z) - S_{YD}^z \, dep^z$	$z = 1,\ldots,S$
Aggregate household income		
S2	$y^z = S_{YF}^z \, y_F^z + S_{YT} \, t_G^z$	$z = 1,\ldots,S$
Aggregate household disposable income (income side)		
S3	$y_d^z = y^z - R_{TY}^z \, t_Y^z$	$z = 1,\ldots,S$
Aggregate household disposable income (disposition side)		
S4	$y_d^z = S_{YS}^z \, sv^z + S_{YC}^z \, c_T^z$	$z = 1,\ldots,S$
Aggregate consumption expenditure		
S5	$c_T^z = sv^z + h_c^z$	$z = 1,\ldots,S$

Number of equations: 5*S*.

[a] Equation numbers preceded by S indicate that the corresponding equation is part of the standard set of equations composing the SALTER model. Other equations used to explain or complement the basic structure of the SALTER model are numbered according to the chapter or appendix in which they are found.

Note: Complete variable and parameter descriptions are found in appendix 1A at the end of this chapter.

The change in returns to a.factor may be attributed to a change in the quantity employed (f_{Dk}^z) or a change in the factor's price (w_k^z). In the case of capital, it is assumed that returns can be differentiated by industry; this gives rise to the second term in equation S1, in which industry-specific returns to capital are summed over all *j* industries in a region.

The three primary factors are assumed to be owned by households, and returns for their services are therefore appropriated by households. Net factor income plus transfers from the government constitute aggregate household income. In equation S2, the change in aggregate household income (y^z) is obtained as a share-weighted sum of changes in net factor incomes (y_F^z) and government transfers to households (t_G^z).

Income taxes are calculated by multiplying aggregate household income by the average income tax rate. Therefore, aggregate household disposable income is obtained by:

$$Y_d^z = Y^z\left(1 - T_Y^z\right) \quad (1.1)$$

where Y_d^z is aggregate household disposable income, Y^z is aggregate household income and T_Y^z is the average income tax rate.

Box 1.3: **Writing the SALTER model in terms of linear percentage changes**

Each equation in the SALTER model is a first-order approximation to an underlying function, which is expressed in terms of linear percentage changes in the variables. An underlying production function may be written:

$$Y = f(X_1, X_2)$$

where Y is output and X_1 and X_2 are the levels of inputs 1 and 2 used in production. Expressed in linear percentage change terms the above relation may be written as a first-order approximation:

$$y = \varepsilon_1 x_1 + \varepsilon_2 x_2$$

where $y = 100\,\mathrm{d}Y/Y$, $x_1 = 100\,\mathrm{d}X_1/X_1$ and $x_2 = 100\,\mathrm{d}X_2/X_2$ are the percentage changes in output, input 1 and input 2 respectively. Parameters ε_1 and ε_2 are the elasticities of output to the use of inputs 1 and 2 respectively.

Using the above conventions for expressing percentage changes, two rules are used extensively in deriving the SALTER system of equations. Using logarithmic differentials, a product expressed in levels is translated as the sum of the percentage changes in the components of the product. Thus an expression of the value of commodity X such as:

$$V = PX$$

where X is the quantity of a commodity, P its price and V its value, results in the following expression after taking the log differentials:

$$\mathrm{d}\log V = \mathrm{d}\log P + \mathrm{d}\log X$$

$$\frac{\mathrm{d}V}{V} = \frac{\mathrm{d}P}{P} + \frac{\mathrm{d}X}{X}$$

$$v = p + x$$

where v, p and x are the percentage changes of V, P and X, the variables expressed in level terms.

An additive relation in the levels of the variables results in a share-weighted expression when expressed in percentage changes. For example, differentiating the following simple relation between output, consumption and savings:

$$Y = C + S$$

where Y is output, C is consumption and S is savings, yields:

$$\mathrm{d}Y = \mathrm{d}C + \mathrm{d}S$$

Taking relative changes, results in:

$$Yy = Cc + Ss$$

where y, c and s are percentage changes in the level variables Y, C and S respectively. Such a relation is expressed in the SALTER equation system as:

$$y = S_C c + S_S s$$

where $S_C = C/Y$ and $S_S = S/Y$ are the shares of each component in the quantity expressed on the left hand side of the equation.

Totally differentiating the expression above and expressing the changes in percentage change form and using the conventions in box 1.3 yields:

$$Y^z_d y^z_d = Y^z y^z - T^z_Y Y^z y^z - T^z_Y Y^z t^z_Y \tag{1.2}$$

$$y^z_d = \frac{\left(Y^z - T^z_Y Y^z\right)}{Y^z_d} y^z - \frac{T^z_Y Y^z}{Y^z_d} t^z_Y \tag{1.3}$$

The term in parentheses amounts to aggregate household disposable income. This results in the expression in equation S3, where the coefficient on Y^z has been simplified to one and the coefficient on t^z_Y (the change in the power of the income tax) is the ratio of total income taxes collected to disposable income (R^z_{TY}).

Given their disposable incomes, households can allocate their resources to savings or consumption expenditures. In equation S4, the percentage change in aggregate disposable household income (y^z_d) is decomposed into the percentage changes in savings (sv^z) and aggregate consumption expenditure (c^z_T).

In many scenarios, savings and consumption are assumed to be a fixed proportion of disposable income. These proportional changes in consumption expenditures (c^z_T) and savings (sv^z) are equal. This is achieved by setting the change in the consumption to savings ratio (h^z_c) exogenously equal to zero in equation S5. Some simulations may, however, require the proportional relationship between consumption and savings be cut. This can be achieved by setting the consumption to savings ratio (h^z_c) endogenously.

Domestic product is a measure of a region's contribution to global production and a measure of income generated in a region. Changes in net and gross domestic product are defined in nominal terms in equations S6 to S8 (table 1.2). Measured from the expenditure side, net domestic product is the sum of all uses of domestically produced output net of depreciation. Thus in equation S6, the percentage change in this measure (ndp^z_E) is obtained as the weighted sum of percentage changes in private consumption expenditure (c^z_T), gross investment (inv^z_T), government consumption expenditure (z^z_G) and export demand (exp^z_T) less changes in depreciation of the capital stock (dep^z) and aggregate imports valued in local currency units and net of duties ($imp^z_T + e^z$). Except for imports, each component of net domestic product is valued at purchasers' prices, and therefore includes all applicable taxes. Imports are valued net of duties because duties are transfers from the private to the public sector which remain within a region's economy and do not add to a region's cost of acquiring commodities from abroad.

Measured from the disposition side, the change in net domestic product (ndp_D^z) in equation S7 is equal to the weighted sum of changes in households' allocation of disposable income between consumption expenditure (c_T^z) and savings (sv^z) and changes in public revenues (r_G^z) less transfers from the government to households (t_G^z). Transfers are subtracted in equation S7 to avoid double counting them as private income and government revenues.

Both definitions of net domestic product should result in the same changes being observed if the initial database is balanced. The standard macroeconomic relations between trade balance and national savings can be derived from them (box 1.4). Also, the expected equality of both measures has been useful in developing the model, providing a check for consistency.

The change in gross domestic product at factor cost (gdp_F^z) is calculated in equation S8 as the weighted sum of changes in income for each primary factor. A change in income is due to a change in factor prices (w_k^z and w_{2j}^z) or a change in factor employment (f_{Dk}^z and f_{2j}^z). The difference between net factor income (the change of which is described in equation S1) and gdp at factor cost is depreciation.

Table 1.2: **Major macroeconomic indicators in the SALTER model**

No.	*Equation*	*Range*
Net domestic product from the expenditure side		
S6	$ndp_E^z = S_{NC}^z c_T^z + S_{NK}^z inv_T^z - S_{ND}^z dep^z + S_{NZ}^z z_G^z + S_{NE}^z exp_T^z - S_{NI}^z\left(e^z + imp_T^z\right)$	$z = 1,...,S$
Net domestic product from the disposition side		
S7	$ndp_D^z = S_{NC}^z c_T^z + S_{NS}^z sv^z + S_{NR}^z r_G^z - S_{NT}^z t_G^z$	$z = 1,...,S$
Gross domestic product at factor cost		
S8	$gdp_F^z = \sum_{k\neq 2} S_{GDPk}^z (w_k^z + f_{Dk}^z) + \sum_{j=1}^{J} S_{GDP2j}^z (w_{2j}^z + f_{2j}^z)$	$z = 1,...,S$
Real aggregate household disposable income		
S9	$y_{dR}^z = y_d^z - cpi^z$	$z = 1,...,S$
Real aggregate household consumption expenditure		
S10	$c_{TR}^z = c_T^z - cpi^z$	$z = 1,...,S$
Real net domestic product from the expenditure side		
S11	$ndp_{ER}^z = ndp_E^z - npi_E^z$	$z = 1,...,S$
Real gross domestic product at factor cost		
S12	$gdp_{FR}^z = gdp_F^z - gpi^z$	$z = 1,...,S$

Number of equations: 7*S*.
Note: Complete variable and parameter descriptions are found in appendix 1A at the end of this chapter.

Real indicators are defined in equations S9 to S12 in table 1.2. Real aggregate household disposable income is obtained by dividing nominal disposable income by the consumer price index. The consumer price index is defined as a weighted average of prices paid for private consumption where the weights are shares of private consumption expenditures on the various commodity groups (see table 1.10). The percentage change in real household disposable income (y^z_{dR}) is obtained in equation S9 as the difference between the percentage changes in disposable income (y^z_d) and the consumer price index (cpi^z).

Real aggregate consumption expenditure is often used as an indicator of the welfare effects of a policy change. The change in real consumption (c^z_{TR}) is obtained in equation S10 by deflating nominal consumption expenditures (c^z_T) by the consumer price index. When the fixed proportion relation between consumption and disposable income is assumed ($h^z_c = 0$ in equation S5), both aggregates in nominal and real terms change by the same relative amount.

Shoven and Whalley (1984) indicate that when government revenues are allowed to change, the welfare impact of a policy change is better measured by adding the provision of government services in the form of real government spending to real consumption. This aggregate measure of welfare is used instead of real consumption in simulations in which real government spending is determined endogenously.

Real net domestic product and gross domestic product at factor prices are obtained by deflating the nominal values by their corresponding price deflators. These deflators are

Box 1.4: Standard macroeconomic identities implied by the SALTER model structure

The macroeconomic identities calculated in the SALTER model can be shown to imply the standard relations between savings and investment and the balance of trade. Expressing equations S6 and S7 in terms of levels and equating them yields:

$$C^z_T + INV^z_T - DEP^z + Z^z_G + EXP^z_T - IMP^z_T = C^z_T + SV^z + R^z_G - T^z_G$$

where upper case symbols represent the levels of the corresponding variables defined in percentage changes, and imports (IMP^z_T) are expressed in local currency units. Rewriting the above equation yields:

$$SV^z + R^z_G - T^z_G - Z^z_G - \left(INV^z_T - DEP^z\right) = EXP^z_T - IMP^z_T$$

The left hand side of this equation defines domestic savings as the sum of net private and public savings, where net private savings are equal to private savings less net investment, and net public savings (as the public sector borrowing requirement) are defined as the difference between government revenues and government outlays. The right hand side is simply the trade surplus. The relations in the model therefore reflect the equality between net domestic savings and a trade surplus.

constructed as indices in which the weights are the nominal components of each aggregate. Changes in real net domestic product and real gross domestic product (ndp^z_{ER} and gdp^z_{FR}) are calculated in equations S11 and S12 respectively as the difference between changes in the nominal values (ndp^z_E and gdp^z_F) and the corresponding deflators (npi^z and gpi^z) defined in table 1.10.

Microeconomic behaviour

Changes in the macroeconomic aggregates discussed above result from the assumptions made about the behaviour of households, firms and governments. Households are assumed to maximise the utility derived from the consumption of commodities, while producers minimise the costs of producing commodities under perfect competition conditions. The government is assumed to minimise the cost of acquiring commodities for public consumption. Since the model is not dynamic, investment cannot be determined with the model, and the real rate of investment is assumed to be fixed. All these microeconomic activities entail a number of commodity flows within the regions modelled and among them. The importance of international trade flows in the SALTER model is reflected in the detailed specification of the choices available to economic agents in terms of their commodity imports.

Consumer demand

Consumer demand in each region is determined by assuming that a single representative consumer maximises the utility derived from consuming a bundle of commodities. The equations specifying consumer behaviour are found in table 1.3. The utility function used results in the linear expenditure system (Phlips 1974) expressed by equation S13. Thus, the change in the consumption of a commodity (c^z_i) is a linear function of changes in the commodity's price paid by consumers (p^z_{Ci}), competing commodities' prices (p^z_{Ch}, $h \neq i$), and the resources allocated to consumption or aggregate consumption expenditure (c^z_T). The parameters specifying these linear relations are the own-price and cross-price elasticities of consumer demand (λ^z_{ih}) which reflect consumers' attitudes to a change in the relative prices of the components of the consumption bundle. The expenditure elasticity (μ^z_i) describes how consumption of a commodity changes with a change in aggregate consumption expenditure. With this system, assuming aggregate consumption expenditure and prices are known, the consumption level of each commodity in each region (c^z_i) can be determined.

Commodities in the SALTER model are differentiated in terms of their origin. Thus, once consumers have determined the level of consumption of a commodity they are assumed to minimise the cost of acquiring this commodity aggregate by choosing among different sources.

This choice is constrained by the 'Armington assumption' (Armington 1969a,b) used to specify the trade structure in the SALTER model. The structure implies that domestic and imported commodities are imperfect substitutes and are exchanged according to a constant elasticity of substitution. Similarly, an elasticity of substitution reflects the degree of substitutability between imports from different sources. This structure is reflected in equations S14 to S16; it requires just two parameters. They are β_i^z, the elasticity of substitution constraining consumers' choices between a domestically produced commodity (c_i^{Dz}) and an imported commodity (c_i^{Iz}); and β_i^{Iz}, the elasticity of substitution constraining choices among imports of commodity *i* from different sources (c_{is}^{Iz}). A graphic representation of the complete consumer demand structure in a region is found in figure 1.1.

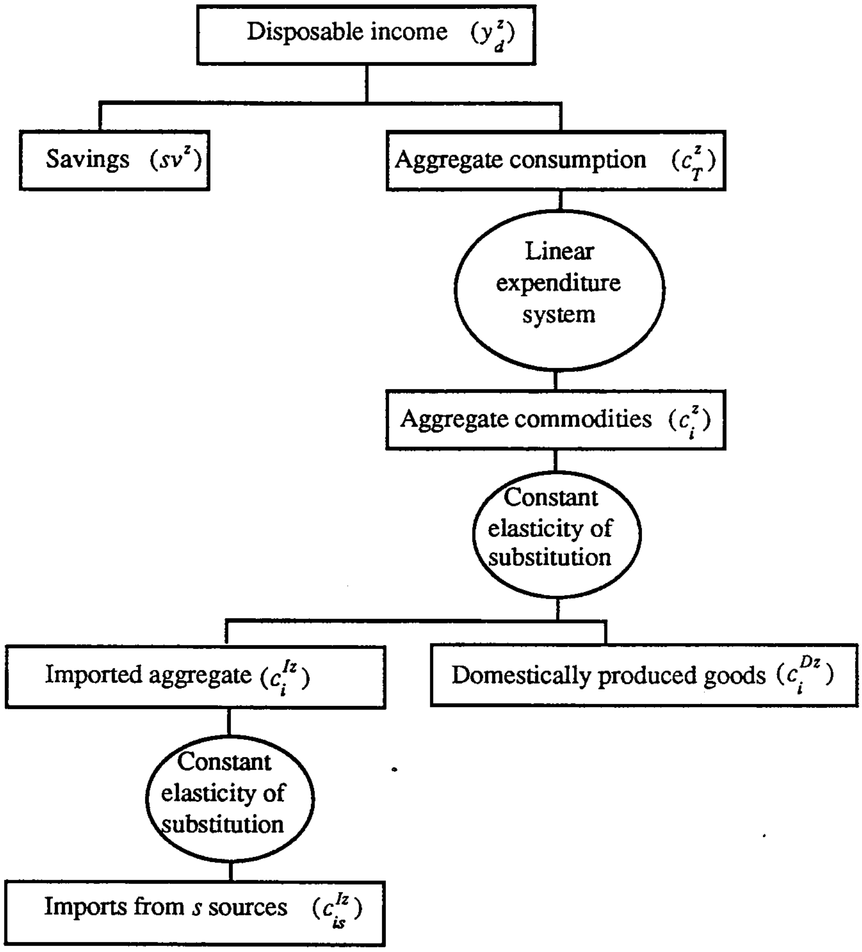
Table 1.3: **Equations describing consumer behaviour in the SALTER model**

No.	*Equation*	*Range*
Consumer demand for commodity aggregates		
S13	$c_i^z = \sum_{h=1}^{I} \lambda_{ih}^z p_{Ch}^z + \mu_i^z c_T^z$	$i = 1,\ldots,I$ $z = 1,\ldots,S$
Demand for domestic commodities		
S14	$c_i^{Dz} = c_i^z - \beta_i^z \left(p_{Ci}^{Dz} - p_{Ci}^z\right)$	$i = 1,\ldots,I$ $z = 1,\ldots,S$
Demand for imported aggregate commodities		
S15	$c_i^{Iz} = c_i^z - \beta_i^z \left(p_{Ci}^{Iz} - p_{Ci}^z\right)$	$i = 1,\ldots,I$ $z = 1,\ldots,S$
Demand for imported commodities, by source		
S16	$c_{is}^{Iz} = c_i^{Iz} - \beta_i^{Iz} \left(p_{Cis}^{Iz} - p_{Ci}^{Iz}\right)$	$i = 1,\ldots,I$ $s = 1,\ldots,S+1$ $z = 1,\ldots,S$
Labour supply		
S17	$f_{S1}^z = \chi_1^z \left[w_1^z - cpi^z - R_{TY}^z t_Y^z\right] + h_D^z$	$z = 1,\ldots,S$

Number of equations: $IS^2 + 4IS + S$.

Note: Complete variable and parameter descriptions are found in appendix 1A at the end of this chapter.

Figure 1.1: **Structure of consumer expenditure and savings in the SALTER model**



IC Chart.

This schematic representation summarises how the representative household first allocates disposable income between savings and consumption expenditures, and then follows the three-step procedure described above to determine the optimal quantities of imported and domestically produced commodities used to minimise the cost of acquiring the aggregate consumption bundle.

In addition to supplying private savings and consuming commodities, households are assumed to supply primary factors — labour, capital and farm land. Households receive the returns paid to primary factors in return for their services. While the supplies of farm land and capital are assumed to be fixed in each region, households are able to adjust their supply of labour in response to changes in the real after-tax wage rate. Equation S17 expresses the change in the supply of labour (f_{S1}^z) as a linear function of changes in the money wage rate

(w_1^z) deflated by the consumer price index (cpi^z), less changes in the income tax rate (t_Y^z). The elasticity of labour supply (χ_1^z) is used to specify the way in which households respond to a change in real after-tax returns to labour.

Firms' demands for inputs

Firms use primary factors along with intermediate inputs to produce output. In each region, single-output firms produce using a constant returns to scale technology. Given a level of output, a representative firm for each sector is assumed to minimise the cost of acquiring the inputs needed for production. The equations describing firms' derived demands are found in table 1.4.

Table 1.4: **Derived demands for inputs in the SALTER model**

No.	*Equation*	*Range*
Industry demands for primary factors		
S18	$f_{kj}^z = q_j^z - \sigma_j^z \left[w_{kj}^z - \sum_{m=1}^{K} S_{mj}^z w_{mj}^z \right] + a_j^z + a_{kj}^z - \sigma_j^z \left[a_{kj}^z - \sum_{m=1}^{K} S_{mj}^z a_{mj}^z \right]$	$j = 1,\dots,J$; $k = 1,\dots,K$; $z = 1,\dots,S$
Aggregate primary factor demands		
S19	$f_{Dk}^z = \sum_{j=1}^{J} S_{Dkj}^z f_{kj}^z$	$k = 1,\dots,K$; $z = 1,\dots,S$
Intermediate demand for domestic commodities		
S20	$x_{ij}^{Dz} = q_j^z - \eta_i^z \left[p_{Pij}^{Dz} - p_{Pij}^z \right] + a_j^z + a_{Xj}^z$	$i = 1,\dots,I$; $j = 1,\dots,J$; $z = 1,\dots,S$
Intermediate demand for imported commodities		
S21	$x_{ij}^{Iz} = q_j^z - \eta_i^z \left[p_{Pij}^{Iz} - p_{Pij}^z \right] + a_j^z + a_{Xj}^z$	$i = 1,\dots,I$; $j = 1,\dots,J$; $z = 1,\dots,S$
Intermediate demand for imported commodities, by source		
S22	$x_{isj}^{k} = x_{ij}^{Iz} - \eta_i^{Iz} \left[p_{Pisj}^{Iz} - p_{Pij}^{Iz} \right]$	$i = 1,\dots,I$; $j = 1,\dots,J$; $s = 1,\dots,S+1$; $z = 1,\dots,S$

Number of equations: $JKS + KS + 3IJS + IJS^2$
Note: Complete variable and parameter descriptions are found in appendix 1A at the end of this chapter.

Individual firms are assumed to combine a bundle of intermediate inputs in fixed proportion with a bundle of primary factors. The bundle of primary factors is composed of labour, capital and land; they are aggregated according to a constant elasticity of substitution function. Thus if a primary factor becomes cheaper, firms have limited opportunities to substitute it for other primary factors, to thereby reduce their costs of production. In equation S18 the change in demand for a primary factor by a firm (f^z_{kj}) is proportional to changes in output (q^z_j), and a linear function of the change in the price of the factor (w^z_{kj}) relative to the prices of other primary factors, calculated as the weighted average return to all primary factors.

In addition to changes in prices, changes in the production efficiency of inputs can effect change in a firm's demand for primary factors. In equation S18 variable a^z_j is used to model a neutral, output-increasing technical change, while variable a^z_{kj} reflects a change affecting the use of a particular primary factor. Because primary factors can be substituted for each other, demand for a factor whose efficiency improves is affected by opportunities for substitution with other primary factors.

Equation S19 describes the change in aggregate demand for a factor as the share-weighted sum of changes in factor demands in individual industries. Since the supplies of farm land and capital are assumed fixed and full employment of these factors prevails, the weighted sum of industries' uses of each factor must add up to zero, indicating that only reallocation among industries is possible, but no growth in aggregate factor demands can occur.

The demand for intermediate inputs is assumed to vary in fixed proportion with a firm's output. Hence, the demand for an intermediate input is determined once the level of output is determined. The Leontief structure implies that production processes are relatively inflexible in their use of intermediate inputs. However, firms are assumed to minimise the cost of acquiring these inputs by purchasing them domestically or from different foreign suppliers. Imported intermediate inputs from different regions are assumed to be imperfect substitutes for each other and for domestically produced inputs. In sourcing their inputs, firms are therefore assumed to face choices similar to those faced by households in sourcing their consumption.

This nested structure of input demand is reflected by equations S20 to S22. Equations S20 and S21 express the changes in demand for domestic and imported inputs, respectively, as changing in direct proportion with the level of output (q^z_j) and the price of the inputs from its corresponding source, relative to the average price of the input across all sources. Output-increasing technical change (a_j^z) and intermediate input-saving technical change (a_{Xj}^z) can affect the demand for both domestically produced and imported inputs.

Equation S22 reflects the ability of firms to substitute among different sources of imports. The change in demand for an input from a given source is affected by the level of aggregate import of this input (x_{ij}^{Iz}) and the change in its price relative to the price of acquiring it from another import source.

In addition to demanding inputs and primary factors for current production, firms demand resources for investment purposes. The amount of each commodity needed to satisfy investment purposes is assumed to vary in fixed proportions with the aggregate level of real investment. The allocation of investment by commodity is determined in equation S23 to S25 (table 1.5) using the same nested Armington structure as for consumers and intermediate input demands.

While real investment is usually determined exogenously, nominal investment used to calculate macroeconomic aggregates is obtained by multiplying real investment by a price index of commodities used in investment. The change in nominal investment is therefore

Table 1.5: **Investment demand in the SALTER model**

No.	*Equation*	*Range*
Investment demand for domestic commodities		
S23	$inv_i^{Dz} = inv_{TR}^z - \beta_{Ki}^z\left(p_{Ki}^{Dz} - p_{Ki}^z\right)$	$i = 1,...,I$ $z = 1,...,S$
Investment demand for imported commodity aggregates		
S24	$inv_i^{Iz} = inv_{TR}^z - \beta_{Ki}^z\left(p_{Ki}^{Iz} - p_{Ki}^z\right)$	$i = 1,...,I$ $z = 1,...,S$
Investment demand for imported commodities, by source		
S25	$inv_{is}^{Iz} = inv_i^{Iz} - \beta_{Ki}^{Iz}\left(p_{Kis}^{Iz} - p_{Ki}^{Iz}\right)$	$i = 1,...,I$ $s = 1,...,S+1$ $z = 1,...,S$
Aggregate nominal investment		
S26	$inv_T^z = inv_{TR}^z + pci^z$	$z = 1,...,S$
Depreciation of the capital stock		
S27	$dep^z = f_{D2}^z + pci^z$	$z = 1,...,S$

Number of equations: $IS^2 + 3IS + 2S$
Note: Complete variable and parameter descriptions are found in appendix 1A at the end of this chapter.

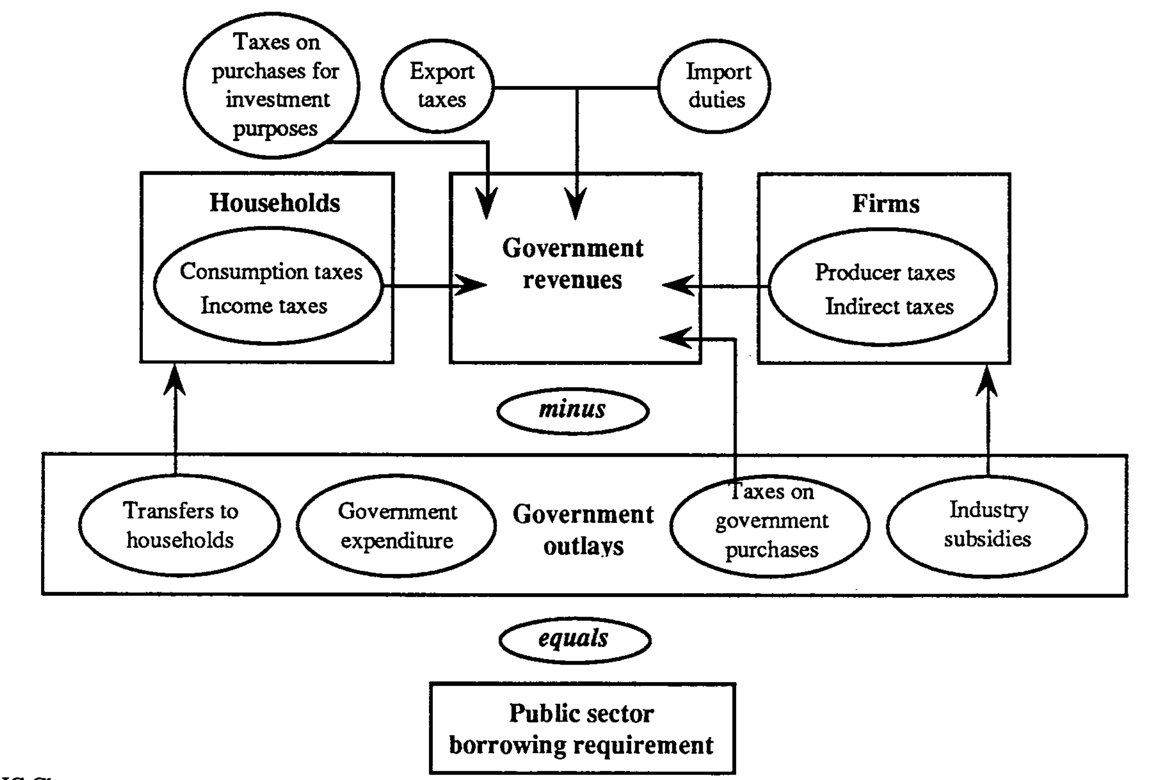
calculated in equation S26 as the sum of changes in real investment (inv^z_{TR}) and the investment price index (pci^z) defined in table 1.10 as the weighted average cost of purchasing commodities for investment purposes.

Depreciation of the capital stock is used to calculate net investment for macroeconomic aggregates. It is based on the value of the capital stock, but valued in terms of the value of capital services supplied during a period. Since the supply of capital services is assumed constant and full employment is assumed to prevail, the supply of capital equals demand. In equation S27, changes in depreciation are therefore calculated as the sum of changes in the demand for capital — used as a proxy for the capital stock — and changes in the prices of investment goods.

Government activities

A number of income transfers occur between the private and government sectors (figure 1.2). The government collects taxes from households in the form of income taxes and taxes on

Figure 1.2: **Fiscal flows in the SALTER model**



IC Chart.

consumer purchases. In return, it redistributes income by distributing transfers to households. Ad valorem taxes are levied on all other purchases of commodities — that is, on purchases by producers and the government and for investment purposes. In each region, governments also collect taxes on international trade, as duties may be imposed on imports and taxes may affect exports. In addition to transfers to households, total government outlays include the provision of subsidies to selected industries and the purchase of commodities. The difference between total outlays and the government's revenue obtained through taxes constitute the public sector's borrowing requirement.

The government's activities in each modelled region is summarised in table 1.6. The government's fiscal activities are described by equations S28 to S37. The contribution of each tax to aggregate government revenue is calculated in equations S27 to S34.

The change in the contribution of a tax to aggregate government revenue is due to two effects. Taking equation S33 as an example, we distinguish the direct effect of a change in taxes on government revenue from commodity taxes (R^z_{GT}) which is proportional to the expenditure on the commodity affected by the tax (E^z_{Ei}). The indirect effect is found in the second term of equation S33 where tax revenues (T^z_{Ei}) are multiplied by the change in the value of the commodity purchased. The change in value reflects the reallocations due to a change in the taxes facing decision makers and is attributed to changes in the quantity exported (exp^z_i) and the price at which exports are sold (p^{Dz}_i). This principle applies to equations S28 to S33. In equation S34, since imports are valued at world prices, changes in the contribution of import duties to government revenues also depend on changes in the exchange rate (e^z).

Revenues from all commodity taxes are aggregated into a single variable. The change in aggregate commodity tax revenue (r^z_{GT}) is calculated in equation S36 as the sum of all contributions of commodity taxes. In equation S37 the change in aggregate government revenues (r^z_G) is calculated as the share-weighted sum of changes in revenues from commodity taxes (r^z_{GT}) and income taxes (r^z_{GY}).

Real transfers to households are calculated by deflating transfers by the consumer price index. In equation S38 changes in real transfers are found to be equal to changes in nominal transfers less the consumer price index.

The government makes demands on the economy in the form of demands for commodities for public consumption. The government's commodity demands by commodity and by source are

Table 1.6: The government's activities in the SALTER model

No.	*Equation*	*Range*
	Contribution of taxes on intermediate commodity use to commodity tax revenue	
S28	$r_{GX}^{z} = \frac{1}{R_{GT}^{z}} \sum_{j=1}^{J} \sum_{i=1}^{I} \left[E_{ij}^{Dz} t_{ij}^{Dz} + T_{ij}^{Dz}\left(x_{ij}^{Dz} + p_{i}^{Dz}\right) + \sum_{s=1}^{S+1} \left[E_{isj}^{Iz} t_{ij}^{Iz} + T_{ij}^{Iz}\left(x_{isj}^{Iz} + p_{is}^{Iz}\right)\right]\right]$	$z = 1,...,S$
	Contribution of consumption taxes to commodity tax revenue	
S29	$r_{GC}^{z} = \frac{1}{R_{GT}^{z}} \sum_{i=1}^{I} \left[E_{Ci}^{Dz} t_{Ci}^{Dz} + T_{Ci}^{Dz}\left(c_{i}^{Dz} + p_{i}^{Dz}\right) + \sum_{s=1}^{S+1} \left[E_{Cis}^{Iz} t_{Ci}^{Iz} + T_{Ci}^{Iz}\left(c_{is}^{Iz} + p_{is}^{Iz}\right)\right]\right]$	$z = 1,...,S$
	Contribution of taxes on government commodity purchases to commodity tax revenue	
S30	$r_{GG}^{z} = \frac{1}{R_{GT}^{z}} \sum_{i=1}^{I} \left[E_{Gi}^{Dz} t_{Gi}^{Dz} + T_{Gi}^{Dz}\left(gov_{i}^{Dz} + p_{i}^{Dz}\right) + \sum_{s=1}^{S+1} \left[E_{Gis}^{Is} t_{Gi}^{Iz} + T_{Gi}^{Iz}\left(gov_{is}^{Iz} + p_{is}^{Iz}\right)\right]\right]$	$z = 1,...,S$
	Contribution of investment taxes to commodity tax revenue	
S31	$r_{GK}^{z} = \frac{1}{R_{G}^{z}} \sum_{i=1}^{I} \left[E_{Ki}^{Dz} t_{Ki}^{Dz} + T_{Ki}^{Dz}\left(inv_{i}^{Dz} + p_{i}^{Dz}\right) + \sum_{s=1}^{S+1} \left[E_{Kis}^{Is} t_{Ki}^{Iz} + T_{Ki}^{Iz}\left(inv_{is}^{Iz} + p_{is}^{Iz}\right)\right]\right]$	$z = 1,...,S$
	Contribution of indirect taxes net of industry subsidies to commodity tax revenue	
S32	$r_{GI}^{z} = \frac{1}{R_{GT}^{z}} \sum_{j=1}^{J} \left[E_{Qj}^{z} s_{Qj}^{z} + S_{Qj}^{z}\left(q_{j}^{z} + p_{j}^{Dz}\right)\right]$	$z = 1,...,S$
	Contribution of export taxes to commodity tax revenue	
S33	$r_{GE}^{z} = \frac{1}{R_{GT}^{z}} \sum_{i=1}^{I} \left[E_{Ei}^{z} t_{Ei}^{z} + T_{Ei}^{z}\left(exp_{i}^{z} + p_{i}^{Dz}\right)\right]$	$z = 1,...,S$
	Contribution of import duties to commodity tax revenue	
S34	$r_{GD}^{z} = \frac{1}{R_{GT}^{z}} \sum_{i=1}^{I} \sum_{s=1}^{S+1} \left[E_{Mis}^{z} d_{is}^{z} + D_{is}^{z}\left(imp_{is}^{z} + p_{is}^{Wz} + e^{z}\right)\right]$	$z = 1,...,S$
	Income tax revenue	
S35	$r_{GY}^{z} = t_{Y}^{z} + y^{z}$	$z = 1,...,S$
	Commodity tax revenue net of industry subsidies	
S36	$r_{GT}^{z} = r_{GC}^{z} + r_{GX}^{z} + r_{GG}^{z} + r_{GK}^{z} + r_{GI}^{z} + r_{GE}^{z} + r_{GD}^{z}$	$z = 1,...,S$
	Aggregate government revenue net of industry subsidies	
S37	$r_{G}^{z} = S_{GY}^{z} r_{GY}^{z} + S_{GT}^{z} r_{GT}^{z}$	$z = 1,...,S$
	Real transfers to households	
S38	$t_{GR}^{z} = t_{G}^{z} - cpi^{z}$	$z = 1,...,S$

Number of equations: 11S.

Note: Complete variable and parameter descriptions are found in appendix 1A at the end of this chapter.

defined using the same structure as consumer and input demands in equation S39 to S41 (table 1.7). Government expenditure on commodities is assumed to be a fixed proportion of real aggregate government spending. Therefore when real government expenditure changes (g^z), public consumption of each commodity changes proportionally. The change in sourcing individual commodities is conditioned by the relative changes in prices of a particular commodity obtained from different sources.

For each demand category, the elasticity of substitution between domestic and imported commodities can be defined independently. In the case of government demand in particular, it might be realistic to assume a strong preference for domestic production, in which case the elasticity of substitution between domestic commodities and imports would be smaller than in other categories of demand.

In equation S42 the change in real government expenditure is obtained by deflating the change in nominal expenditure (z_G^z) by the price index corresponding to government purchases. In most simulations real government expenditure is assumed to be predetermined; hence equation S42 usually determines the change in nominal government expenditure, which is used in calculating macroeconomic aggregates.

Table 1.7: **Government demands for commodities and budget deficit**

No.	*Equation*	*Range*
Government demand for domestic commodities		
S39	$gov_i^{Dz} = g^z - \beta_{Gi}^z\left(p_{Gi}^{Dz} - p_{Gi}^z\right)$	$i = 1,\ldots,I$ $z = 1,\ldots,S$
Government demand for imported aggregate commodities		
S40	$gov_i^{Iz} = g^z - \beta_{Gi}^z\left(p_{Gi}^{Iz} - p_{Gi}^z\right)$	$i = 1,\ldots,I$ $z = 1,\ldots,S$
Government demand for imported commodities, by source		
S41	$gov_{is}^{Iz} = gov_i^{Iz} - \beta_{Gi}^{Iz}\left(p_{Gis}^{Iz} - p_{Gi}^{Iz}\right)$	$i = 1,\ldots,I$ $s = 1\ldots,S+1$ $z = 1,\ldots,S$
Real government purchases of commodities		
S42	$g^z = z_G^z - zpi^z$	$z = 1,\ldots,S$
Government budget deficit		
S43	$100\ bd^z = R_G^z r_G^z - \left(Z_G^z z_G^z + T_G^z t_G^z\right)$	$z = 1,\ldots,S$

Number of equations: $IS^2 + 3IS + 2S$.
Note: Complete variable and parameter descriptions are found in appendix 1A at the end of this chapter.

The government is assumed to be able to borrow in order to cover its deficit. The government budget deficit is calculated as the difference between government revenue and outlays — that is, government expenditure and transfers to households (equation S43). Because the government can run a deficit or a surplus, the variable describing the change in the budget deficit (bd^z) is not defined in terms of percentage changes as are most other variables in the SALTER model. A switch from a positive to a negative value would affect the sign of a variable defined in terms of percentage changes. Thus the change in the budget deficit (bd^z) is identified in terms of the absolute change in the budget deficit, and is calculated as the difference between the absolute change in government revenue ($R^z_G r^z_G$) and the sum of government expenditure ($Z^z_G z^z_G$) and transfers to households ($T^z_G t^z_G$).

In each region, the sum of all demands for commodities and primary factors is required to equal the supplies of each commodity and primary factor. These market clearing conditions are listed in table 1.8. In equation S44 the change in the production of each commodity (q^z_i) is required to equal the weighted sum of changes in all demands for the commodity. Changes in aggregate demand for a commodity are composed of changes in the demand for intermediate inputs, consumer demand, government demand, investment demand and export demand. The weights in the equation are the respective shares of each component in the aggregate demand for a commodity.

Table 1.8: **Market clearing conditions**

No.	*Equation*	*Range*
Market clearing condition for domestic commodities		
S44	$q^z_i = \sum_{j=1}^{J} S^{Dz}_{QXij}\, x^{Dz}_{ij} + S^{Dz}_{QKi}\, inv^{Dz}_i + S^{Dz}_{QCi}\, c^{Dz}_i + S^{Dz}_{QEi}\, exp^z_i + S^{Dz}_{QGi}\, gov^{Dz}_i$	$i = 1,\dots,J$ $z = 1,\dots,S$
Labour employment rate		
S45	$em^z_1 = f^z_{S1} - f^z_{D1}$	$z = 1,\dots,S$
Export demand for commodities, by destination		
S46	$exp^z_{si} = imp^s_{iz}$	$i = 1,\dots,J$ $s = 1,\dots,S+1$ $z = 1,\dots,S+1$
Imports of commodities, by source		
S47	$imp^z_{is} = \sum_{j=1}^{J} S^{Iz}_{MXisj}\, x^{Iz}_{isj} + S^{Iz}_{MKis}\, inv^{Iz}_{is} + S^{Iz}_{MCis}\, c^{Iz}_{is} + S^{Iz}_{MGis}\, gov^{Iz}_{is}$	$i = 1,\dots,J$ $s = 1,\dots,S+1$ $z = 1,\dots,S$

Number of equations: $2IS^2 + JS + 3IS + I + S$.

Note: Complete variable and parameter descriptions are found in appendix 1A at the end of this chapter.

Equilibrium in the labour market is expressed in equation S45 in terms of the rate of employment. This equation enables the change in the rate of employment (em_1^z) to be set exogenously for some simulations. The rate of employment is calculated as the difference between changes in labour supply and labour demand. For other primary factors (land and capital), full employment is assumed. For these factors, market equilibrium is modelled by setting aggregate demand for them ($f_{Dk}^z, k \neq 1$) exogenously.

Equilibrium among international commodity flows is ensured through equations S46 and S47. Equation S46 shows that changes in exports of a commodity from a given region are equal to changes in the imports by the receiving region of the corresponding commodity originating from the exporting region. On a more aggregate level, the sum of all uses of an imported commodity from a specified source is required to equal imports of that commodity from that source. Thus in equation S47 the change in an import (imp_{is}^z) is equal to the weighted sum of all uses of the commodity.

The equations in table 1.9 show the relation between prices of individual commodities from each source, taxes and price indexes of commodity aggregates. Ad valorem commodity taxes can be applied on entry to an economy in the form of a duty specific to the source of a commodity (d_{is}^z), or once inside an economy in the form of taxes according to the commodity, whether domestic or imported, and according to the use to which it is to be put (that is, t_{ij}^{Iz}, t_{ij}^{Dz}, t_{Ci}^{Iz}, t_{Ci}^{Dz}, t_{Gi}^{Iz}, t_{Gi}^{Dz}, t_{Ki}^{Iz}, t_{Ki}^{Dz}). Exports may also be taxed using t_{Ei}^z. All these variables are defined in terms of powers of the tax (that is, one plus the tax rate). This system of taxes allows the user to modify the wedges between prices at different stages of the exchange process. Since taxes are expressed in ad valorem terms, the change in a tax-paid price is equal to the sum of the change in the tax-free price and the change in the power of the tax. This principle applies to equations S48–S50, S53–S54, S57–S58, S61–S62 and S65.

Other equations in table 1.9 describe the changes in various price aggregates, such as the prices facing consumers in their choice between imports from different sources or the prices facing governments in their choices between domestic products and imports. Changes in these price aggregates are calculated as a weighted average of changes in disaggregated prices. Changes in aggregate prices are calculated for different levels of aggregation in intermediate demands (equations S51–S52), consumer demand (equations S55–S56), government demands (equations S59–S60) and investment demand (equations S63–S64).

Table 1.9: **Price transmission and price aggregation equations**

No.	*Equation*	*Range*
Border price of imported commodities, by source (cif)		
S48	$p_{is}^{Iz} = p_{is}^{Wz} + e^{z} + d_{is}^{z}$	$i = 1,...,I$ $s = 1,...,S+1$ $z = 1,...,S$
Producer price of imported intermediate commodities		
S49	$p_{Pisj}^{Iz} = p_{is}^{Iz} + t_{ij}^{Iz}$	$i = 1,...,I$ $j = 1,...,J$ $s = 1,...,S+1$ $z = 1,...,S$
Producer price of domestic intermediate commodities		
S50	$p_{Pij}^{Dz} = p_{i}^{Dz} + t_{ij}^{Dz}$	$i = 1,...,I$ $j = 1,...,J$ $z = 1,...,S$
Producer price of imported commodities		
S51	$p_{Pij}^{Iz} = \sum_{s=1}^{S+1} S_{Pisj}^{Iz}\, p_{Pisj}^{Iz}$	$i = 1,...,I$ $j = 1,...,J$ $z = 1,...,S$
Producer price of commodity *i*		
S52	$p_{Pij}^{z} = S_{Pij}^{Dz}\, p_{Pij}^{Dz} + S_{Pij}^{Iz}\, p_{Pij}^{Iz}$	$i = 1,...,I$ $j = 1,...,J$ $z = 1,...,S$
Consumer price of imported commodities, by source		
S53	$p_{Cis}^{Iz} = p_{is}^{Iz} + t_{Ci}^{Iz}$	$i = 1,...,I$ $s = 1,...,S+1$ $z = 1,...,S$
Consumer price of domestic commodities		
S54	$p_{Ci}^{Dz} = p_{i}^{Dz} + t_{Ci}^{Dz}$	$i = 1,...,I$ $z = 1,...,S$
Consumer price of composite imported commodities		
S55	$p_{Ci}^{Iz} = \sum_{s=1}^{S+1} S_{Cis}^{Iz}\, p_{Cis}^{Iz}$	$i = 1,...,I$ $z = 1,...,S$
Price paid by consumers for commodity *i*		
S56	$p_{Ci}^{z} = S_{Ci}^{Iz}\, p_{Ci}^{Iz} + S_{Ci}^{Dz}\, p_{Ci}^{Dz}$	$i = 1,...,I$ $z = 1,...,S$
Price paid by the government for imported commodities, by source		
S57	$p_{Gis}^{Iz} = p_{is}^{Iz} + t_{Gi}^{Iz}$	$i = 1,...,I$ $s = 1,...,S+1$ $z = 1,...,S$
Price paid by the government for domestic commodities		
S58	$p_{Gi}^{Dz} = p_{i}^{Dz} + t_{Gi}^{Dz}$	$i = 1,...,I$ $z = 1,...,S$

(Continued on next page)

Table 1.9: **Price transmission and price aggregation equations** *(continued)*

No.	*Equation*	*Range*
Price paid by the government for composite imported commodities		
S59	$p_{Gi}^{Iz} = \sum_{s=1}^{S+1} S_{Gis}^{Iz} p_{Gis}^{Iz}$	$i = 1,...,I$ $z = 1,...,S$
Price paid by the government for composite commodities		
S60	$p_{Gi}^{z} = S_{Gi}^{Iz} p_{Gi}^{Iz} + S_{Gi}^{Dz} p_{Gi}^{Dz}$	$i = 1,...,I$ $z = 1,...,S$
Price of imported commodities used in investment, by source		
S61	$p_{Kis}^{Iz} = p_{is}^{Iz} + t_{Ki}^{Iz}$	$i = 1,...,I$ $s = 1,...,S+1$ $z = 1,...,S$
Price of domestic commodities used in investment		
S62	$p_{Ki}^{Dz} = p_{i}^{Dz} + t_{Ki}^{Dz}$	$i = 1,...,I$ $z = 1,...,S$
Price of imported commodities used in investment		
S63	$p_{Ki}^{Iz} = \sum_{s=1}^{S+1} S_{Kis}^{Iz} p_{Kis}^{Iz}$	$i = 1,...,I$ $z = 1,...,S$
Price of composite commodities used in investment		
S64	$p_{Ki}^{z} = S_{Ki}^{Iz} p_{Ki}^{Iz} + S_{Ki}^{Dz} p_{Ki}^{Dz}$	$i = 1,...,I$ $z = 1,...,S$
Export price (fob)		
S65	$p_{Ei}^{z} = p_{i}^{Dz} + t_{Ei}^{z}$	$i = 1,...,I$ $z = 1,...,S$
Foreign currency landed duty-free price of imported commodities, by source		
S66	$p_{is}^{Wz} = S_{Vis}^{Wz}\left(p_{Ei}^{s} - e^{s}\right) + S_{Fis}^{Wz} p_{T}$	$i = 1,...,I$ $s = 1,...,S+1$ $z = 1,...,S+1$
Price of international freight		
S67	$p_{T} = \sum_{s=1}^{S+1} S_{Fs}\left(p_{EJ}^{s} - e^{s}\right)$	
Landed duty-free price of composite commodities imported by the rest of the world		
S68	$p_{i}^{WS+1} = \sum_{s=1}^{S+1} S_{is}^{WS+1} p_{is}^{WS+1}$	$i = 1,...,I$
Wage indexation		
S69	$w_{1}^{z} = h_{W1}^{z}\, cpi^{z} + h_{W2}^{z}$	$z = 1,...,S$

(Continued on next page)

Table 1.9: **Price transmission and price aggregation equations** *(continued)*

No.	*Equation*	*Range*
Industry-specific returns to capital		
S70	$w^z_{2j} = w^z_2 + \varphi^z_{2j}$	$j = 1,...,J$; $z = 1,...,S$
Zero profit condition for each industry		
S71	$p^{Dz}_j = s^z_{Qj} + \sum_{i=1}^{I} H^{Dz}_{ij} p^{Dz}_{Pij} + \sum_{i=1}^{I} H^{Iz}_{ij} p^{Iz}_{Pij} + \sum_{k=1}^{K} H^z_{kj} w^z_{kj} + a^z_j + H^z_{Xj} a^z_{Xj} + \sum_{k=1}^{K} H^z_{kj} a^z_{kj}$	$j = 1,...,J$; $z = 1,...,S$

Number of equations: $IJS^2 + 5IS^2 + 5IJS + 17IS + 2JS + 2I + S + 1$.
Note: Complete variable and parameter descriptions are found in appendix 1A at the end of this chapter.

In equation S66 the change in the foreign currency landed duty-free price of an import is composed of the change in the free-on-board export price of the commodity expressed in the currency of the exporting country ($p^s_{Ei} - e^s$) and the change in the price of freight (p_T), weighted by the respective shares of these items (S^{Wz}_{Vis} *and* S^{Wz}_{Fis}) in the landed duty-free value of the commodity. The price of freight is defined in equation S67 as a weighted average of the prices of transport services provided by each region and the rest of the world (p^s_{EJ}), adjusted to a common currency by the exchange rate (e^s).

In equation S69 the wage rate can be indexed to the consumer price index (when the second term is exogenously set to zero and the coefficient on the consumer price index is set to the level of indexation desired) or set exogenously (by endogenising h^z_{W2}). Equation S70 allows the user to set industry-specific differentials in the changes in returns to primary factors. These differential rates of change are implemented by specifying $\varphi^z_{kj} \neq 0$. Such differentials may be induced by sectoral policies that are not explicitly modelled in the SALTER model, but affect industries' allocation decisions. Such differentials are applied only to returns to capital; wages and returns to farm land are assumed uniform in any of the modelled countries.

The prices for individual and composite commodities are used to define the zero pure profits condition in equation S71. Perfect competition is assumed to prohibit firms from receiving excess profits. Alternatively, a firm with losses is assumed to withdraw from production.

Thus the price received for a commodity is exactly equal to the sum of all costs of production incurred and indirect taxes the firm might be subjected to. The change in a firm's output price is therefore equal to the weighted sum of the changes in the costs of domestic and imported intermediate inputs and primary factors used by the firm and changes in taxes (s^z_{Qj}). In addition to financial effects, competition also forces a firm to reduce the price of its output in response to technological improvements. This is reflected by the last three terms in equation S71: a 1 per cent technological gain in overall production or intermediate input use reduces the price proportionally; a 1 per cent improvement in the use of a primary factor reduces the price of output by the share of this factor in the value of output.

Price indices are available for the major macroeconomic aggregates and are given in table 1.10. All are indices that use the database describing the original state of the system to calculate the weights of each price in the index. Price indices are available for consumption (cpi^z) in equation S72, government expenditures on commodities (zpi^z) in S73, investment (pci^z) in S74, exports (epi^z) in S75 and imports (ipi^z) in S76, as well as gross domestic product (gpi^z) in S77 and net domestic product (npi_E^z) in S78. They are weighted averages of

Table 1.10: **Major price indices calculated in the SALTER model**

No.	*Equation*	*Range*
Consumer price index		
S72	$cpi^z = \sum_{i=1}^{I} S_{CTi}^{Dz} p_{Ci}^{Dz} + \sum_{i=1}^{I} S_{CTi}^{Iz} p_{Ci}^{Iz}$	$z = 1,...,S$
Price index for government purchases		
S73	$zpi^z = \sum_{i=1}^{I} S_{GTi}^{Dz} p_{Gi}^{Dz} + \sum_{i=1}^{I} S_{GTi}^{Iz} p_{Gi}^{Iz}$	$z = 1,...,S$
Price index for investment		
S74	$pci^z = \sum_{i=1}^{I} S_{KTi}^{Dz} p_{Ki}^{Dz} + \sum_{i=1}^{I} S_{KTi}^{Iz} p_{Ki}^{Iz}$	$z = 1,...,S$
Price index for exports (fob)		
S75	$epi^z = \sum_{i=1}^{I} S_{Ei}^{z} p_{Ei}^{z}$	$z = 1,...,S$
Domestic currency price index for imports (cif)		
S76	$ipi^z = \sum_{i=1}^{I} \sum_{s=1}^{S+1} S_{Mis}^{z} p_{is}^{Wz}$	$z = 1,...,S$
Gross domestic product deflator at factor cost		
S77	$gpi^z = \sum_{k \neq 2} S_{GDPk}^{z} w_k^z + \sum_{j=1}^{J} S_{GDP2j}^{z} w_{2j}^z$	$z = 1,...,S$
Price index for net domestic product from the expenditure side		
S78	$npi_E^z = S_{NC}^z cpi^z + \left(S_{NK}^z - S_{ND}^z\right) pci^z + S_{NZ}^z zpi^z + S_{NE}^z epi^z - S_{NI}^z\left(e^z + ipi^z\right)$	$z = 1,...,S$

Number of equations: 7*S*.
Note: Complete variable and parameter descriptions are found in appendix 1A at the end of this chapter.

the prices of commodities composing the aggregates where the weights are the shares of each commodity in the aggregate corresponding to the price index calculated. The bundles of commodities demanded by different decision makers are composed of different commodity combinations. Prices faced by decision makers also differ by the way taxes are applied. The different price indices calculated reflect this variety of prices faces by different groups in choosing their aggregate commodity bundles.

The ndp deflator is calculated by using the expenditure definition of ndp. Thus a change in the ndp deflator (npi^z_E) is equal to the weighted sum of the changes in price indices of consumption, net investment, government expenditure on commodities, and net exports. The price index of exports is evaluated at fob prices, while that of imports is made up of landed duty-free prices. The import and export price indices enable the user to assess the terms of trade effects of a policy change.

Trade in the SALTER model is created by the demands made by households, firms and governments for commodities from different sources. Several trade aggregates are calculated in the course of a simulation using the SALTER model. These different measures of trade flows are useful in interpreting the simulation results. Equations S79 and S80 calculate changes in two import aggregates (table 1.11). In equation S79 the change in aggregate imports of each commodity is evaluated at foreign currency landed duty-free prices. This is a measure of the change in imports of a commodity into a region, from all sources combined. It is measured in terms of the value of imports before duties are applied so that a change in tariff protection does not affect this aggregate directly, but indirectly, through changes in world prices (p^{Wz}_{is})and quantities imported (imp^z_{is}) that are induced by changes in protection or other conditions facing decision makers. In equation S80 the change in the value of aggregate bilateral imports is evaluated as the weighted sum of changes in the value of imports into a region of all commodities from another region in the model.

Table 1.11: **Import aggregates in the SALTER model**

No.	*Equation*	*Range*
Aggregate imports, by commodity, at foreign currency landed duty-free prices		
S79	$imp^z_i = \sum_{s=1}^{S} S^z_{Mis}\left(p^{Wz}_{is} + imp^z_{is}\right)$	$i = 1,...,I$ $z = 1,...,S$
Aggregate imports, by source and destination, at foreign currency landed duty-free prices		
S80	$imps^z_s = \sum_{i=1}^{I} S^z_{MSis}(p^{Wz}_{is} + imp^z_{is})$	$s = 1,...,S+1$ $z = 1,...,S+1$

Number of equations: $S^2 + IS + 2S + 1$.
Note: Complete variable and parameter descriptions are found in appendix 1A at the end of this chapter.

Table 1.12: **Export aggregates in the SALTER model**

No.	*Equation*	*Range*
Aggregate exports at fob prices, by commodity		
S81	$expi_i^z = \sum_{s=1}^{S+1} S_{EIsi}^z (p_{Ei}^z + exp_{si}^z)$	$i = 1,...,I$ $z = 1,...,S$
Aggregate exports at fob prices, by destination		
S82	$exps_s^z = \sum_{i=1}^{I} S_{ESsi}^z (p_{Ei}^z + \mathrm{exp}_{si}^z)$	$s = 1,...,S+1$ $z = 1,...,S+1$
Commodity exports to all destinations		
S83	$exp_i^z = \sum_{s=1}^{S+1} S_{Esi}^z \, exp_{si}^z$	$i = 1,...,I$ $z = 1,...,S+1$

Number of equations: $S^2 + 2IS + 2S + I + 1$.
Note: Complete variable and parameter descriptions are found in appendix 1A at the end of this chapter.

Similar aggregate measures are calculated for exports (table 1.12). In equation S81 the change in aggregate exports to all destinations ($expi_i^z$) is evaluated at fob prices. Again, this aggregate changes when export prices (p_{Ei}^z) and quantities (exp_{si}^z) change. In equation S82 the change in aggregate exports into a region ($exps_s^z$) is evaluated at fob prices as the weighted average of changes in the value of each commodity exported to that region.

By contrast to the two previous measures the change in the export aggregate calculated in equation S83 is a change in an index of exports of a commodity to all destinations (exp_i^z). This change is evaluated as the sum of changes in exports to each possible destination (exp_{si}^z).

The trade system described above for the explicitly modelled regions results from the assumed behaviour of households, firms and governments in these regions. In addition to the regions explicitly modelled, the SALTER model includes a rest of the world aggregate region, which is composed of all regions whose domestic economies are not explicitly modelled. This aggregate region includes such different countries and areas of the world as the European countries that are not members of the European Community, Africa and South and Central American countries, as well as most Asian economies and the centrally planned economies. Such diversity would make it difficult to model this part of the world economy in detail. Trade with this heterogeneous group of countries is therefore assumed to be captured in two simple equations (table 1.13).

The change in imports of a commodity by the rest of the world (imp_i^{S+1}) is assumed to be determined in equation S84 by the difference between the change in prices faced by the rest

Table 1.13: **Importing behaviour by the rest of the world in the SALTER model**

No.	*Equation*	*Range*
Demand by the rest of the world for composite commodities		
S84	$imp_i^{S+1} = \varepsilon_i\left(p_i^{WS+1} - p_{Ei}^{S+1} - e^{S+1}\right)$	$i = 1,...,I$
Demand by the rest of the world for commodities, by source		
S85	$imp_{is}^{S+1} = imp_i^{S+1} - \beta_i^{IS+1}\left(p_{is}^{WS+1} - p_i^{WS+1}\right)$	$i = 1,...,I$ $s = 1,...,S+1$

Number of equations: $IS + 2I$.
Note: Complete variable and parameter descriptions are found in appendix 1A at the end of this chapter.

of the world (p_i^{WS+1}) and its export price for the commodity (p_{Ei}^{S+1}), taken as a measure of the cost of producing the commodity locally. The only parameter necessary to specify this relation is the elasticity of demand for exports (ε_i). This elasticity of demand relates the change in quantity imported by the rest of the world (imp_i^{S+1}) to changes in relative prices facing the rest of the world in importing commodities. The change in the price of exports from the rest of the world (p_{Ei}^{S+1}) is adjusted by changes in the exchange rate (e^{S+1}) because the world price (p_i^{WS+1}) is expressed in international currency units.

Once the change in a commodity's import is determined, the rest of the world is assumed in equation S85 to minimise the cost of acquiring the imports from different sources much in the same way that commodity demands in the other regions are modelled. The difference with the way it is handled in the other regions lies in the fact that the cost minimising choice is made at the aggregate import level in the rest of the world, whereas in the explicitly modelled regions, each demand category (consumer, intermediate input, investment, and government demand) is assumed to choose among import sources.

The function constraining choices among import sources is assumed to be of the constant elasticity of substitution type and requires the specification of a single parameter, the elasticity of substitution among import sources facing the rest of the world (β_i^{IS+1}).

This completes the specification of microeconomic behaviour in international trade in the SALTER model. The resulting macroeconomic aggregates for each explicitly modelled region are nominal and real trade aggregates. Changes in these variables resulting from a simulated change in policy are calculated in equations S86 to S90 (table 1.14).

The change in nominal imports at foreign currency landed duty-free prices is calculated in equation S86 as the weighted sum of changes in the value of each import from each region. Since the value of imports can change as a consequence of a change in prices (p_{is}^{Wz}) or in the volume of imports (imp^z_{is}), the percentage change in the value of an import is equal to the sum of the percentage change in each of these variables. The weights applied to the individual changes (S^z_{MTis}) are the share of each commodity import by source in aggregate imports into a region. The components of aggregate imports are summed over the different sources a commodity can be imported from, and over all commodities imported by a given region. The same principles apply when changes in aggregate exports (exp^z_T) are calculated in equation S88 as the weighted sum of the value of all commodity exports, weighted by the share of a commodity's value in aggregate exports (S^z_{ETi}). Again, the change in the value of an export is a function of the change in export prices (p^z_{Ei}) or the change in volume (exp^z_i).

In equations S87 and S89, changes in real imports (imp^z_{TR}) and exports (exp^z_{TR}) are calculated by deflating the nominal values calculated in equations S86 and S88 (imp^z_T and exp^z_T respectively) by the appropriate price index (ipi^z and epi^z respectively), calculated in equations S76 and S75.

The absolute change in the balance of trade is calculated in equation S90 as the difference between absolute changes in exports and imports. As for the budget deficit, this variable is defined in terms of an absolute change to avoid difficulties arising from changes in signs when the trade deficit turns into a surplus or vice versa. Because aggregate imports are

Table 1.14: **Macroeconomic trade aggregates in the SALTER model**

No.	*Equation*	*Range*
Aggregate imports at foreign currency landed duty-free prices		
S86	$imp^z_T = \sum_{i=1}^{I} \sum_{s=1}^{S+1} S^z_{MTis}(p^{Wz}_{is} + imp^z_{is})$	$z = 1,...,S$
Real aggregate imports		
S87	$imp^z_{TR} = imp^z_T - ipi^z$	$z = 1,...,S$
Aggregate exports at fob prices		
S88	$exp^z_T = \sum_{i=1}^{I} S^z_{ETi}(p^z_{Ei} + exp^z_i)$	$z = 1,...,S$
Real aggregate exports		
S89	$exp^z_{TR} = exp^z_T - epi^z$	$z = 1,...,S$
Balance of trade at current domestic prices		
S90	$100\ tb^z = EXP^z_T\ exp^z_T - IMP^z_T\left(e^z + imp^z_T\right)$	$z = 1,...,S$

Number of equations: 5*S*.
Note: Complete variable and parameter descriptions are found in appendix 1A at the end of this chapter.

calculated at foreign currency prices, they are adjusted by the exchange rate. Thus a change in imports evaluated in domestic currency units is equal to the change in imports evaluated in foreign currency units (imp_T^z) and the change in nominal exchange rate (e^z).

Table 1.15 completes the specification of the SALTER model. Equations S91 to S94 define a number of ratios that are used to specify different closures to the model. Equation S91 defines the change in the ratio (r_1^z) of private consumption (c_T^z) to public consumption (z_G^z) expenditures. By fixing variable r_1^z to be a constant, a common rate of growth in private and public expenditures is assumed, thereby maintaining the size of government relative to the private sector.

A similar ratio (r_2^z) is defined between changes in net factor income (y_F^z) and government transfers to households (t_G^z) in equation S92, the two components of private income. Fixing r_2^z implies a common rate of growth in the private and public components of aggregate private income.

Equation S93 defines the change in the ratio of the government budget deficit to net domestic product. When variable r_3^z is set exogenously equal to zero, a constant rate of growth is maintained between the government budget deficit and net domestic product. Thus the change in the budget deficit (bd^z) is equal to the change in net domestic product. This maintains constant the size of the budget deficit relative to net domestic product.

Table 1.15: **Ratios used in defining alternative closures in the SALTER model**

No.	*Equation*	*Range*
Ratio of private to public consumption expenditure		
S91	$r_1^z = c_T^z - z_G^z$	$z = 1,...,S$
Ratio of net factor income to transfer payments to households		
S92	$r_2^z = y_F^z - t_G^z$	$z = 1,...,S$
Ratio of the budget deficit to net domestic product		
S93	$r_3^z = \dfrac{100\ bd^z - BD^z\ ndp_E^z}{NDP_E^z}$	$z = 1,...,S$
Ratio of the trade balance to net domestic product		
S94	$r_4^z = \dfrac{100\ tb^z - TB^z\ ndp_E^z}{NDP_E^z}$	$z = 1,...,S$

Number of equations: 4*S*.
Note: Complete variable and parameter descriptions are found in appendix 1A at the end of this chapter.

A similar ratio between the trade balance and net domestic product is calculated in percentage change terms in equation S94. By setting r_4^z equal to zero, the size of the trade deficit relative to net domestic product is held constant.

Economic environments

It is possible to specify three broad economic environments based on the ability of decision makers to adapt their resources in response to the simulated policy changes. In a short run environment, adaptations that could be made within a one or two year time frame are assumed to be possible. In a medium run environment, adaptations over a five year period are assumed to be made by decision makers, while a long run environment would produce results of simulated changes ten years hence. The SALTER model is in this sense not a dynamic model in that it does not show how these changes occur. It is a comparative static model in which a new equilibrium resulting from adaptations to new conditions can be compared to the initial equilibrium.

Defining the environment in which decision makers operate is also necessary when solving a simulation. The SALTER model is composed of a large number of equations, and an even larger number of variables. These variables include the policy instruments such as taxes, duties and subsidies, through which most shocks are modelled, as well as variables that are typically not determined by the model. Solving a system of equations requires that the number of unknowns (endogenous variables) equal the number of equations used to specify the model. In order to obtain this, a number of variables are assumed to be predetermined, or exogenous to the model.

Choosing which variables are exogenous defines the closure of the model and the constraints faced by decision makers in adapting to new conditions. Usually, the SALTER model is used to reflect adaptations that can be made within five years after a policy change.

Adaptations in the medium run

The closure typically used to characterise opportunities in the medium run is found in table 1A.1. In the status column, an X indicates that the corresponding variable is typically set exogenously in medium run simulations. Over the medium run the domestic stocks of capital and farm land are assumed to be fixed in each region. There is therefore a fixed supply of services from these primary factors of production. The SALTER model does not include a separate variable for the supply of services from capital and farm land. However, assuming full employment, the corresponding demands can be set exogenously to zero to reflect medium run condition. This amounts to setting exogenously f^z_{Dk} equal to zero (for $k = 2, 3$). Full employment and mobility of capital across sectors imply that rates of return to capital are equal among industries within a region. Setting the differential change in the rate of return to capital (φ^z_{2j}) equal to zero in equation S70 ensures that change in the industry-specific rate of return (w^z_{2j}) is equal to the economy-wide return to capital (w^z_2).

A constant level of employment is assumed to prevail in the medium run. This means that changes in labour supply and labour demand are equal, and the employment rate (em^z_1) is exogenously set equal to zero. Money wages can vary independently of the consumer price index. This requires setting the shift term relating money wages to the consumer price index (h^z_{W2}) to be endogenous.

Consumers are assumed to vary the proportion of their income allocated to consumption and savings, and the ratio of the balance of trade to domestic product is held fixed. This reflects forward-looking behaviour by households who expect present trade deficits to reduce future spending power. In terms of the model's closure, this requires cutting the link between consumption expenditure and savings by setting variable h^z_c to be endogenous in equation S5. In equation S94 the change in the ratio of the trade balance to net domestic product (r^z_4) is held constant. Since there is no endogenous determination of the rate of investment in the SALTER model, the change in real investment is set exogenously to be zero.

The government's behaviour is also affected by the time horizon considered in the model. In the medium run the government is assumed to increase its expenditure and transfers to households in line with increases in aggregate income. Thus variable r^z_1, the change in the ratio of private to public consumption, is exogenously set equal to zero. Similarly, variable r^z_2, the change in the ratio of factor incomes to government transfers, is set equal to zero.

To further maintain the size of the public sector relative to the rest of the economy, and minimise the effect of public sector borrowing on private allocation decisions, the ratio of the budget deficit to net domestic product is held constant. This requires setting variable r^z_3 equal to zero in equation S93. Adaptations in the level of the budget deficit can be made by endogenous adjustments in public expenditure (z^z_G), transfers to households (t^z_G) or government revenue through a change in the marginal income tax rate (t^z_Y)

The other exogenous variables in table 1A.1 are used to model shifts in policies or exogenous changes in conditions facing decision makers. Thus all the tax variables are set exogenously, as well as variables used to model technical changes and changes in the demographic index (h_D^z).

Adaptations in the short run

In a typical short run closure it is assumed that producers have insufficient time to adjust capital stocks in each industry. Thus movements in the profitability of employing capital are reflected in movements in its rental price rather than adjustments in each industry's demand for capital services. In order to model this, the industry-specific demands for capital services (f_{2j}^z) are made exogenous and industry-specific returns to capital (w_{2j}^k) are made endogenous. Now the aggregate demand for capital (f_{Dz}^z) is determined endogenously as the sum of the (fixed) industry demands for capital, and overall returns to capital (w_2^z) are exogenous. Variable φ_{2j}^z is allowed to vary endogenously to maintain the equality in equation S70 (table 1.9).

In the short run it is assumed that labour supply exceeds labour demand and that the resulting pool of unemployed workers can be hired at the going wage rate. Thus money wages are indexed to the consumer price index and the rate of employment adjusts to equate labour use to labour demand at the real wage rate determined in the model. To reflect wage indexation, parameter h_{W1}^z in equation S69 (table 1.9) is set to the level of indexation required and variable h_{W2}^z is exogenously set to zero. The employment rate (em_1^z) and aggregate labour supply (f_{S1}^z) are set to be endogenous and determined as a function of the real, after-tax wage rate in equation S17 (table 1.3).

An important component of the short run closure of the model is the specification of public sector borrowing requirements. The government is assumed to face two choices. First, it can allow taxes to vary and maintain the public sector borrowing requirement fixed. Alternatively, it may hold income tax rates constant and allow public sector borrowing to vary. In the short run closure, the latter assumption is used, and while components of government outlays are fixed exogenously in real terms (t_{GR}^z and gov_i^z) and the marginal tax rate (t_Y^z) is assumed to be fixed, the budget deficit (bd^z) and therefore the public sector borrowing requirement is allowed to vary endogenously.

Over the short run, households are assumed to allocate disposable income in fixed proportions between consumption and savings. This is achieved by setting the private consumption to savings ratio (h_c^z) exogenously equal to zero. Since aggregate investment (inv_{TR}^z) is set exogenously a change in the level of savings implies a change in the trade balance (see figure 1.2). Therefore changes in the ratio of the trade balance to net domestic product (r_4^z) are specified as endogenous.

As illustrated here, changing the environment in which decisions are assumed to be made involves carefully swapping between endogenous and exogenous variables in order to maintain the equality between the number of equations in the model and the number of endogenous variables. This aspect of model closure is discussed in the last part of this chapter.

Adaptations in the long run

In the long run, a closure similar to the medium run closure can be used to model consumers' behaviour, the decisions of government, and labour supply, but the supply of capital is now allowed to adjust to changing conditions. In addition to the ability of industries to change the size of their capital stock, it is now assumed that there is an international market for capital. This implies linking the availability of capital with the supply of savings, and allowing capital to be traded internationally. It is envisioned to expand the SALTER model to include international capital flows and an endogenous supply of capital. At this stage of the model's development, this facility is not available, and a full long term closure cannot be implemented.

Solving the linear system of equations

The SALTER model is specified in terms of the percentage change in its variables. Although the underlying relationships are highly nonlinear, it is assumed that percentage changes can be a good approximation of the true outcome of a policy change — provided the policy change is small. Where the policy change being simulated is large the Euler solution procedure can also be used. The procedure solves the model in a series of smaller steps and can reduce linearisation errors. A further improvement on the Euler solution procedure involves an extrapolation using results from several solutions obtained with a Euler procedure, using a different number of steps (Dixon et al. 1982). Before such methods can be applied, the simple linear problem must be specified in a way that it can be solved.

In general equilibrium models, the number of variables typically exceeds the number of equations specified. Variables include instruments through which shocks can be applied to the model — that is, exogenous variables — as well as variables whose behaviour is to be observed — the endogenous variables.

The SALTER model structure consists of 270 698 variables and 245 831 equations. In order to solve this linear system, the number of endogenous variables must equal the number of equations. The set of variables is therefore partitioned into an exogenous subset and an endogenous subset. This partitioning, known as the closure of the model, is linked to the economic environments in which the simulated policy changes are assumed to take place in. Table 1.16 is used to illustrate this principle in the case of the SALTER model.

Table 1.16: **Numbers of equations, exogenous, endogenous and absorbed variables in the SALTER model**

Total variables	$2(S+1)^2 + 2IJS(S+1) + 3I(S+1)^2 + 8IS(S+1) + 7IJS + 38IS + 2IS + 2I + 59S + 2$	270 698
Exogenous variables	$IS(S+1) + 2IJS + JKS + 11IS + I + 10S + 1$	24 867
Equations	$2IJS^2 + 10IS^2 + 8IJS + JKS + 2S^2 + 3JS + KS + 34IS + 50S + 6I + 3$	245 831
Absorbed variables	$6IS(S+1) + 2IJS(S+1)^2 + 5IJS + 15IS$	236 980
Endogenous variables in the condensed system	$6IS(S+1) + 2IJS(S+1) + 2I(S+1)^2 + 5IJS + 15IS$	8 851

The exogenous variables include policy instruments such as taxes and subsidies, or variables that are assumed to be predetermined. These variables are set to a chosen value by the user. Of the 270 698 variables in the model 24 867 variables are exogenous. This results in 245 831 endogenous variables, the same number as equations specified in this chapter. The system of equations can therefore theoretically be solved.

However, solving such a large linear system requires a substantial amount of computational resources. By condensing variables out, the linear system to be solved can be made smaller. Condensation involves replacing endogenous variables of relatively minor importance by their algebraic expression, thus reducing the number of endogenous variables to be solved for and the number of equations simultaneously (Codsi and Pearson 1988). Variables substituted by their algebraic expression — or absorbed — are indicated with an A in the status column of table 1A.1. There is a total of 236 980 absorbed variables which reduce the linear system of equations by the same number of variables and equations. After condensation, the system used for simulations is actually composed of 8851 endogenous variables and equations (table 1.16).

Solving for large changes

As mentioned earlier the SALTER model is solved in percentage changes and this solution is an approximation of the true solution. The accuracy of the approximation depends on the degree of nonlinearity of the model in the neighbourhood of the initial equilibrium and the size of the policy shock modelled. The difference between the linearised solution and the (unknown) solution to the nonlinear problem is called linearisation error. Keller (1980) indicates 'that static general equilibrium systems are only moderately non-linear' when compared with dynamic systems. Linearisation errors limit the magnitude of changes that can be simulated, but Keller suggests that a 10 per cent change in taxes does not impair the accuracy of the linearised model.

When policy changes being simulated are large, the Euler solution procedure can be used to obtain a more accurate solution of the model. The Euler procedure involves dividing a large policy change into a number of small changes in order to reduce linearisation error. A first simulation is performed using a fraction of the large change. This results in a certain number of linear changes in the endogenous variables. These changes are applied to the original data to obtain a new updated database on which a second simulation is performed applying a small policy shock to obtain new linear responses with respect to the data resulting from the previous simulation. This process is repeated until the entire large change has been performed through the small changes. The accuracy of the approximation depends on the number of small changes made, but increasing the number of steps increases the time needed to obtain a solution. Dixon et al. (1982) indicate that a significantly improved solution can be obtained through an extrapolation based on two or three simulation solutions obtained through Euler procedures with different numbers of steps. The Richardson extrapolation procedure (Dahlquist, Bjorck and Anderson 1974) uses the fact that increasing the number of steps in a Euler procedure improves the solution. The rate of improvement as the number of steps is increased is used to extrapolate a new solution. Dixon et al. note that only small numbers of steps are necessary to obtain significantly improved solutions over those obtained through a Euler procedure without extrapolation.

APPENDIX 1A: VARIABLES AND PARAMETERS IN THE SALTER MODEL

This appendix provides a complete list and description of variables and parameters used in formulating the structure of the SALTER model. Variables are found in table 1A.1 and parameters in table 1A.2. These tables relate largely to the equations presented in tables 1.1 to 1.15. The equations that are strictly part of the SALTER model are numbered with a letter S prefix.

All lower case variables represent percentage changes in the corresponding price or quantity index. Upper case symbols correspond to the actual levels of a quantity and are described in the parameter list as 'level' in parentheses.

As discussed in chapter 1, the set of variables is partitioned into an exogenous subset and an endogenous subset. The exogenous variables in a typical medium run closure are marked with an X in the status column in table 1A.1. A number of endogenous variables have been condensed through absorption. These variables are indicated with an A in the status column in the variable list.

Unless specified otherwise, items described in the tables are indexed by country $z = 1,...,S$. In the interest of conciseness, the regional reference is omitted in the descriptions of equations, variables and parameters. The model structure is the same for all S regions modelled explicitly. References to the rest of the world (region S+1) are specifically mentioned.

In general, geographical references are confined to superscripts. Most variables and parameters are specific to one of the S modelled countries and are superscripted z ($z = 1,...,S$). Other possible superscripts are D ('domestically produced' — or shortened to 'domestic'), I ('imported'), W ('world') and S+1 ('rest of the world').

Subscripts generally specify the commodity (i), factor of production (k) and/or industry (j) characterising the main symbol. Since commodities are differentiated by country of origin (source is generally denoted by s), thus making them products with 'different' characteristics, this particular geographical reference is included in the form of a subscript.

Upper case subscripts indicate a particular use in final demand or another macroeconomic aggregate — that is, X ('intermediate demand'), C ('consumption'), G ('government consumption'), K ('investment demand'), E ('export demand') and Q ('aggregate supply').

Table 1A.1: **Variables in the SALTER model**

Variable	*Range*	*Status*[a]	*Description*
Disaggregated quantities			
c_i^z	$i = 1,...,I$ $z = 1,...,S$		Consumer demand for aggregate commodity i
c_i^{Dz}	$i = 1,...,I$ $z = 1,...,S$	A	Consumer demand for domestic commodity i
c_i^{Iz}	$i = 1,...,I$ $z = 1,...,S$	A	Consumer demand for imported aggregate commodity i
c_{is}^{Iz}	$i = 1,...,I$ $s = 1,...,S+1$ $z = 1,...,S$	A	Consumer demand for imported aggregate commodity i from source s
exp_i^z	$i = 1,...,I$ $z = 1,...,S+1$		Aggregate exports of commodity i
exp_{si}^z	$i = 1,...,I$ $s = 1,...,S+1$ $z = 1,...,S+1$	A	Export demand for commodity i by region s
$expi_i^z$	$i = 1,...,I$ $z = 1,...,S$		Aggregate exports of commodity i at fob prices
$exps_s^z$	$s = 1,...,S+1$ $z = 1,...,S+1$		Aggregate exports by source and destination at fob prices
f_{kj}^z	$j = 1,...,J$ $k = 1,...,K$ $z = 1,...,S$		Demand by industry j for primary factor k
gov_i^{Dz}	$i = 1,...,I$ $z = 1,...,S$	A	Government demand for domestic commodity i
gov_i^{Iz}	$i = 1,...,I$ $z = 1,...,S$	A	Government demand for aggregate imported commodity i
gov_{is}^{Iz}	$i = 1,...,I$ $s = 1,...,S+1$ $z = 1,...,S$	A	Government demand for imported commodity i from source s
imp_i^z	$i = 1,...,I$ $z = 1,...,S+1$		Aggregate imports of commodity i
imp_{is}^z	$i = 1,...,I$ $s = 1,...,S+1$ $z = 1,...,S+1$		Imports of commodity i from source s
$imps_s^z$	$s = 1,...,S+1$ $z = 1,...,S+1$		Aggregate imports by source and destination at foreign currency landed duty-free prices

(*Continued on next page*)

Table 1A.1: **Variables in the SALTER model** *(continued)*

Variable	*Range*	*Status*	*Description*
Disaggregated quantities *(continued)*			
inv_i^z	$i = 1,...,I$ $z = 1,...,S$		Investment use of aggregate commodity i
inv_i^{Dz}	$i = 1,...,I$ $z = 1,...,S$	A	Investment use of domestic commodity i
inv_i^{Iz}	$i = 1,...,I$ $z = 1,...,S$	A	Investment use of imported aggregate commodity i
inv_{is}^{Iz}	$i = 1,...,I$ $s = 1,...,S+1$ $z = 1,...,S$	A	Investment use of imported commodity i from source s
q_j^z	$j = 1,...,J$ $z = 1,...,S$		Supply of commodity j
x_{ij}^{Dz}	$i = 1,...,I$ $j = 1,...,J$ $z = 1,...,S$	A	Demand by industry j for domestic commodity i
x_{ij}^{Iz}	$i = 1,...,I$ $j = 1,...,J$ $z = 1,...,S$	A	Demand by industry j for imported aggregate commodity i
x_{isj}^{Iz}	$i = 1,...,I$ $j = 1,...,J$ $s = 1,...,S+1$ $z = 1,...,S$	A	Demand by industry j for imported aggregate commodity i from source s
Prices and price indices			
cpi^z	$z = 1,...,S$		Consumer price index
e^s	$s = 1,...,S+1$	X	Exchange rate
epi^z	$z = 1,...,S$		Export price index (fob)
gpi^z	$z = 1,...,S$		Gross domestic product price deflator at factor cost
ipi^z	$z = 1,...,S$		Price index of imports (cif)
pci^z	$z = 1,...,S$		Price index of capital
npi_E^z	$z = 1,...,S$		Price index for net domestic product from the expenditure side
p_i^{Dz}	$i = 1,...,I$ $z = 1,...,S$		Basic price of domestic commodity i

(Continued on next page)

Table 1A.1: **Variables in the SALTER model** *(continued)*

Variable	*Range*	*Status*	*Description*
Prices and price indices *(continued)*			
p_{is}^{Iz}	$i = 1,...,I$ $s = 1,...,S+1$ $z = 1,...,S$		Border price of commodity i from source s (cif)
p_{Ci}^{z}	$i = 1,...,I$ $z = 1,...,S$	A	Price of commodity i paid by consumers
p_{Ci}^{Dz}	$i = 1,...,I$ $z = 1,...,S$	A	Price of domestic commodity i paid by consumers
p_{Ci}^{Iz}	$i = 1,...,I$ $z = 1,...,S$	A	Price of imported commodity i paid by consumers
p_{Cis}^{Iz}	$i = 1,...,I$ $s = 1,...,S+1$ $z = 1,...,S$	A	Price of imported commodity i from source s paid by consumers
p_{Ei}^{z}	$i = 1,...,I$ $z = 1,...,S+1$	X	Export price of commodity i (fob)
p_{Gi}^{z}	$i = 1,...,I$ $z = 1,...,S$	A	Price of commodity i paid by the government
p_{Gi}^{Dz}	$i = 1,...,I$ $z = 1,...,S$	A	Price of domestic commodity i purchased by the government
p_{Gi}^{Iz}	$i = 1,...,I$ $z = 1,...,S$	A	Price of imported aggregate commodity i purchased by the government
p_{Gis}^{Iz}	$i = 1,...,I$ $s = 1,...,S+1$ $z = 1,...,S$	A	Price of imported commodity i from source s purchased by the government
p_{Ki}^{z}	$i = 1,...,I$ $z = 1,...,S$	A	Price of commodity i used in investment
p_{Ki}^{Dz}	$i = 1,...,I$ $z = 1,...,S$	A	Price of domestic commodity i used in investment
p_{Ki}^{Iz}	$i = 1,...,I$ $z = 1,...,S$	A	Price of imported aggregate commodity i used in investment
p_{Kis}^{Iz}	$i = 1,...,I$ $s = 1,...,S+1$ $z = 1,...,S$	A	Price of imported commodity i from source s used in investment
p_{Pij}^{z}	$i = 1,...,I$ $j = 1,...,J$ $z = 1,...,S$	A	Price of aggregate commodity i paid by industry j

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Table 1A.1: **Variables in the SALTER model** *(continued)*

Variable	*Range*	*Status*	*Description*
Prices and price indices *(continued)*			
p_{Pij}^{Dz}	$i = 1,...,J$ $j = 1,...,J$ $z = 1,...,S$	A	Price of domestic commodity i paid by industry j
p_{Pisj}^{Iz}	$i = 1,...,J$ $j = 1,...,J$ $s = 1,...,S+1$ $z = 1,...,S$	A	Price of imported commodity i from source s paid by industry j
p_{is}^{Wz}	$i = 1,...,J$ $s = 1,...,S+1$ $z = 1,...,S+1$	A	Foreign currency landed duty-free price of imported commodity i from source s
p_i^{WS+1}	$i = 1,...,J$		Average foreign currency landed duty-free price of imports into the rest of the world
p_T			Price of freight
w_k^z	$k = 1,...,K$ $z = 1,...,S$		Basic returns to primary factors
w_{kj}^z	$j = 1,...,J$ $k = 1,...,K$ $z = 1,...,S$		Price paid by industry j for primary factor k
zpi^z	$z = 1,...,S$		Price index for government expenditure
Macroeconomic aggregates			
bd^z	$z = 1,...,S$		Government budget deficit
c_T^z	$z = 1,...,S$		Aggregate consumption expenditure
c_{TR}^z	$z = 1,...,S$		Real aggregate consumption
dep^z	$z = 1,...,S$		Depreciation of capital
em_1^z	$z = 1,...,S$	X	Rate of employment
exp_T^z	$z = 1,...,S$		Aggregate exports at fob prices
exp_{TR}^z	$z = 1,...,S$		Real aggregate exports
f_{Dk}^z	$k = 1,...,K$ $z = 1,...,S$	X	Aggregate demand for of primary factor k

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Table 1A.1: **Variables in the SALTER model** *(continued)*

Variable	*Range*	*Status*	*Description*
Macroeconomic aggregates *(continued)*			
f^z_{S1}	$z = 1,...,S$		Aggregate labour supply
g^z	$z = 1,...,S$		Real government spending on commodities
gdp^z_F	$z = 1,...,S$		Gross domestic product at factor costs
gdp^z_{FR}	$z = 1,...,S$		Real gross domestic product at factor costs
imp^z_T	$z = 1,...,S$		Aggregate imports at foreign currency landed duty-free prices
imp^z_{TR}	$z = 1,...,S$		Real aggregate imports
inv^z_T	$z = 1,...,S$		Aggregate investment
inv^z_{TR}	$z = 1,...,S$	X	Real aggregate investment
ndp^z_E	$z = 1,...,S$		Net domestic product from the expenditure side
ndp^z_{ER}	$z = 1,...,S$		Real net domestic product from the expenditure side
ndp^z_D	$z = 1,...,S$		Net domestic product from the disposition side
r^z_G	$z = 1,...,S$		Government revenue net of non-commodity subsidies
r^z_{GI}	$z = 1,...,S$		Contribution of subsidies net of indirect taxes to aggregate government revenue
r^z_{GX}	$z = 1,...,S$		Contribution of taxes on intermediate commodity use to aggregate revenue from commodity taxes
r^z_{GC}	$z = 1,...,S$		Contribution of consumption taxes to aggregate revenue from commodity taxes
r^z_{GG}	$z = 1,...,S$		Contribution of taxes on government commodity purchases to aggregate revenue from commodity taxes
r^z_{GK}	$z = 1,...,S$		Contribution of investment taxes to aggregate revenue from commodity taxes
r^z_{GE}	$z = 1,...,S$		Contribution of export taxes to aggregate revenue from commodity taxes
r^z_{GD}	$z = 1,...,S$		Contribution of import duties to aggregate revenue from commodity taxes

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Table 1A.1: **Variables in the SALTER model** *(continued)*

Variable	*Range*	*Status*	*Description*
Macroeconomic aggregates *(continued)*			
r^z_{GY}	$z = 1,\ldots,S$		Contribution of income taxes to government revenue
r^z_{GT}	$z = 1,\ldots,S$		Aggregate commodity tax revenues
sv^z	$z = 1,\ldots,S$		Private savings supply
tb^z	$z = 1,\ldots,S$		Balance of trade at current domestic prices
y^z_F	$z = 1,\ldots,S$		Aggregate net primary factor income
y^z	$z = 1,\ldots,S$		Aggregate private household income
y^z_d	$z = 1,\ldots,S$		Aggregate household disposable income
y^z_{dR}	$z = 1,\ldots,S$		Real aggregate household disposable income
z^z_G	$z = 1,\ldots,S$		Government spending (nominal)
Policy instruments			
d^z_{is}	$i = 1,\ldots,J$ $s = 1,\ldots,S+1$ $z = 1,\ldots,S$	X	Power of the duty applied to imported commodity i from source s in all uses
s^z_{Qj}	$j = 1,\ldots,J$ $z = 1,\ldots,S$	X	Power of the subsidies net of indirect taxes allocated to industry j
t^{Dz}_{Ci}	$i = 1,\ldots,J$ $z = 1,\ldots,S$	X	Power of the ad valorem tax applied to the consumption of domestic commodity i
t^{Iz}_{Ci}	$i = 1,\ldots,J$ $z = 1,\ldots,S$	X	Power of the ad valorem tax applied to the consumption of imported commodity i
t^{Dz}_{ij}	$i = 1,\ldots,J$ $j = 1,\ldots,J$ $z = 1,\ldots,S$	X	Power of the ad valorem tax applied to domestic commodity i purchased by industry j
t^{Iz}_{ij}	$i = 1,\ldots,J$ $j = 1,\ldots,J$ $z = 1,\ldots,S$	X	Power of the ad valorem tax applied to imported commodity i purchased by industry j
t^{Dz}_{Gi}	$i = 1,\ldots,J$ $z = 1,\ldots,S$	X	Power of the ad valorem tax applied to domestic commodity i purchased by the government
t^{Iz}_{Gi}	$i = 1,\ldots,J$ $z = 1,\ldots,S$	X	Power of the ad valorem tax applied to imported commodity i purchased by the government

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Table 1A.1: **Variables in the SALTER model** *(continued)*

Variable	*Range*	*Status*	*Description*
Policy instruments *(continued)*			
t_{Ki}^{Dz}	$i = 1,...,I$ $z = 1,...,S$	X	Power of the ad valorem investment tax applied to domestic commodity *i*
t_{Ei}^{z}	$i = 1,...,I$ $z = 1,...,S$	X	Power of the ad valorem export tax applied to commodity *i*
t_{G}^{z}	$z = 1,...,S$		Government transfer payments to private households
t_{GR}^{z}	$z = 1,...,S$		Real government transfers to private households
t_{Y}^{z}	$z = 1,...,S$		Income tax rate
Modelling instruments			
φ_{2j}^{z}	$j = 1,...,J$ $z = 1,...,S$	X	Industry-specific differential for returns to capital in industry *j*
a_{j}^{z}	$j = 1,...,J$ $z = 1,...,S$	X	Output augmenting technical change in industry *j*
a_{Xj}^{z}	$j = 1,...,J$ $z = 1,...,S$	X	Aggregate intermediate input augmenting technical change in industry *j*
a_{kj}^{z}	$j = 1,...,J$ $k = 1,...,K$ $z = 1,...,S$	X	Primary factor *k* augmenting technical change in industry *j*
h_{D}^{z}	$z = 1,...,S$	X	Demographic index
h_{W2}^{z}	$z = 1,...,S$		Variable used to disconnect wages from the consumer price index
h_{c}^{z}	$z = 1,...,S$		Consumption to savings ratio
r_{1}^{z}	$z = 1,...,S$	X	Ratio of private to public expenditure
r_{2}^{z}	$z = 1,...,S$	X	Ratio of net factor income to government transfer payments to households
r_{3}^{z}	$z = 1,...,S$	X	Ratio of the budget deficit to net domestic product
r_{4}^{z}	$z = 1,...,S$	X	Ratio of the trade balance to net domestic product

[a] An A in the status column indicates an endogenous variable is absorbed; an X in the status column indicates a variable is exogenous in a typical medium run closure.

Table 1A.2: **Parameters in the SALTER model**

Equation	*Parameter*	*Description*
S1	S^z_{Yk}	Share of primary factor *k*'s income in total primary factor income
	S^z_{Y2j}	Share of capital income in industry *j* in total primary factor income
	S^z_{YD}	Ratio of depreciation to total factor income
S2	S^z_{YF}	Share of factor income in aggregate private income
	S^z_{YT}	Share of government transfers in aggregate private income
S3	R^z_{TY}	Ratio of income tax revenues to household disposable income
S4	S^z_{YS}	Share of savings in private disposable income
	S^z_{YC}	Share of aggregate consumption in private disposable income
S6,S7	S^z_{NC}	Share of aggregate consumption in net domestic product
	S^z_{NK}	Share of aggregate investment in net domestic product
	S^z_{ND}	Share of capital depreciation in net domestic product
	S^z_{NZ}	Share of government expenditure in net domestic product
	S^z_{NE}	Share of exports in net domestic product
	S^z_{NE}	Ratio of imports to net domestic product
S7	S^z_{NS}	Ratio of private savings to net domestic product
	S^z_{NI}	Ratio of aggregate government revenues to net domestic product
	S^z_{NT}	Ratio of government transfers to households to net domestic product
S8	S^z_{GDPk}	Share of primary factor *k*'s income in gross domestic product valued at factor cost
	S^z_{GDP2j}	Share of capital in industry *j* in gross domestic product valued at factor cost
S13	λ^z_{ih}	Elasticity of consumer demand for commodity *i* with respect to the price of commodity *h*

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Table 1A.2: **Parameters in the SALTER model** *(continued)*

Equation	*Parameter*	*Description*
	μ_i^z	Elasticity of demand for commodity *i* with respect to aggregate consumption expenditure
S14,S15	β_i^z	Elasticity of substitution in private consumption between domestic commodity *i* and imported aggregate commodity *i*
S16	β_i^{Iz}	Elasticity of substitution in private consumption between commodities imported from different sources
S17	χ_1^z	Elasticity of labour supply to after-tax wages
	R_{TY}^z	See equation S3
S18	σ_j^z	Elasticity of substitution between primary factors in industry *j*
	S_{mj}^z	Share of primary factor *m* used by industry *j*
S19	S_{Dkj}^z	Share of industry *j*'s use of primary factor *k* in the aggregate use of factor *k*
S20,S21	η_i^z	Elasticity of substitution in production between domestic commodity *i* and imported aggregate commodity *i*
S22	η_i^{Iz}	Elasticity of substitution in production between commodities imported from different sources
S23,S24	β_{Ki}^z	Elasticity of substitution in investment demand between domestic commodity *i* and imported aggregate commodity *i*
S25	β_{Ki}^{Iz}	Elasticity of substitution in investment demand between commodities imported from different sources
S28–S34	R_G^z	Aggregate government revenue (level)
S28	E_{ij}^{Dz}	Post-tax expenditure in intermediate use on domestic commodity *i* (level)
	E_{isj}^{Iz}	Post-tax expenditure in intermediate use on commodity *i* imported from source *s* (level)
	T_{ij}^{Dz}	Ad valorem tax rate on intermediate use of imported commodity *i* (level)
	T_{ij}^{Iz}	Total tax bill on intermediate use of imported commodity *i* (level)
S29	E_{Ci}^{Dz}	Post-tax consumption expenditure on domestic commodity *i* (level)
	E_{Cis}^{Iz}	Post-tax consumption expenditure on commodity *i* imported from source *s* (level)

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Table 1A.2: **Parameters in the SALTER model** *(continued)*

Equation	*Parameter*	*Description*
	T^{Dz}_{Ci}	Total tax bill on consumption of imported commodity *i* (level)
	T^{Iz}_{Ci}	Total tax bill on consumption of imported commodity *i* (level)
S30	E^{Dz}_{Gi}	Post-tax government expenditure on domestic commodity *i* (level)
	E^{Iz}_{Gis}	Post-tax government expenditure on commodity *i* imported from source *s* (level)
	T^{Dz}_{Gi}	Total tax bill on domestic commodity *i* purchased by the government (level)
	T^{Iz}_{Gi}	Total tax bill on imported commodity *i* purchased by the government (level)
S31	E^{Dz}_{Ki}	Post-tax investment expenditure on domestic commodity *i* (level)
	E^{Iz}_{Kis}	Post-tax investment expenditure on commodity *i* imported from source *s* (level)
	T^{Dz}_{Ki}	Total tax bill on domestic commodity *i* used in investment (level)
	T^{Iz}_{Ki}	Total tax bill on imported commodity *i* used in investment (level)
S32	E^{z}_{Qj}	Total costs of industry *j* (level)
	S^{z}_{Qj}	Subsidies net of indirect taxes provided to industry *j* (level)
S33	E^{z}_{Ei}	Post-tax value of exports of commodity *i* (level)
	T^{z}_{Ei}	Total export tax bill (level)
S34	E^{z}_{Mis}	Post-duty value of imports of commodity *i* from source *s* (level)
	D^{z}_{is}	Total duty imposed on imported commodity *i* from source *s*
S37	S^{z}_{GY}	Share of income taxes in aggregate government revenue
	S^{z}_{GT}	Share of commodity taxes in aggregate government revenue
S39,S40	β^{z}_{Gi}	Elasticity of substitution in government consumption between domestic commodity *i* and imported aggregate commodity *i*
S41	β^{Iz}_{Gi}	Elasticity of substitution in government consumption between commodities imported from different sources

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Table 1A.2: **Parameters in the SALTER model** *(continued)*

Equation	*Parameter*	*Description*
S43	Z^z_G	Government spending (level)
	T^z_G	Government transfers to private households (level)
S44	S^{Dz}_{QXij}	Share of the intermediate use by industry *j* in aggregate demand for domestically produced commodity *i*
	S^{Dz}_{QCi}	Share of consumption in aggregate demand for domestically produced commodity *i*
	S^{Dz}_{QEi}	Share of exports in aggregate demand for domestically produced commodity *i*
	S^{Dz}_{QGi}	Share of government use in aggregate demand for domestically produced commodity *i*
	S^{Dz}_{QKi}	Share of investment use in aggregate demand for domestically produced commodity *i*
S47	S^{Iz}_{MXisj}	Share of intermediate demand by industry *j* in imports of commodity *i* from source *s*
	S^{Iz}_{MKis}	Share of investment demand in imports of commodity *i* from source *s*
	S^{Iz}_{MCis}	Share of consumption demand in imports of commodity *i* from source *s*
	S^{Iz}_{MGis}	Share of government demand in imports of commodity *i* from source *s*
S51	S^{Iz}_{Pisj}	Share of imported commodity *i* from source *s* in the aggregate use of imports of the commodity by industry *j*
S52	S^{Dz}_{Pij}	Share of domestic commodity *i* in the aggregate use of commodity *i* by industry *j*
	S^{Iz}_{Pij}	Share of imported commodity *i* in the aggregate use of commodity *i* by industry *j*
S55	S^{Iz}_{Cis}	Share of imported commodity *i* from source *s* in consumer demand for aggregate imported commodity *i*
S56	S^{Dz}_{Ci}	Share of domestic commodity *i* in consumer demand for aggregate commodity *i*
	S^{Iz}_{Ci}	Share of imported commodity aggregate *i* in consumer demand for aggregate commodity *i*
S59	S^{Iz}_{Gis}	Share of imported commodity *i* from source *s* in government demand for imported commodity *i*

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Table 1A.2: **Parameters in the SALTER model** *(continued)*

Equation	*Parameter*	*Description*
S60	S_{Gi}^{Dz}	Share of domestic commodity *i* in government consumption of aggregate commodity *i*
	S_{Gi}^{Iz}	Share of imported aggregate commodity *i* in government consumption of aggregate commodity *i*
S63	S_{Kis}^{Iz}	Share of imported commodity *i* from source *s* in investment use of imported commodity *i*
S64	S_{Ki}^{Dz}	Share of domestic commodity *i* in investment use of aggregate commodity *i*
	S_{Ki}^{Iz}	Share of imported commodity *i* in investment use of aggregate commodity *i*
S66	S_{Vis}^{Wz}	Share of the fob value in the landed duty-free value of commodity *i* from source *s*
	S_{Fis}^{Wz}	Share of the international freight cost in the landed duty-free value of commodity *i* from source *s*
S67	S_{Fs}	Share of international freight supplied by region *s* in the total value of international freight
S68	S_{is}^{WS+1}	Share of imported commodity *i* from source *s* in imports of aggregate commodity *i* by the rest of the world
S69	h_{W1}^{z}	Wage indexation parameter
S71	H_{ij}^{Dz}	Share of domestic intermediate commodity *i* in total costs of industry *j*
	H_{ij}^{Iz}	Share of imported intermediate commodity aggregate *i* in total costs of industry *j*
	H_{kj}^{z}	Share of primary factor *k* in total costs of industry *j*
	H_{Xj}^{z}	Share of intermediate input use in total costs of industry *j*
S72	S_{CTi}^{Dz}	Share of domestic commodity *i* in aggregate consumer demand
	S_{CTi}^{Iz}	Share of imported commodity *i* in aggregate consumer demand
S73	S_{GTi}^{Dz}	Share of domestic commodity *i* in aggregate government purchases of commodities
	S_{GTi}^{Iz}	Share of imported commodity *i* in aggregate government purchases of commodities

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Table 1A.2: **Parameters in the SALTER model** *(continued)*

Equation	*Parameter*	*Description*
S74	S^{Dz}_{KTi}	Share of domestic commodity *i* in aggregate investment expenditure
	S^{Iz}_{KTi}	Share of imported commodity *i* in aggregate investment expenditure
S75	S^{z}_{Ei}	Share of commodity *i* in aggregate exports
S76	S^{z}_{Mis}	Share of imported commodity *i* from source *s* in imports of aggregate commodity *i*
S77	S^{z}_{GDPk}, S^{z}_{GDP2j}	See equation S8
S78	S^{z}_{NC}, S^{z}_{NK}, S^{z}_{ND}, S^{z}_{NZ}, S^{z}_{NE}, S^{z}_{NI}	See equations S6, S7
S79	S^{z}_{Mis}	Share of imports of commodity *i* from source *s* in total imports from source *s*
S80	S^{z}_{MSis}	Share of imports of commodity *i* by region *z* from region *s* in total imports of commodity *i* by region *z*
S81	S^{z}_{EIsi}	Share of exports of commodity *i* from region *z* to region *s* in total exports of commodity *i* from region *z*
S82	S^{z}_{ESsi}	Share of exports of commodity *i* in total exports from region *z* to region *s*
S83	S^{z}_{Esi}	Share of exports of commodity *i* to region *s* in total aggregate exports of commodity *i*
S84	ε_i	Price elasticity of demand by the rest of the world for commodity *i*
S85	β^{IS+1}_i	Elasticity of substitution in aggregate demand by the rest of the world between commodities imported from different sources
S86	S^{z}_{MTis}	Share of imports of commodity *i* from region *s* in total imports by region *z*
S88	S^{z}_{ETi}	Share of exports of commodity *i* from region *z* in total exports of region *z*
S90	EXP^{z}_{T}	Domestic currency value of total exports (level)
	IMP^{z}_{T}	Domestic currency value of total imports (level)

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Table 1A.2: **Parameters in the SALTER model** *(continued)*

Equation	*Parameter*	*Description*
S93	BD^z	Government budget deficit (level)
	NDP_E^z	Net domestic product calculated from the expenditure side (level)
S94	TB^z	Domestic currency value of the trade balance (level)
	NDP_E^z	Net domestic product calculated from the expenditure side (level)

2 THE BENCHMARK DATA SET

The initial equilibrium data set for the SALTER model was constructed from basic input–output tables and fiscal information supplied by the different countries modelled or from secondary data sources. In addition to country-specific information, international trade flow data are also necessary to specify the SALTER model.

Sources for each input–output data set are found in table 2.1 along with the year to which they apply. Data sources are heterogeneous, based on varying commodity classifications, and apply to a variety of different years. The benchmark data set, however, must present a picture of a homogeneous system being modelled at a point in time. The reference time period chosen for the SALTER model is 1988.

Table 2.1: **Origin of the input–output data used to build the equilibrium database**

	Year	*Source*[a]	*Original commodity disaggregation*
Australia	1981	Industry Commission	109
New Zealand	1981	Government of New Zealand	34
Canada	1987	Statistics Canada	593
United States	1985	MITI (1989)	163
Japan	1985	MITI (1989)	163
South Korea	1985	Government of Korea	403
European Community	1980	Ryan (1991)	34
ASEAN	1975	Institute of Developing Economies (1982)	56

[a] Sources without dates are unpublished and were produced by the cited organisations for the purpose of the SALTER model.

Because all the input–output tables are not available for a common year it was necessary to update them so that they reflect conditions in the model's base year, 1988. In addition, examination of the trade data implied by these tables indicated that the trade flows were inconsistent. For example, one region's value of imports of a commodity did not equal the partner regions' value of exports at those regions' borders of that commodity after allowing for freight and insurance. Also the input–output databases contain changes in stocks. These were assumed to represent temporary disequilibrium in supply and demand and it was therefore considered necessary to remove stock changes from the database.

Construction of the database

The model's database was constructed in several steps including:

- the development of concordances to map the industry structure in the various input–output tables to the industry structure of the SALTER model and the construction of the input–output database according to these concordances;
- the construction of a trade flow database in which trade in each commodity between partner countries is consistent;
- the removal of changes in stocks from the databases;
- the incorporation of protection data into each region's database;
- the incorporation of trade flows in an international trade database and into each region's database; and
- the update of each region's database to 1988.

Development of input–output data for the SALTER model

Raw input–output data are supplied in a variety of forms and commodity disaggregations. The first step in making the diverse databases compatible involved converting them to the 34-commodity classification used in the SALTER model. This involved aggregating some commodities and disaggregating others, based on external information. The concordances used to map the industry specification in the various input–output databases into the SALTER model's 34 sectors are available on request.

Development of the trade flow database

The trade database was constructed from data provided by Reuters. The data are compiled by the Statistical Office of the United Nations and reflect the trade flows that occurred in 1988. These data had to be adjusted to fit the commodity classification used in the SALTER model. They also were made to balance so that the fob value of exports from all regions and the rest of the world to a given region add up to the cif value less freight costs of imports into that region. Details of the procedure followed to develop this database are found in appendix 2A at the end of this chapter.

Removing changes in stocks from the input–output database

National accounting systems typically account for changes in stocks. As indicated above, this form of final demand is not required in the SALTER model. An update procedure (UPDATE1) was used to eliminate the changes in stocks present in the regional databases. The UPDATE1 procedure involves using a single-country version of the SALTER model which includes a set of variables and equations to describe changes in stocks. The equations and variables added for this purpose are found in appendix 2A. For UPDATE1, the behavioural parameter settings and the closure are adjusted so as effectively to reduce the model to a Leontief input–output model. The usual model structure is not appropriate, because it is designed to represent changes between equilibria, whereas the elimination of changes in stocks represents a change from disequilibrium to equilibrium. The Leontief structure used in this update procedure holds all prices and the cost structure of industries constant, and holds final demands fixed. The model is run with the following parameter settings:

- factor substitution elasticities are set equal to zero, to enforce Leontief relations between primary factors;
- the compensated price elasticities of consumer demand are made very small to make the consumption of each commodity a fixed proportion of aggregate real consumption;
- import demand elasticities by the rest of the world are set equal to zero to make export volumes constant; and
- import substitution elasticities are set equal to zero to maintain fixed proportions between domestic products and imports.

To remove changes in stocks from the database, the medium run closure (see chapter 1 and appendix 2A) is modified as follows:

- aggregate real changes in stocks are made endogenous;
- the aggregate employment of primary factors is made endogenous and primary factor prices are made exogenous;
- the consumption to savings ratio is made endogenous and aggregate real consumption is made exogenous;
- real government transfers are made endogenous and the ratio of transfer payments to real factor income is made exogenous;
- the real government budget deficit is made endogenous and the income tax rate is made exogenous.

The variables for nominal changes in stocks are set exogenously to –100 per cent. Thus, at the end of the first update procedure a database is obtained for each modelled region that does not include changes in stocks and reflects the changes in production and consumption structure implied by allocating the changes in stocks to the various components of demand.

Incorporating the protection data

In standard input–output tables, taxes and subsidies are only recorded in the aggregate. In order to model protection adequately, more precise information by commodity, industry and type of tax, must be used. Such data have been collected from a variety of sources. They are described later in this chapter.

In order to incorporate this information in each region's model, an update procedure (UPDATE2) is used. This update procedure uses the same parameter settings as UPDATE1. Since the database already contains some fiscal information, the tax instruments described in chapter 1 are shocked by the amount required to reach the ad valorem rates desired. This changes the price paid for a commodity and government revenues. At the end of UPDATE2, each region's database reflects the estimated fiscal aspects of protection for the base year.

Incorporating the trade data

The trade component of most regional databases consists of import and export flows for each commodity. The trade pattern they reflect is that prevailing in their respective years. However, trade for 1988 is required given that this is the reference year.

The third update procedure (UPDATE3) is designed to modify the databases produced with UPDATE2 so they reflect the structure of trade in 1988. To facilitate this, variables are introduced into the model to define the ratio of imports and exports of each commodity to net domestic product (see appendix 2A). This constitutes a set of target ratios for 1988. The difference between the initial trade ratios and the target trade ratios for 1988 is the amount of the shocks that must be applied to the initial trade ratios.

Changes in trade ratios represent changes in prices or relative volumes, and may arise from changes in either domestic or foreign demand and supply. For UPDATE3, they are assumed to represent volume rather than price changes; this appears to agree broadly with actual medium run trade changes for most broad commodity categories (with the notable exception of oil). The source of change in the trade ratios is assumed to be changes in foreign demand and supply. The closure is therefore modified, so that import prices and export demand shift terms are endogenous. The equation system is altered by adding equations defining the import and export to net domestic product ratios (see appendix 2A); these variables are made exogenous.

Further changes are required to the medium run closure, to generate a solvable equation system. Merely exogenising the trade ratios and endogenising import prices and export demand shift terms would lead to a singular system. In effect, we would be trying to hit $2T$ targets (where T denotes the number of tradable goods) — the trade ratios — with $2T$ instruments — the import prices and export demand shift terms. Usually this is possible, but in this case it is not because raising all the instrument variables by the same percentage would merely raise the domestic price level without changing any real variables, in particular, without changing any of the trade ratios. So the $2T$ price instruments span at most $(2T-1)$ dimensions of variation in the trade ratios. The complementary problem is that merely specifying the trade ratios leaves the general level of trade prices undetermined.

To fix the general price level, the net domestic product deflator is made exogenous. To allow all the trade ratio targets to be hit, the saving shift term is made endogenous. A change in the savings ratio represents a change in external balance, which is required if the trade ratio changes for individual commodities imply in aggregate a change in the trade balance. This gives a set of $(2T+1)$ instruments — import prices, export demand shift terms, and the saving ratio — sufficient for hitting the $(2T+1)$ targets — the trade ratios and the net domestic product deflator.

With the usual behavioural parameter settings, the required changes in trade volumes may be very great for some commodities, because some domestic demand elasticities are liable to be close to unity (so that the effects of price and volume changes on trade values almost offset each other). The usual settings are therefore unsuitable for UPDATE3. But the Leontief structure used for UPDATE1 is also unsuitable because it involves fixed ratios between imported inputs and domestic activity levels, preventing the necessary changes in import use.

For UPDATE3, therefore, the behavioural parameters are changed to greatly increase the substitution effects of price changes. In a model with no income effects, increasing all price elasticities of demand and supply by a common factor would have the effect of leaving quantity responses to any real shock unchanged, while diminishing all price responses by the same common factor. In the SALTER model, magnifying all substitution effects enables the required changes in trade values to be achieved by quantity responses, with only minute price changes. The new parameter settings are therefore:

- factor substitution elasticities are made large so that the allocation of factors responds to the shocks applied instead of to their prices;
- the compensated price elasticities of consumer demand are made large;
- import demand elasticities by the rest of the world are made large so that this demand for commodities is elastic; and
- import substitution elasticities are made large to reflect large own-price and cross-price elasticities for all imports.

The model closure reflecting the medium term conditions discussed in chapter 1 is adapted by making:

- the savings shift term endogenous and the net domestic product deflator exogenous; and
- real government expenditure endogenous and the ratio of private to public expenditure constant.

Applying the shocks to the trade ratios in this environment produces a database for each region with a trade pattern which reflects 1988 trade flows and the production and protection structure characterising the original database.

Updating net domestic product

In the following step the regional databases are updated to 1988 levels of net domestic product and converted to US dollars. This is simply done by scaling all aggregates in each regional database by the difference between the database level of net domestic product resulting from the UPDATE3 procedure and the target (1988) level of net domestic product. This results in aggregate commodity trade flows that match exactly the flows of the 1988 trade database and reflects production and consumption levels assumed to prevail in 1988. Thus the balanced trade database providing the corresponding information on all bilateral trade flows can be aggregated with the balanced regional databases. This yields a balanced equilibrium database composed of production, consumption and fiscal activities in eight regions, and trade flows among these regions and with the rest of the world.

Having reviewed the process by which the database for the SALTER model was developed, it is appropriate to consider some of the structure and characteristics of the economies modelled that are expected to play an important role in determining results in simulations.

Relative size and characteristics of modelled economies

The regional disaggregation in the SALTER model results in a group of large economies (Japan, the European Community, and the United States) accounting for over 90 per cent of the net domestic product explicitly accounted for in the SALTER model (table 2.2). Among the smaller economies, New Zealand accounts for only 0.3 per cent of total net domestic product accounted for, while the other regions account for 1–4 per cent each.

The large economies are expected to determine much of the global results in the SALTER model and smaller economies such as the ASEAN region are expected to be affected by policy changes made in the larger countries. But policy changes in smaller countries are not expected to significantly affect large countries. Net production in the modelled regions accounts for about three-quarters of net world production.

The factoral distribution of income in each region is found in table 2.3. The share of labour is around 55–65 per cent in most countries except for Korea and the ASEAN countries. In these

Table 2.2: **Net domestic product of economies modelled: 1988**

	Net domestic product	*Share of ndp in modelled economies*
	US$m	%
Australia[a]	224 881	1.9
New Zealand[a]	38 501	0.3
Canada[a]	429 047	3.6
United States[a]	4 228 343	35.4
Japan[a]	2 442 351	20.5
Korea[b]	159 173	1.3
European Community[a]	4 201 765	35.2
ASEAN[b]	216 930	1.8

[a] *Source*: OECD (1990a). [b] *Source*: United Nations (1990).

Table 2.3: **Share of primary factors in domestic factor income: 1988**

	Labour	*Capital*	*Land*
	%	%	%
Australia	65	33	2
New Zealand	58	39	3
Canada	54	45	1
United States	65	34	..
Japan	58	41	1
Korea	45	50	5
European Community	65	34	1
ASEAN	35	58	8

.. Less than 0.5 per cent.

two regions, the income allocated to land is large (5 per cent and 8 per cent respectively), reflecting the high level of assistance afforded to agriculture in Korea and the relatively large size of the agricultural sector in the ASEAN region.

Production and trade structure

The structure of trade and production is reviewed in the remainder of this chapter. The analysis will refer to the industry groupings described in box 2.1.

Structure of production

The structure of production, by broad industry group, in each of the modelled economies is found in table 2.4. Relative to other productive activities, agriculture is largest in the ASEAN region where it constitutes 13 per cent of aggregate production. In the other regions of the SALTER model agriculture accounts for a maximum of 8 per cent of aggregate production.

Box 2.1: **Industry and commodity groupings**

Agriculture
1 Paddy rice
2 Non-grain crops
3 Wheat
4 Other grains
5 Wool
6 Other livestock products

Resources
7 Forestry
8 Fishing
9 Coal
10 Oil and gas
11 Other minerals

Food
12 Meat products
13 Milk products
14 Other food products
15 Beverages and tobacco

Manufacturing non-metallic
16 Spinning, dyeing and made-up textiles
17 Wearing apparel

Manufacturing non-metallic *(continued)*
18 Leather, fur and their products
19 Lumber and wood products
20 Pulp, paper and printing
21 Chemicals, rubber and plastic
22 Petroleum and coal products
23 Non-metallic mineral products

Manufacturing metallic
24 Primary iron and steel
25 Other metals and products
26 Transport industries
27 Other machinery and equipment
28 Other manufacturing

Services
29 Electricity, gas and water
30 Construction
31 Trade and transport
32 Other services (private)
33 Other services (government)
34 Other services (ownership of dwellings)

Table 2.4: **Share of sectors in gross aggregate production[a]: 1988**

	Agriculture[b]	Resources	Processed foods	—— Manufacturing —— Non-metallic	Metallic	Services
	%	%	%	%	%	%
Australia	5	5	6	12	12	60
New Zealand	8	3	9	16	12	52
Canada	3	5	5	14	12	61
United States	2	3	4	13	13	65
Japan	3	1	6	14	17	59
Korea	6	2	8	23	18	43
European Community	4	5	7	17	14	54
ASEAN	13	7	16	15	15	34

[a] Calculated as the share of each sector's costs in the total costs of gross production. [b] Industry and commodity groupings are defined in box 2.1.

Processed foods account for 16 per cent of production in the ASEAN region making this region very reliant on agricultural products.

Manufacturing accounts for a large portion of production in Korea (41 per cent) whilst only 25–30 per cent in other countries. The services industries typically represent more than 50 per cent of gross output, except in Korea and the ASEAN countries where they account for 43 per cent and 34 per cent of gross output respectively.

Production costs

The structure of production costs in each modelled region is presented in table 2.5. Overall, labour costs as a proportion of total production costs are largest for the United States, the European Community and Australia. Labour costs are relatively low in Korea and the ASEAN countries, accounting for less than 20 per cent of production costs.

Returns to farm land are relatively small, accounting for 1 per cent or less of costs in most countries, but 2 per cent in Korea and 4 per cent in the ASEAN region. This reflects the importance of the agricultural sector in the larger ASEAN countries. In the non-agricultural sectors, returns to land are aggregated with those of capital; this results in relatively high returns to capital in the resources sector.

The overall share of intermediate inputs in the costs of production is between 44 and 57 per cent for all economies except Korea (61 per cent). Imports usually play a relatively minor role in production, accounting for less than 8 per cent of intermediate use in all regions except in Korea and the ASEAN region, where they account for around 15 per cent of total intermediate use.

Table 2.5: **Share of costs in gross aggregate production: 1988**

	– Intermediate inputs –				
	Domestic	*Imported*	*Labour*	*Capital*	*Land*
	%	%	%	%	%
Australia	43	6	33	17	1
New Zealand	50	7	25	17	1
Canada	44	8	26	22	1
United States	41	3	36	19	..
Japan	45	4	30	21	1
Korea	46	15	18	20	2
European Community	41	5	35	18	..
ASEAN	32	16	18	30	4

.. Less than 0.5 per cent.

Global trade structure

The main international commodity flows are summarised in table 2.6. This table contains the shares of aggregate imports, by origin, and exports, by destination, for each modelled region. Australia's main suppliers are the United States, Japan, the European Community and the rest of the world, each accounting for about 20 per cent of Australia's aggregate imports. The data show the importance of Australia in New Zealand's imports (24 per cent), the importance Japan plays in supplying the Korean and ASEAN economies (29 per cent and 27 per cent of imports respectively) and the heavy reliance of Canada on imports from the United States. The strong links of the European Community with economies not explicitly modelled here, such as the preferential agreements with the European Free Trade Area (EFTA) and African nations, are evidenced by the large share of the rest of the world as a source of European Community imports.

On the export side, the main trade links observed in the import structure are largely reinforced. The export structure, by broad commodity group, of each region is summarised in table 2.7. Agriculture constitutes a significant part of export earnings for Australia and New Zealand (18 per cent and 21 per cent respectively), and resources are most important for Australia (26 per cent of exports), Canada (13 per cent) and ASEAN countries (15 per cent). Processed food products represent over a third of New Zealand's export earnings, but account for less than 15 per cent of earnings in other regions.

For most regions in the model, manufactures represent 80–90 per cent of export earnings; this is the case for Canada, the United States, Korea and the European Community, while in Japan, practically all exports are manufactured products.

Table 2.6: **Major trade flows in the SALTER model: 1988**

Imports, by source

	Imports from								
	Australia	*New Zealand*	*Canada*	*United States*	*Japan*	*Korea*	*European Community*	*ASEAN*	*Rest of the world*
	%	%	%	%	%	%	%	%	%
Importer									
Australia	–	4	3	18	22	3	22	7	22
New Zealand	24	–	2	17	16	2	16	4	20
Canada	1	..	–	68	6	2	12	1	11
United States	1	..	18	–	20	4	16	5	36
Japan	6	1	4	22	–	5	12	12	38
Korea	4	1	2	20	29	–	11	7	26
European Community	1	..	2	12	10	1	–	3	70
ASEAN	4	1	1	19	27	3	16	–	28
Rest of the world	1	..	1	11	8	1	35	2	41[a]

Exports, by destination

	Exports to								
	Australia	*New Zealand*	*Canada*	*United States*	*Japan*	*Korea*	*European Community*	*ASEAN*	*Rest of the world*
	%	%	%	%	%	%	%	%	%
Exporter									
Australia	–	5	2	8	27	4	13	9	33
New Zealand	14	–	2	11	17	2	16	5	32
Canada	1	..	–	68	7	1	8	1	15
United States	2	..	19	–	12	3	16	5	44
Japan	3	..	2	30	–	5	15	8	37
Korea	2	..	3	31	17	–	12	6	28
European Community	1	..	2	12	4	1	–	2	78
ASEAN	3	..	1	25	25	4	16	–	27
Rest of the world	1	..	1	13	6	1	27	2	48[a]

[a] Trade among countries in the rest of the world is included as it is used to determine some important share parameters in the model.
.. Less than 0.5 per cent.

Table 2.7: **Share of each non-service broad industry group[a] in aggregate exports: 1988**

				Manufacturing	
	Agriculture	*Resources*	*Processed foods*	*Non-metallic*	*Metallic*
	%	%	%	%	%
Australia	18	26	13	10	33
New Zealand	21	6	37	20	16
Canada	5	13	4	28	51
United States	6	3	7	21	62
Japan	..	..	..	11	88
Korea	1	2	2	43	52
European Community	2	3	6	29	60
ASEAN	9	15	11	27	37

[a] Industry and commodity groupings are defined in box 2.1. .. Less than 0.5 per cent.

Table 2.8: **Share of each country in non-service commodity exports, by broad commodity group[a]: 1988**

	Agriculture	Resources	Processed foods	Manufacturing Non-metallic	Manufacturing Metallic
	%	%	%	%	%
Australia	13	15	6	1	1
New Zealand	4	1	4	1	..
Canada	11	21	5	9	6
United States	37	16	26	19	21
Japan	..	1	1	9	26
Korea	1	1	1	6	3
European Community	18	23	42	49	38
ASEAN	16	22	13	8	4

[a] Industry and commodity groupings are defined in box 2.1. .. Less than 0.5 per cent.

This structure of exports does not account for the relative size of exports by each region, but confirms some of the conclusions reached in analysing the production costs above: primary products are the major export earners for Australia and New Zealand. As a low cost producer of processed food in the South Pacific region, New Zealand earns a substantial amount of its earnings from this type of export. Although the United States is a major exporter of agricultural products (its exports of these commodities are twice as large as those for any other SALTER country), these products are dwarfed by the importance of its manufactured commodity exports. Japan and Korea are similarly more heavily specialised in manufactured products, indicating a significant advantage in these countries' costs in producing these commodities.

The modelled regions account for 50 per cent of world agricultural exports, 31 per cent of resource exports, 52 per cent of exports of processed foods and around 61 per cent of exports of manufactured goods. The prominence of large countries in exports, by broad commodity groups, is shown in table 2.8. Among the trade flows between modelled regions, the United States accounts for 37 per cent of agricultural exports. New Zealand, Japan and Korea together account for only 3 per cent of trade in resources. The large exporters of processed food products are the United States and the European Community, and these regions are also major players in the manufactured goods markets. Japan, however, contributes significantly to trade in metallic manufactures. In summary, the structure of exports is in large part related to the production capacity of the regions modelled.

Trade margins and the trade database

The trade data used to model the international non-service commodity trade flows in the SALTER model stem from the Statistical Office of the United Nations. These data are compiled from reports of imports and exports provided by each government and are notoriously inconsistent, but Tsigas, Hertel and Binkley (1990) have devised a method by which the database can be made to balance. The method of these authors relies heavily on the fact that each trade flow is reported twice and by different reporters (once by the importer and once by the exporter). It entails estimating systematic biases in the reported imports and exports. The method for estimating these biases follows closely that used by Tsigas et al.

The first step involves identifying a pair of unbiased reporting countries. The United States is found to be a good reporter of exports, while Japan is found to report imports most accurately (table 2.9). The reporting biases of other regions are estimated relative to these two countries' assumed correct reports. Values in excess of 1.0 reflect a region's tendency to underreport a particular trade flow, and is the factor by which its reported trade flows must be adjusted for them to match a balanced trade database. The converse interpretation applies for values less than 1.0. These consistent bias estimates are used to adjust the trade flows reported in the original trade database.

Trade margins are defined as the ratio of cif import values to fob export values for broad commodity groups and trade routes. Estimates of these trade margins are found in table 2.10 and 2.11. Bulky products of relatively low specific value have high margins associated with them. It is hypothesised that high margins for high valued items (such as the high technology category) result from high insurance costs.

These commodity and route specific trade margins are used to generate a set of cif/fob margins for the SALTER commodity classification transported between the regions defined

Table 2.9: **Estimated trade reporting biases for eight regions**

	Export bias	*Import bias*
Australia	1.06618	1.05109
New Zealand	1.07635	1.00420
Canada	0.92944	1.03083
United States	1	1.03823
Japan	1.00241	1
Korea	0.82946	1.06444
European Community	1.01623	0.93874
ASEAN	1.18071	1.39461

Source: Appendix 2A.

Table 2.10: **Estimated trade margins, by commodity** (imports cif/exports fob)

No.	*SALTER commodities*	*Aggregated UN trade data classification*	*Geometric mean*
1	Paddy rice	Rice	1.064
2	Non-grain crops	Coffee, tea and spices, sugar, sweeteners and cocoa, candy, chocolates, non-alcoholic beverages	1.094
3	Wheat	Wheat	1.175
4	Other grains	Other grains, and milled feed grains and oilseeds	1.175
5	Wool	Non-edible crop and livestock products	1.091
6	Other livestock products	Non-edible crop and livestock products	1.091
7	Forestry	Forestry products	1.388
8	Fishing	Fisheries and products	1.182
9	Coal	Mining and resource extraction	1.300
10	Oil and gas	Mining and resource extraction	1.300
11	Other minerals	Basic intermediates	1.147
12	Meat products	Meats and live animals	1.207
13	Milk products	Dairy products	1.227
14	Other food products	Grain flour and meal, cereals and grain-based foods, oilseeds, fats and oils, fresh fruits and vegetables, processed fruits and vegetables	1.194
15	Beverages and tobacco	Tobacco and alcoholic beverages	1.094
16	Spinning, weaving, dyeing, made-up textiles	Light industry	1.066
17	Wearing apparel	Light industry	1.066
18	Leather, fur and their products	Light industry	1.066
19	Lumber and wood products	Basic intermediates	1.147
20	Pulp, paper and printing	Basic intermediates	1.147
21	Chemicals, rubber and plastic	Basic intermediates	1.147
22	Petroleum and coal products	Mining and resource extraction	1.300
23	Non-metallic mineral products	Mining and resource extraction	1.300
24	Primary iron and steel	Basic intermediates	1.147
25	Other metals and products	Basic intermediates	1.147
26	Transport industries	Finished capital goods	1.051
27	Other machinery and equipment	High technology	1.247
28	Other manufacturing	Intermediate manufactures	1.169

Source: Appendix 2A.

Table 2.11: **Estimated trade margins, by route** (imports cif/exports fob)

	Australia	*New Zealand*	*Canada*	*United States*	*Japan*	*Korea*	*European Community*	*ASEAN*
Australia	–	1.051	1.191	1.317	1.118	1.212	1.151	1.022
New Zealand		–	1.191	1.214	1.097	1.212	1.217	1.022
Canada			–	1.131	1.201	1.155	1.097	1.388
United States				–	1.109	1.326	1.048	1.239
Japan					–	1.292	1.210	1.197
Korea				Symmetric		–	1.177	1.130
European Community							–	1.308
ASEAN								–

Source: Appendix 2A.

in the model. First, the trade margins in tables 2.10 and 2.11 are used to generate a set of cif/fob ratios by trading route and commodity. The original 17 commodity and 28 trade-route margins are made to match the 28 non-service commodities specified in the trade database used in the SALTER model (trade routes with the rest of the world are assumed to be the same as those representing ASEAN). This yields a set of 28 by 28 or 784 cif/fob margins each of which describes the cost of transporting (freight and insurance) a commodity from one region to another. Thus a complete set of trade margins for the non-service commodities in the SALTER model is obtained. These ratios are then applied to the exports of the trade database to obtain a first estimate of the cif value of imports. The data are then scaled using the RAS method (Stone 1962; Bacharach 1970) to obtain an unbiased and balanced trade data set where imports and exports have been corrected to account for reporting bias and imports are equal to corresponding exports plus the cost of freight. A more detailed description of the procedure followed is available in appendix 2A. This appendix also provides the method by which trade in services was derived, based on aggregate trade patterns and information contained in the regional databases.

Protection database

Basic national accounts provide taxes and government revenues in aggregate terms. This is not useful to model the specific policies that protect and subsidise, or handicap a particular sector in a region. A database of industry protection was compiled for the SALTER model. It is composed of tariff and non-tariff assistance expressed in ad valorem equivalents.

Assistance to producers can be provided in a variety of different ways. The structure of the SALTER model provides instruments through which changes in producer assistance can be made. Omitting the effects of technical change, the change in price received by the producer of commodity j is given by:

$$(2.1) \qquad p_j^{Dz} = s_{Qj}^z + \sum_{i=1}^{I} H_{ij}^{Dz}\left[p_i^{Dz} + t_{ij}^{Dz}\right] + \sum_{i=1}^{I} H_{ij}^{Iz}\left[\sum_{s=1}^{S=1} S_{isj}^{Iz}\left[p_{is}^{Wz} + e^z + d_{is}^z\right] + t_{ij}^{Iz}\right] + \sum_{k=1}^{K} H_{kj}^z w_{kj}^z$$

where

p_j^{Dz} is the price of industry j's output;

p_i^{Dz} is the price of domestically produced commodity i;

p_{is}^{Wz} is the world price of input i from source s; and

w_{kj}^z is the price of primary factor k paid by industry j.

$H_{ij}^{Dz}, H_{ij}^{Iz}, H_{kj}^{z}$ and S_{isj}^{Iz} are share parameters (see appendix 1A), and the instruments through which protection policy changes can be modelled are:

- s_{Qj}^{z}, the rate of indirect tax applied to industry *j*;
- t_{ij}^{Dz} and t_{ij}^{Iz}, the taxes applied respectively on the use of domestically produced and imported commodity *i* by industry *j*;
- d_{is}^{z}, the rate of duty applied to imports of commodity *i* from source *s*.

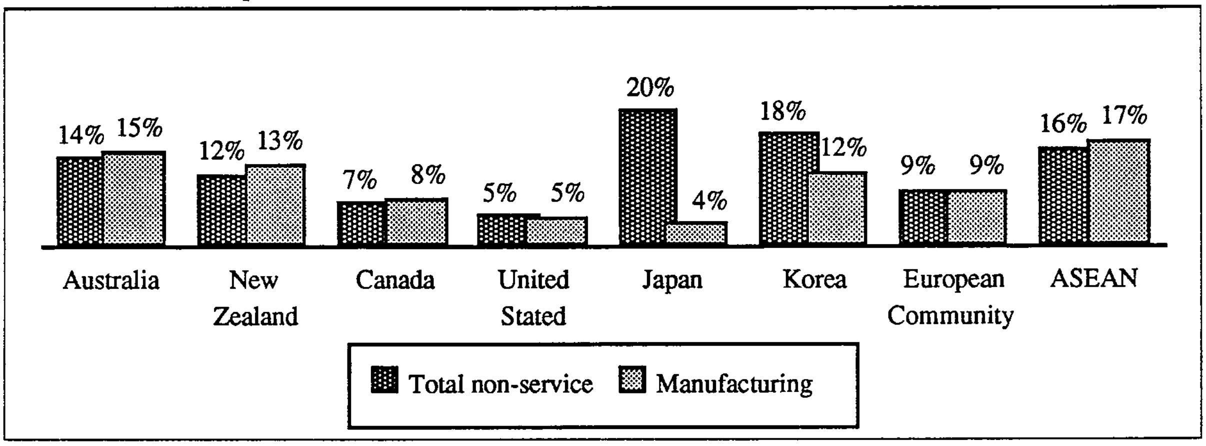
These instruments enable the user to specify a large number of policy changes expressed in ad valorem terms. Other policies such as specific taxes and quantitative restrictions must be converted to ad valorem equivalents before they can be incorporated in the protection database. An increase in direct subsidies to industry *j* is modelled by setting s_{Qj}^{z} less than zero, which reduces the price of output, p_{j}^{Dz}. An increase in input subsidies is obtained by setting t_{ij}^{Dz} and t_{ij}^{Iz} less than zero. While a duty increases the price of an imported input *i* for industry *j*, a duty applied to imported commodity *j* increases the price of imported commodity *j*; this enables domestic producers to increase the price of domestically produced commodity *j* (p_{j}^{Dz}). The protection database contains the information necessary to establish the patterns of market intervention existing in the initial situation, prior to a simulation. It is composed of tariff assistance measures and domestic subsidy measures.

Tariff assistance

Tariff assistance measures insert a wedge between the world price of a commodity and the price paid in a given region. Tariff barriers have fallen from around 40 per cent in the 1940s to 8 per cent by the early 1980s and around 5.5 per cent by 1988 (Laird and Yeats 1990). Aggregate tariff assistance on non-service trade in the SALTER model is largest for the Asian economies and lowest in North America (figure 2.1).

Liberalisation has, however, been largely uneven, and while protection is especially low in the trade of manufactured products (figure 2.1), each country still has pockets of industries in the liberalised manufacturing sectors which are highly protected. These industries are largely in the food processing and textile sectors (Laird and Yeats 1990). In general, the assistance provided to the manufacturing sectors is close to that provided on average in the economy. The large difference between assistance to non-service industries in Japan and Korea and assistance in the manufacturing sector is due to the significant assistance programs which benefit agriculture in these economies.

Figure 2.1: **Ad valorem tariff equivalents on all non-service commodity trade and trade in manufactured products in the SALTER model: 1988**

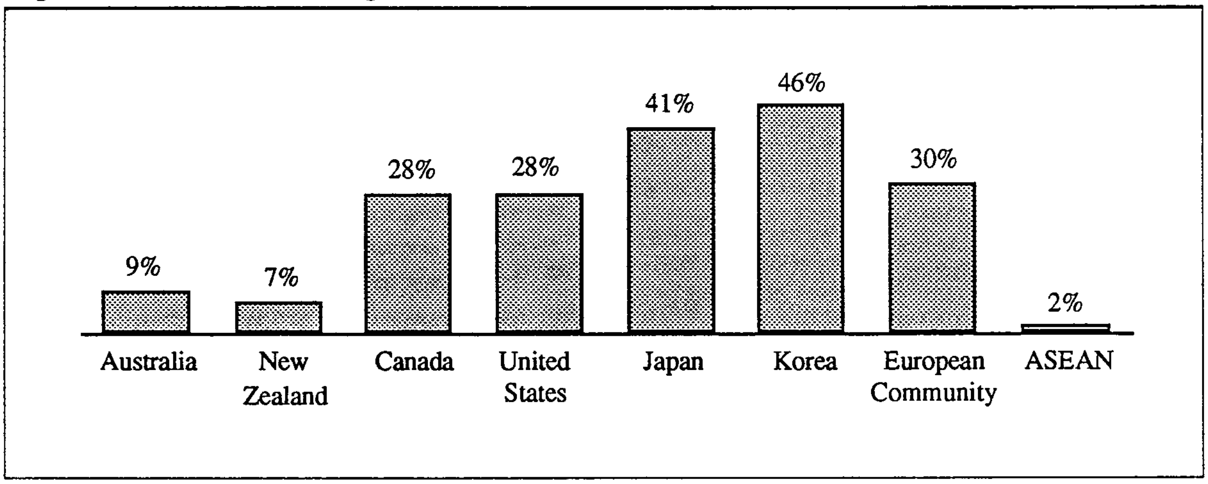


Assistance to agriculture

The levels of assistance provided to agriculture can be categorised in three groups according to the share of income that farmers derive from assistance (figure 2.2):

- low assistance countries such as Australia, New Zealand and the ASEAN region in which agricultural assistance accounts for less than 10 per cent of farm income;
- medium assistance countries, including North America and European Community economies, whose farmers derive about 25–30 per cent of their income from assistance; and
- high assistance countries — that is, Japan and Korea — in which farm support contributes more than 40 per cent to aggregate farm income.

Figure 2.2: **Proportion of agricultural receipts derived from assistance: 1988**



Assistance in the agricultural sectors is assumed to be provided mainly through producer subsidies. Producer subsidy equivalents (pse) calculated for 1988 by the OECD (1990b) and for 1986 and 1987 by the US Department of Agriculture (1988, 1990) were used to estimate the policy instruments embedded in the SALTER database. Four measures were calculated:

- the ad valorem equivalent duty applying to imported commodities;
- the ad valorem export tax equivalent applying to exported commodities;
- the tax equivalent applying to the production of a commodity; and
- the consumer subsidy equivalent.

These measures can all be viewed as tax or subsidy equivalents. The trade wedges applied to imports and exports were obtained by calculating the unit support derived from market price support and expressing this as a percentage of each commodity's world price. The world price was calculated by deducting the per unit assistance derived through market price supports from the per unit price received by producers.

Assistance other than price support is treated as a production subsidy. This assistance includes direct payments to farmers and some assistance which affects the cost of inputs. For each commodity, the aggregate value of this type of assistance is divided by the quantity provided to derive the per unit production subsidy. The per unit subsidy is converted to its ad valorem equivalent by dividing it by the world price of each commodity. The same process is applied to derive subsidies allocated to consumers.

The policy instruments directly affecting agricultural production accounted for in the SALTER protection database are detailed in table 2.12. Each element of the protection scheme in a region is an ad valorem equivalent of taxes and subsidies which includes the effect of ad valorem and specific tariffs as well as non-tariff barriers. The effective protection afforded several products in Japan and Korea is far above the high rates of protection found in the European Community. These high rates result from non-tariff barriers such as quota measures which significantly restrict imports.

Trade barriers in non-agricultural sectors

While the decline in tariff assistance is a major success of GATT negotiations, non-tariff barriers have proliferated. The current increase in non-tariff barriers can be traced to the 1955 waiver provided to the United States under which that country was allowed to use quantitative controls to facilitate domestic pricing policies. The discriminatory restraints

Table 2.12: Support provided to the agricultural and food sectors of the modelled regions through taxes and subsidies[a] in the SALTER model: 1988

	Export tax	*Import tax*	*Production tax*	*Consumption tax*	*Export tax*	*Import tax*	*Production tax*	*Consumption tax*
	%	*%*	*%*	*%*	*%*	*%*	*%*	*%*
	Australia				*New Zealand*			
Paddy rice	–13.91	16.17	–15.90	0.00	0.00	0.00	0.00	0.00
Non grain crops	0.00	0.00	–0.89	0.00	0.00	0.00	0.00	0.00
Wheat	0.00	0.00	–9.77	0.00	0.00	0.00	–13.38	0.00
Other grains	0.00	0.00	–7.57	0.00	0.00	0.00	–2.89	0.00
Wool	0.00	0.00	–3.80	0.00	0.00	0.00	–5.21	0.00
Other livestock	–0.52	0.00	–0.14	0.01	0.00	0.00	–0.11	1.04
Meat	0.00	0.00	–7.23	0.00	–0.06	10.49	–6.84	–3.19
Dairy	–28.27	39.41	–26.18	0.07	0.00	0.00	–4.97	0.00
Other food	–6.84	0.00	0.00	9.14	0.00	0.00	0.00	0.00
	Canada				*United States*			
Paddy rice	0.00	0.00	0.00	0.00	0.00	0.00	–49.29	0.00
Non grain crops	–3.27	3.54	–7.60	0.03	0.00	0.00	–2.86	0.00
Wheat	–16.42	19.65	–30.44	9.28	–8.23	8.97	–28.50	–1.35
Other grains	–12.61	14.43	–13.36	–0.52	0.00	0.00	–34.54	–0.05
Wool	0.00	0.00	0.00	0.00	–3.92	4.08	–26.08	–0.80
Other livestock	0.00	0.00	–1.23	0.01	0.00	0.00	–0.22	–0.04
Meat	–13.14	37.42	–18.35	–0.01	–23.40	34.53	–7.00	0.00
Dairy	–56.11	127.86	–17.09	–0.06	–46.43	86.68	–9.44	–5.29
Other food	–0.62	0.02	0.00	0.11	–0.77	16.25	–0.21	–0.01
	Japan				*Korea*			
Paddy rice	–88.99	808.58	–15.07	0.00	–87.18	679.92	–6.90	0.00
Non grain crops	–0.56	1.53	–1.24	0.00	–0.73	3.61	–0.28	1.05
Wheat	–83.19	494.98	–18.31	–77.70	–33.27	49.85	–37.02	–32.03
Other grains	–86.20	624.71	–20.35	–73.50	–83.52	548.40	–4.16	–10.75
Wool	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Other livestock	0.00	0.00	–0.27	0.03	0.00	0.00	–0.84	5.94
Meat	–41.29	121.46	–3.60	–0.04	49.46	27.06	–6.57	45.29
Dairy	–79.80	395.09	–12.61	–50.01	–53.71	116.04	–5.56	84.20
Other food	–8.54	43.82	0.00	5.04	–52.72	107.92	0.00	0.00
	European Community				*ASEAN*			
Paddy rice	–63.41	173.27	–6.04	0.00	–0.71	0.00	–6.33	0.00
Non grain crops	0.00	0.00	–2.45	0.00	0.00	0.00	0.00	0.00
Wheat	–24.92	33.19	–5.04	–0.96	0.00	0.00	0.00	44.22
Other grains	–31.47	45.93	–2.29	–2.77	7.42	–2.47	0.00	10.73
Wool	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Other livestock	0.00	0.00	–0.39	–0.08	0.00	0.00	0.00	0.00
Meat	–40.76	71.19	–8.95	0.00	–0.47	27.67	0.00	3.76
Dairy	–56.61	130.49	–5.82	–7.18	–37.16	29.57	0.00	0.00
Other food	–19.80	9.97	0.00	–0.08	1.27	0.44	0.00	13.14

[a] A negative tax is interpreted as a subsidy.

imposed on Japanese textile exports under the Short-Term Arrangements on Cotton Textiles of 1961 were also allowed. Such measures have provided the means to implement discriminatory trade policies within GATT rules (Stoeckel, Pearce and Banks 1990).

Measures such as the Multifibre Arrangements are becoming increasingly discriminatory against products of importance to developing countries. The variety of non-tariff barriers (box 2.2) and their lack of transparency contribute to making any estimation of their effect a difficult proposition. While extensive work on agricultural products has been incorporated in the estimates of protection shown above, studies of measures affecting manufactured products are more difficult to use in developing a complete protection database. Deardorff and Stern (1989) have estimated a consistent set of non-tariff barrier tariff equivalents for developed countries. Their estimates apply to a number of years, mostly prior to 1981 and are believed to be incomplete measures of non-tariff barriers to trade. This lack of consistent information

Box 2.2: **Types of non-tariff barriers**

Type	*Definition*
Import quota	Quantitative restrictions on imports.
Voluntary export restraint (VER)	Action undertaken by the government of an exporting country to restrict exports of a particular good to a particular country.
Variable levy	A tariff equal to the difference between the world price and a determined, fixed target price;.the levy therefore varies as the world price varies.
Government procurement regulations	Preference by a government for its own country's products over imports.
Domestic subsidies	Payments to individuals or businesses by the government for which it receives no goods or services in return.
Exchange controls	Rationing of foreign exchange which usually involves some form of import licensing and therefore has similar effects to a quota.
Domestic content requirement	Requirement that goods sold on the domestic market have a certain fraction of domestic value added.
Antidumping duties	A duty levied on imports sold at low prices (usually below cost).
Customs valuation procedures	Various valuation procedures applied to imports which slow the flow of imports into a country
Technical barriers	Certain standards and methods of certification applied to imports which slows the flow of imports into a country.

Source: Adapted from Deardorff and Stern (1984).

is in large part responsible for the sparsity of the ad valorem tariff equivalents applied in the SALTER model. The aggregate effects listed in table 2.13 result from the compilation of tariff and non-tariff information found in Deardorff and Stern (1989). In particular, no information is included for ASEAN countries and while resource commodities are affected by significant trade limitations — for example, the stringent Japanese import quota for coal and

Table 2.13: **Ad valorem tariff equivalents in the manufacturing and beverages and tobacco industries applied in the SALTER model**

	Australia	*New Zealand*	*Canada*	*United States*	*Japan*	*Korea*	*European Community*	*ASEAN*
	%	%	%	%	%	%	%	%
Beverages and tobacco	13.96	23.50 (4.10)	11.70 (4.10)	17.80 (14.50)	43.30 (27.10)	17.00	21.90 (7.40)	24.02
Spinning, weaving, dyeing and made-up textiles	35.78	10.40	20.00	16.25	9.80	14.00	10.60	40.52
Wearing apparel	65.47	37.65	22.30	13.20	15.75	17.25	12.00	39.87
Leather, fur and their products	9.04	21.90	12.90	10.40	10.40	10.10	4.80	26.68
Lumber and wood products	11.32	17.20	7.00	2.30	3.50	14.40	3.40	18.48
Pulp, paper and printing	7.08	11.90	5.20	22.80 (22.30)	0.80	4.70	8.50 (3.40)	13.44
Chemicals, rubber and plastic	11.73	7.90	8.20	3.20	4.00	11.60	5.00	14.37
Petroleum and coal products	0.10	14.20 (6.10)	2.20	0.90	6.40 (1.30)	8.55	30.70 (29.70)	8.80
Non-metallic mineral products	4.48	15.90 (0.80)	8.20	6.55	4.10 (1.10)	15.20	7.20 (0.70)	25.27
Primary iron and steel	7.59	8.80	6.90	15.55 (11.30)	3.50	7.60	21.50 (17.00)	9.65
Other metals and products	13.32	14.20	6.15	2.43	4.65	11.50	3.95	19.45
Transport industries	19.70	14.00	8.00	2.20	1.70	5.50	5.20	20.92
Other machinery and equipment	13.41	14.43 (0.70)	6.63 (1.40)	3.57 (0.20)	0.97	14.23	10.63 (4.30)	15.24
Other manufacturing	17.97	20.70 (0.40)	6.90	3.45	2.30 (0.80)	12.30	3.90 (1.50)	17.02

Note: Figures in parentheses are the non-tariff barrier component of the aggregate tariff equivalent.

regulations on petroleum imports in the United States (Laird and Yeats 1990) — no barriers have been included in the SALTER model.

The ad valorem tariff equivalents accounted for in the SALTER database are composed of both tariff and non-tariff effects (table 2.13). In addition to the instruments applying directly to imports, some commodities are subjected to voluntary export restraints. These restrictions are modelled as export tax equivalents applied in the country of origin. The rates applied result from the Multifibre Arrangement which affects trade in textile products and restraints on Japanese automobile exports (table 2.14).

Table 2.14: **Export tax equivalents used to model voluntary export restraints in the SALTER model**

	Export tax equivalent
	%
Korea	
Spinning, weaving and made-up textiles	10.7
Wearing apparel	10.7
Japan	
Transport equipment	11.4

Source: Deardorff and Stern (1989).

APPENDIX 2A: UPDATING REGIONAL AND TRADE DATABASES

Changes in the model's structure

This appendix indicates the changes to the standard SALTER model structure needed to update the databases as indicated in chapter 2. The procedure followed in obtaining cif/fob ratios mentioned in chapter 2 is also detailed. The initial database is obtained from a variety of heterogeneous sources. These data are made compatible by using the UPDATE procedure, a large-change facility in GEMPACK (Pearson 1990), the software used to develop and solve the SALTER model. To include a regional database in the equilibrium database, several modifications are performed:

- changes in stocks are eliminated in each regional database;
- external tax information is incorporated;
- the regional database is updated to reflect 1988 trade patterns; and
- the regional database is scaled to reflect 1988 levels of net domestic product.

Eliminating changes in stocks and updating trade patterns require small changes to the standard SALTER model structure, these changes are outlined here.

Eliminating changes in stocks

To account for changes in stocks usually supplied by national accounts data, the single-country model version of the SALTER model includes the following additional equations:

(2A.1) $sto_i^D = sto_R$

(2A.2) $sto_{is}^I = sto_R$

where variables are expressed in percentage changes, and

sto_i^D is changes in the stock of domestic commodity *i;*

sto_{is}^I is changes in the stock of commodity *i* imported from source *s;* and

sto_R is aggregate real changes in stocks.

Relations 2A.1 and 2A.2 indicate a fixed proportion is assumed between aggregate and individual commodity changes in stocks. As outlined in chapter 2, to eliminate changes in stocks, the SALTER model is used as a Leontief model where fixed proportions rule production and consumption relations.

Adapting the trade structure

The trade flows in each regional model must correspond to the flows reported for 1988. United Nations commodity trade data supplied by Reuters were used to build ratios of commodity imports and exports to net domestic product. To obtain the 1988 trade flow structure for each regional database, a simulation was conducted using the trade ratios as targets to modify the databases.

To run this simulation, variables for the trade ratios are defined for each regional model. The following equations define the corresponding percentage change variables and the demand for imports by the rest of the world:

(2A.3) $$r_{Mi} = \sum_{s=1}^{S+1} S_{is} imp_{is} - ndp_E$$

(2A.4) $$r_{Xi} = exp_i - ndp_E$$

(2A.5) $$imp_i^{S+1} = \varepsilon_i \left(p_i^{WS+1} - p_{Ei}^{S+1} \right) + h_{Ti}$$

where variables are expressed in percentage change terms, and:

r_{Mi} is the ratio of commodity *i* imports to ndp;

r_{Xi} is the ratio of commodity *i* exports to ndp;

S_{is} is the share of commodity *i* from source *s* in total imports of *i*;

imp_{is} is imports of commodity *i* from source *s*;

ndp_E is net domestic product measured from the expenditure side;

exp_i is total exports of commodity *i*;

imp_i^{S+1} is aggregate imports of commodity *i* by the rest of the world;

ε_i is the price elasticity of demand for imports of commodity *i* by the rest of the world;

p_i^{WS+1} is the average foreign currency landed duty-free price of imports of commodity i into the rest of the world;

p_{Ei}^{S+1} is the export price of commodity *i* by the rest of the world; and

h_{Ti} is a trade shift term used to cut the link between quantities imported by the rest of the world and prices.

To obtain the trade structure prevailing in 1988, the ratios r_{Mi} and r_{Xi} are exogenously set to the percentage difference between the regional database value and the corresponding value in the trade database for 1988. These shocks applied to each regional database affect the patterns of production and consumption and other uses throughout the regional database; the resulting database is consistent with the flows described in the trade database for 1988.

Producing a consistent trade database

The United Nations' trade database is unreliable when it comes to any given flow of disaggregated commodity between two reporters. Differences in reporting practices, the absence of strong incentives for delivering quality data, and the absence of any attempt to reconcile discrepancies have contributed to significant inconsistencies in reported trade flows. However, the database is exhaustive, which means that there are two observations on every commodity flow (exporter and importer). These observations are available for more than 25 years. The statistical procedure developed by Tsigas, Hertel and Binkley (1990) and used here is designed to capitalise on the information available in order to estimate systematic trade reporting biases and trade margins. While the detailed model is presented in Tsigas et al. only a summary of the process followed to produce a consistent database is provided here.

There are good reasons to believe *a priori* that certain regions in the database are more reliable than others. OECD countries report more regularly than do other countries. They also show evidence of having fewer wildly discrepant trade flows. This feature is used to generate the estimates below.

Several steps are followed in the process of generating the necessary trade margins. First, reporting biases are estimated for the OECD regions in the SALTER model. Reporting biases represent the systematic tendency of a country to overreport or underreport exports or imports relative to their partners.

In order to use the information on exporting biases to reconcile trade flows in the database, it is necessary to define which transactions are unbiased. Tsigas et al. identify US exports and Japanese imports as providing the unbiased benchmark for export and import reporting, respectively. Reporting biases for other OECD countries included in the SALTER model are estimated relative to these two benchmarks (table 2A.1). A bias in excess of one means that the reported data must be inflated in order to reconcile it with the rest of the data set. Thus,

Table 2A.1: **Bias estimates in the United Nations trade database**

	Export bias	*Import bias*
Australia	1.06618	1.05109
New Zealand	1.07635	1.00420
Canada	0.92944	1.03083
United States	1	1.03823
Japan	1.00241	1
European Community	1.01623	0.93874
Newly industrialised countries	0.82946	1.06444
Other South-East Asia	1.18071	1.39461

Source: Estimation results.

among OECD countries, Canada is found to systematically overreport exports, but to underreport imports, relative to the United States and Japan used as benchmarks.

Reporting biases for the remaining regions in the SALTER model are estimated by imposing the biases for OECD countries estimated earlier. This two-stage approach lends precedence to the trade data reported by the OECD countries. The reporting bias estimates are largest for the newly industrialised countries and other South-East Asian countries. Both regions appear to underreport imports, while the newly industrialised countries appear to overreport exports, but the other South-East Asian economies underreport exports.

Simultaneous with the estimation of reporting biases, trade margins are estimated. The trade margins represent estimated cif/fob ratios, by commodity (table 2A.2). A number of the ratios are less than.one, implying a negative margin. This problem arises from the reporting biases underlying the original database. An additional step is found to significantly improve the estimation of margins.

In a third step, the reporting biases estimated earlier are applied to the original trade database in order to obtain a set of bias-corrected trade flows. The trade margins are then estimated by calculating the geometric mean of the ratio of imports to exports, by route and by commodity.

Table 2A.2: **Estimates of trade margins**

	Geometric mean		*Geometric mean*
Rice	0.93630	Other agricultural products	1.05141
Other tropical crops	0.88744	Forestry	1.22173
Wheat	0.78990	Mining	1.14451
Other grains	1.03419	Basic intermediate goods	1.00951
Dairy products	1.07988	Intermediate manufacturing	1.02891
Meat and live animals	1.06226	Light industry	0.93788
Non-edible crops and livestock	0.96057	Finished capital goods	0.92475
Alcohol, beverages and tobacco	0.96338	High technology commodities	1.09773
Fish	1.04019		

Source: Estimation results.

Observations for which the importer reports on an fob basis (such as Australia) are excluded, since this would imply trade margins of zero. Except for wheat, the commodity-specific trade margins exceed one (table 2A.3). Among the route-specific margins, margins estimated with bias corrected data exceed one except in trade between the newly industrialised countries and New Zealand and the other South-East Asian countries (table 2A.4).

The relative magnitudes of the margins appear reasonable. Bulky, low-value commodities and perishable products (forestry, mining, dairy products) have relatively larger margins, while high-value, dense products such as finished capital goods have a low margin. The high technology category consistently is associated with a high margin regardless of the aggregation scheme. The estimated margin for the other tropical crops category appears to be low.

Table 2A.3: **Commodity-specific trade margins estimated as the ratio of imports cif to exports fob, based on bias-corrected data**

	Geometric mean		*Geometric mean*
Rice	1.06372	Other agricultural products	1.19449
Other tropical crops	1.00821	Forestry	1.38798
Wheat	0.89740	Mining	1.30026
Other grains	1.17492	Basic intermediate goods	1.14689
Dairy products	1.22683	Intermediate manufacturing	1.16892
Meats and live animals	1.20681	Light industry	1.06551
Non-edible crops and livestock	1.09128	Finished capital goods	1.05059
Alcohol, beverages and tobacco	1.09448	High technology commodities	1.24711
Fish	1.18174		

Source: Estimation results.

Table 2A.4: **Route-specific margins estimated as the ratio of imports cif to exports fob, based on bias-corrected data**

	Australia	*New Zealand*	*Canada*	*United States*	*Japan*	*European Community*	*NIC*[a]	*Other SE Asia*
Australia	–	1.051	–[b]	1.317	1.118	1.151	1.212	1.008
New Zealand		–	1.191	1.214	1.097	1.217	0.987	1.022
Canada			–	1.131	1.201	1.097	1.155	1.388
United States				–	1.109	1.048	1.326	1.239
Japan					–	1.210	1.292	1.197
European Community				Symmetric		–	1.177	1.308
NIC[a]							–	0.928
Other SE Asia								–

[a] Newly industrialised countries. [b] Canada and Australia report imports on an fob basis, thus a margin between these countries cannot be estimated.

The route-specific margins are more difficult to estimate because they closely parallel the consistent reporting bias problem. In order to overcome this, the matrix of trade flows is assumed to be symmetric, implying that shipments in either direction have the same margin. However, due to the differing composition of trade between two partners, the trade margins are not necessarily a monotonically increasing function of distance. Also, when two partners both report imports on an fob basis, no information is available for calculating margins along that route.

In the light of the results obtained above, a consistent and plausible set of estimates is obtained by applying:

- the margin for other grains to trade in wheat;
- the margin for alcoholic beverages and tobacco to trade in other tropical crops;
- the geometric mean of all trade involving the newly industrialised countries and Other South-East Asian economies to trade between these two regions;
- the margin on trade between newly industrialised countries and Australia for the low margin between newly industrialised countries and New Zealand, and the margin on trade between Other South-East Asian countries and New Zealand to trade between the Other South-East Asian countries and Australia; and
- the New Zealand–Canadian margin for the unobservable Australian–Canadian margins.

This yields trade margins, by commodity (table 2A.5) and trade routes (table 2A.6), that are used to generate the trade margins for the commodity trade flows in the SALTER model. Overall, the geometric mean for all commodities and routes is 1.15258.

Table 2A.5: **Judgmentally adjusted margins, by commodity**

	Geometric mean		*Geometric mean*
Rice	1.06372	Other agricultural products	1.19449
Other tropical crops	1.09448	Forestry	1.38798
Wheat	1.17492	Mining	1.30026
Other grains	1.17492	Basic intermediate goods	1.14689
Dairy products	1.22683	Intermediate manufacturing	1.16892
Meats and live animals	1.20681	Light industry	1.06551
Non-edible crops and livestock	1.09128	Finished capital goods	1.05059
Alcohol, beverages and tobacco	1.09448	High technology commodities	1.24711
Fish	1.18174		

Source: Estimation results.

Table 2A.6: **Judgmentally adjusted margins, by trade route**

	Australia	*New Zealand*	*Canada*	*United States*	*Japan*	*European Community*	*NIC*[a]	*Other SE Asia*
Australia	–	1.051	1.191	1.317	1.118	1.151	1.212	1.022
New Zealand		–	1.191	1.214	1.097	1.217	1.212	1.022
Canada			–	1.131	1.201	1.097	1.155	1.388
United States				–	1.109	1.048	1.326	1.239
Japan					–	1.210	1.292	1.197
European Community				Symmetric		–	1.177	1.308
NIC[a]							–	1.130
Other SE Asia								–

[a] Newly industrialised countries.
Source: Estimation results.

Table 2A.7: **Correspondence between commodity aggregated SALTER commodities**

No.	*SALTER commodities*	*Aggregated UN trade data classification*
1	Paddy rice	Rice
2	Non-grain crops	Coffee, tea and spices, sugar, sweeteners and cocoa, candy, chocolates and non-alcoholic beverages
3	Wheat	Wheat
4	Other grains	Other grains, milled feed grains and oilseeds
5	Wool	Non-edible crop and livestock products
6	Other livestock products	Non-edible crop and livestock products
7	Forestry	Forestry products
8	Fishing	Fisheries and products
9	Coal	Mining and resource extraction
10	Oil and gas	Mining and resource extraction
11	Other minerals	Basic intermediates
12	Meat products	Meats and live animals
13	Milk products	Dairy products
14	Other food products	Grain flour and meal, cereals and grain-based foods, oilseeds, fats and oils, fresh fruits and vegetables, processed fruits and vegetables
15	Beverages and tobacco	Tobacco and alcoholic beverages
16	Spinning, weaving, dyeing, made-up textiles	Light industry
17	Wearing apparel	Light industry
18	Leather, fur and their products	Light industry
19	Lumber and wood products	Basic intermediates
20	Pulp, paper and printing	Basic intermediates
21	Chemicals, rubber and plastic	Basic intermediates
22	Petroleum and coal products	Mining and resource extraction
23	Non-metallic mineral products	Mining and resource extraction
24	Primary iron and steel	Basic intermediates
25	Other metals and products	Basic intermediates
26	Transport industries	Finished capital goods
27	Other machinery and equipment	High technology
28	Other manufacturing	Intermediate manufactures

The trade margin estimates obtained above are used to produce a trade database that is consistent with the regional database in the SALTER model. The trade database comprises data for exports fob, trade margins and imports cif, by source, commodity and destination. Values are recorded in US dollars, and the reference period is calendar 1988. The correspondence between commodities and regions used in the estimation above and those required in the SALTER model is found in tables 2A.7 and 2A.8 respectively.

Table 2A.8: **Correspondence between regions**

SALTER regions	*Regions used in trade estimation*
Australia	Australia
New Zealand	New Zealand
Canada	Canada
United States	United States
Japan	Japan
Korea	Korea
European Community	European Community
ASEAN	Other South-East Asian countries
Rest of the world	Other South-East Asian countries

The following major steps can be identified in the construction of a trade database that is consistent with the regional databases:

- the derivation of initial estimates of exports fob and imports cif, by commodity and trade route, for 1988;
- the determination of cif/fob ratios for each commodity and route that are consistent with the database; and
- the reconciliation of export and import estimates.

The first step, the derivation of initial trade estimates from the trade database provided by Reuters consists of:

- scaling all data that do not apply to 1988, using the ratio of trade flow to net domestic product in US dollars at current prices; and
- rescaling the entire trade database for 1988 with the estimated bias correction factors in table 2A.1.

The trade margins estimated above are adjusted to match the trade database by:

- scaling the commodity estimates in table 2A.5 so that, weighting by the initial export estimates, their mean is equal to the overall mean of trade margins calculated above (1.15258);
- applying the same procedure to the margins, by route, in table 2A.6; and

- applying the RAS scaling method (Stone 1962; Bacharach 1970) to determine a set of commodity-specific and route-specific ratios consistent with the new margins obtained, weighting by the initial export estimates.

Geometric means are used in rescaling the commodity-specific and route-specific margins. Instead of the margins themselves, the logarithms are scaled so that the arithmetic means of the logarithms, weighted by export shares, are equal to the logarithm of the overall mean. This ensures that the geometric mean of the trade margins is equal to the overall mean across commodities and routes. Likewise, in applying the RAS method to derive commodity-specific and route-specific ratios, the weighted geometric means across routes and commodities are required to agree with the predetermined commodity and trade means. To achieve this, a two-dimensional array is defined. Each element of the array is obtained by weighting the logarithm of the cif/fob ratio by the share of the commodity, by route, in total exports. Row and column totals represent logarithms of commodity or route means, multiplied by the share of the commodity or trade route in total exports. For the initial estimates in the RAS procedure, we use the rescaled commodity means.

Finally, the export and import estimates are reconciled as follows.

- For each commodity, two two-dimensional arrays are constructed, in which one dimension represents source and the other destination; in one array the elements represent exports fob, by source and destination, and in the other, they represent imports cif.
- The imports matrix is revalued to fob prices, using the cif/fob ratios determined in the previous stage.
- An initial fob trade matrix is calculated, as the maximum of the exports fob and imports fob matrices.
- An initial import-valuation trade matrix is calculated from the fob trade matrix and the cif/fob ratios, in which trade is shown either fob or cif, depending on the reporting practice of the importing country.
- All zeros in imports from or exports to the rest of the world are replaced by a small number (0.01).
- A variant of the RAS method is used to generate fob and import valuation trade matrices, in which:

- source totals in the fob trade matrix agree with the initial exports estimates for each reporting region;
- destination totals in the import valuation trade matrix agree with the initial imports estimates for each reporting region; and
- cif/fob ratios agree with the ratios previously determined.

- From the final matrices generated by the RAS, and the previously determined cif/fob ratios, a matrix is constructed for each country, showing exports fob, imports cif and trade margins on imports, by commodity and trading partner.

In the modified RAS procedure, the first step is to rescale the import valuation matrix so that destination totals agree with the initial import estimates; the second is to compute a new fob trade matrix, using the predetermined cif/fob ratios; the third is to rescale the new fob trade matrix so that source totals agree with the initial exports estimates; and the fourth is to compute a new import valuation matrix, using the predetermined cif/fob ratios. This four-step cycle is repeated until the conditions on source and destination totals are satisfied simultaneously.

The rest of the world is treated in a special way during the scaling involved in the modified RAS procedure. Suppose we are scaling across rows. Then the row corresponding to the rest of world is not scaled. The elements in the column corresponding to the rest of the world are not scaled by the scaling factor for their respective row but are replaced by the difference between the target row total and the sum of the scaled other elements in their row. It will be noted that trade within the rest of world is not determined by this procedure. It is merely set equal to a small number (0.01) and is determined elsewhere.

Trade in services

The United Nations' trade data cover only trade in physical commodities. The SALTER model includes trade in services — that is, SALTER commodities 29–34. A simple procedure is used to generate trade in services among regions in the SALTER model, based on the commodity trade database discussed above and the regional databases.

The regional databases include entries for exports and imports of services, but these are not differentiated by destination or origin. From the trade database, we obtain ratios of exports, by destination, to total exports of a region and ratios of imports, by source, to total imports of region. These ratios are applied to the aggregate exports and imports of services available from the regional databases to obtain two arrays of trade in services, one for exports and one for imports, both measured in fob terms. A single array is produced by choosing the maximum value in both arrays obtained above or a small number if both are zero, to avoid computational difficulties. The single array of trade flows thus obtained is then modified using the RAS method with the two original arrays (exports and imports) from the regional database as targets and the rest of the world accumulating the changes to obtain the targets.

3 PARAMETER SETTINGS

In addition to input–output and national accounts data, the SALTER model requires the specification of a number of behavioural parameters. These parameters describe cost minimising opportunities available to producers, utility maximising opportunities available to consumers in each modelled region and import demand behaviour by the rest of the world. The parameters necessary for the numerical specification of the SALTER model are listed and described in table 3.1. A total number of $I^2 + 10I + 1$ (where I is the number of commodities in the model) or 1496 parameters are required to specify economic behaviour in each modelled country. An additional $2I$ or 68 parameters are required to describe imports by the rest of the world. Other parameters such as the marginal tax rate and the rate of capital depreciation must also be specified. This chapter provides the rationale behind the choice of parameters in the SALTER model.

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 (1–2 years) or a medium term (3–5 years) mode, and behavioural parameters for alternative planning horizons are supplied. Little information is available on the relation between medium 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 specification of the SALTER model are chosen. This review is based in part on a recent survey of parameter specification in a number of general equilibrium models (Adams, Dixon, Meagher, Parmenter and Peter 1990).

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

Table 3.1: **Behavioural parameters in the SALTER model**

Parameter	*Description*	*Range*
σ^z_j	Elasticity of substitution between primary factors in industry j	$j = 1,\ldots,J$ $z = 1,\ldots,S$
η^z_i	Elasticity of substitution in production between domestic commodity i and imported aggregate commodity i	$i = 1,\ldots,I$ $z = 1,\ldots,S$
β^z_i	Elasticity of substitution in private consumption between domestic commodity i and imported aggregate commodity i	$i = 1,\ldots,I$ $z = 1,\ldots,S$
β^z_{Gi}	Elasticity of substitution in government consumption between domestic commodity i and imported aggregate commodity i	$i = 1,\ldots,I$ $z = 1,\ldots,S$
β^z_{Ki}	Elasticity of substitution in investment demand between domestic commodity i and imported aggregate commodity i	$i = 1,\ldots,I$ $z =1,\ldots,S$
η^{Iz}_i	Elasticity of substitution in production between commodities imported from different sources	$i = 1,\ldots,I$ $z = 1,\ldots,S$
β^{Iz}_i	Elasticity of substitution in private consumption between commodities imported from different sources	$i = 1,\ldots,I$ $z = 1,\ldots,S$
β^{Iz}_{Gi}	Elasticity of substitution in government consumption between commodities imported from different sources	$i = 1,\ldots,I$ $z = 1,\ldots,S$
β^{Iz}_{Ki}	Elasticity of substitution in investment demand between commodities imported from different sources	$i = 1,\ldots,I$ $z = 1,\ldots,S$
β^{IS+1}_i	Elasticity of substitution in aggregate demand by the rest of the world between commodities imported from different sources	$i = 1,\ldots,I$
ε_i	Price elasticity of demand by the rest of the world for commodity i	$i = 1,\ldots,I$
μ^z_i	Elasticity of demand for commodity i with respect to aggregate consumption expenditure	$i = 1,\ldots,I$ $z =1,\ldots,S$
λ^z_{ih}	Price elasticity of demand for commodity i with respect to the price of commodity h	$i = 1,\ldots,I$ $h = 1,\ldots,J$ $z = 1,\ldots,S$
χ^z_1	Elasticity of labour supply to after-tax wages	$z = 1,\ldots,S$

Total parameters: $IJS + JS + 9IS + 2I + S$.

assumed to be used only in the agricultural sectors. This 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 (σ^z_j). An estimate of this parameter is required for each of the j industries in the z modelled countries. This represents 272 parameters.

Econometric evidence

Caddy (1976) reviews 21 cross-section and 13 time series studies of empirical estimates of primary factors of 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

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).

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 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, specifically the ASEAN members included in the SALTER model. However, the lack of reliable estimates makes it difficult to use differentiated sets of elasticities and 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. They are based on Rimmer's (1990) estimates, except for manufacturing. Since the industry specification in SALTER is more disaggregated, the synthetic estimates of Whalley (1985) are used for the manufacturing industries.

In the short run, there are less opportunities to adjust the mix of primary factors in response to relative changes in their prices. To reflect this, short run elasticities of substitution are assumed to be lower than those affecting decisions in the medium term.

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, and the short term (two years) and long term (ten years) values of the parameters change linearly, the doubling in the central values observed by Caddy implies a rate of change of 12 per cent a year. Thus, the medium term (five years) estimates in table 3.3 are obtained by increasing the short term (two years) estimates by 40 per cent.

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

No.	*SALTER commodities*	*Short run*	*Medium run*[a]
	Agriculture and primary non–extractive industries		
1	Paddy rice	0.40	0.56
2	Non-grain crops	0.40	0.56
3	Wheat	0.40	0.56
4	Other grains	0.40	0.56
5	Wool	0.40	0.56
6	Other livestock products	0.40	0.56
7	Forestry	0.40	0.56
8	Fishing	0.40	0.56
	Mining industries		
9	Coal	0.80	1.12
10	Oil and gas	0.80	1.12
11	Other minerals	0.80	1.12
	Food processing industries		
12	Meat products	0.80	1.12
13	Milk products	0.80	1.12
14	Other food products	0.80	1.12
15	Beverages and tobacco	0.80	1.12
	Textile industries		
16	Spinning, weaving, dyeing and made-up textiles	0.90	1.26
17	Wearing apparel	0.90	1.26
18	Leather, fur and their products	0.80	1.26
	Manufacturing industries		
19	Lumber and wood products	0.90	1.26
20	Pulp, paper and printing	0.80	1.26
21	Chemicals, rubber and plastic	0.90	1.26
22	Petroleum and coal products	0.90	1.26
23	Non-metallic mineral products	0.90	1.26
24	Primary iron and steel	0.90	1.26
25	Other metals and products	0.80	1.26
26	Transport industries	0.90	1.26
27	Other machinery and equipment	0.90	1.26
28	Other manufacturing	0.90	1.26
	Services		
29	Electricity, gas and water	0.90	1.26
30	Construction	1.00	1.40
31	Trade and transport	1.20	1.68
32	Other services (private)	0.90	1.26
33	Other services (government)	0.90	1.26
34	Other services (ownership of dwellings)	0.90	1.26

[a] Calculated as 40 per cent larger than the short term values.

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 origins are likewise only partial substitutes. This applies to all categories of aggregate demand — that is, intermediate industry demands, consumer demands as well as government and investment demand in the explicitly modelled regions. In addition, demands for imports by the rest of the world are specified for each commodity.

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

- elasticities of substitution between domestic and imported commodities ($4IS$ or 1088 parameters);
- elasticities of substitution between imports from different sources ($4IS + I$ or 1122 parameters); and
- import demand elasticities by the rest of the world (I or 34 parameters).

The numerical specification of these three sets of 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 modellers 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 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 of manufactures; this is, however, not 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 of the short term value 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

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).

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.

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 his 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.

The foregoing example illustrates the fact that evidence other than strict econometric estimates 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 in 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 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 high 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).

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

This box provides a simplified explanation of the relation between import substitution elasticities and export demand elasticities facing small countries in the SALTER model.

Consider a small country exporting a good with a single use to a single destination. Let p_1^I denote (the percentage change in) the price of imports from the small country, and p_2^I the price of imports from other sources. Then we may define an import price index,

$$p^I = S_1^I p_1^I + S_2^I p_2^I,$$

where S_s^I denotes the share of source s in the value of imports, $s = 1, 2$. Let p^D denote the price of domestically produced goods of the same description. Then we may define a price index for all goods of this description,

$$p = S^D p^D + S^I p^I,$$

where S^D denotes the share of domestic products and S^I the share of imports in total purchases of these goods.

Imports from all sources are assumed to be combined in a constant elasticity of substitution aggregation function to form a composite imported variety. Then demand for imports from the small country is:

$$x_1^I = x^I - \sigma^I (p_1^I - p^I),$$

where x^I denotes demand for the composite imported variety, and σ^I the elasticity of substitution between imports from different sources. Similarly, the domestically produced and the composite imported variety are assumed to be combined in another constant elasticity of substitution function to form a composite good. Then demand for the composite variety is

$$x^I = x - \sigma(p^I - p)$$

where x denotes demand for the composite good, and σ the elasticity of substitution between the domestically produced and the composite imported variety.

Finally, demand for the composite good depends on its price,

$$x = -\eta p,$$

where η denotes the absolute magnitude of the demand elasticities (assumed negative).

Combining these relations, we obtain the demand for imports from the small country

$$x_1^I = -\sigma^I (p_1^I - p^I) - \sigma(p^I - p) - \eta p$$
$$= -(S_2^I \sigma^I + S_1^I S^D \sigma + S_1^I S^I \eta) p_1^I + S_2^I (\sigma^I - S_1^I S^D \sigma - S^I \eta) p_2^I + S^D (\sigma - \eta) p^D$$

Then the own-price elasticity of demand for imports from the small country,

$$\eta_1^I = -(S_2^I \sigma^I + S_1^I S^D \sigma + S_1^I S^I \eta)$$

This expresses the elasticity as the sum of the three effects: one representing substitution between imports from different services, the second, substitution between imports and domestic products, and the third, variation in use of the composite good.

(*Continued on next page*)

Box 3.1 *(continued)*

The statement that the first exporting country is small may be interpreted as meaning that its share of the import market, S_1^I, is approximately equal to zero. Then the expression for the own-price demand elasticity reduces to

$$\eta_1^I = -\sigma^I.$$

So under the model's assumptions, variation in the price of imports from a small country affects demand for those imports only through substitution for imports from other sources; and the import demand elasticity is equal in magnitude to the elasticity of substitution between imports from different sources.

From the assumption that the small country exports the good to just one destination, where the good has just one use, we may identify the export demand elasticity with the import demand elasticity, and conclude that the export demand elasticity is equal in magnitude to the import–import substitution elasticity.

There are several reasons why this conclusion may not hold exactly in the actual model. First, even for small exporters, market shares are not exactly zero. Second, exports are generally sold into several markets. Then even if the substitution elasticity is the same in all individual markets, the aggregate substitution elasticity is in general smaller. 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 derive our preferred values, we use a loss function minimisation approach to set the medium 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 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 medium run elasticities in table 3.5 are determined according to this method.

The short run elasticities are derived from the medium run elasticities applying the ratios of the preferred values to the econometric estimates chosen for the medium run to the short run

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*	*Medium run elasticity*
1	Paddy rice	Food	2.2	2.2
2	Non-grain crops	Food	2.2	2.2
3	Wheat	Food	2.2	2.2
4	Other grains	Food	2.2	2.2
5	Wool	Textiles	1.8	2.2
6	Other livestock products	Manufactures	2.2	2.8
7	Forestry	Manufactures	2.2	2.8
8	Fishing	Manufactures	2.2	2.8
9	Coal	Manufactures	2.2	2.8
10	Oil and gas	Manufactures	2.2	2.8
11	Other minerals	Manufactures	2.2	2.8
12	Meat products	Food	2.2	2.2
13	Milk products	Food	2.2	2.2
14	Other food products	Food	2.2	2.2
15	Beverages and tobacco	Beverages	3.1	3.1
16	Spinning, weaving, dyeing, made-up goods	Textiles	1.8	2.2
17	Wearing apparel	Apparel	3.1	4.4
18	Leather, fur and their products	Apparel	3.1	4.4
19	Lumber and wood products	Manufactures	2.2	2.8
20	Pulp, paper and printing	Pulp and paper	1.4	1.8
21	Chemicals, rubber and plastic	Chemicals	1.9	1.9
22	Petroleum and coal products	Chemicals	1.9	1.9
23	Non-metallic mineral products	Manufactures	2.2	2.8
24	Primary iron and steel	Manufactures	2.2	2.8
25	Other metals and products	Manufactures	2.2	2.8
26	Transport industries	Vehicles	3.0	5.2
27	Other machinery and equipment	Manufactures	2.2	2.8
28	Other manufacturing	Manufactures	2.2	2.8
29	Electricity, gas and water	Manufactures	2.2	2.8
30	Construction	Construction	1.9	1.9
31	Trade and transport	Construction	1.9	1.9
32	Other services (private)	Construction	1.9	1.9
33	Other services (government)	Construction	1.9	1.9
34	Other services (ownership of dwellings)	Construction	1.9	1.9

estimates found in table 3.3, assuming that the long run estimates apply to the definition of the medium run in the SALTER model (five years).

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 structure, 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 can be specified for each of four end users and commodity imports (I) in each country. This represents a total of $4IS$ or 1088 parameters.

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).

The Industry Commission (1991, appendix D) 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 18 of the 34 commodity classifications in the SALTER model. These estimates are given in table 3.6 where they are compared with the estimates obtained for Portuguese imports by Corado and de Melo (1983).

In general, estimates from the Industry Commission study are smaller than the Portuguese estimates. The simple average of the New Zealand estimates (1.3) represents 70 per cent of

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

	New Zealand[b]	*Portugal*[c]
Non-grain crops	0.99	1.67
Other minerals	1.81	–0.66
Meat products	1.31	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 the Industry Commission study; the commodity categories were closely matched with those used by Corado and de Melo. [b] *Source*: Industry Commission (1991). [c] *Source*: Corado and de Melo (1983).

the average of the estimates for Portugal (1.8) 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 at 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 values for this parameter range from 2.8 to 10.4.

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*	*Medium run elasticity*
1	Paddy rice	Food	4.4	4.4
2	Non-grain crops	Food	4.4	4.4
3	Wheat	Food	4.4	4.4
4	Other grains	Food	4.4	4.4
5	Wool	Textiles	3.6	4.4
6	Other livestock products	Manufactures	4.4	5.6
7	Forestry	Manufactures	4.4	5.6
8	Fishing	Manufactures	4.4	5.6
9	Coal	Manufactures	4.4	5.6
10	Oil and gas	Manufactures	4.4	5.6
11	Other minerals	Manufactures	4.4	5.6
12	Meat products	Food	4.4	4.4
13	Milk products	Food	4.4	4.4
14	Other food products	Food	4.4	4.4
15	Beverages and tobacco	Beverages	6.2	6.2
16	Spinning, weaving, dyeing, made-up goods	Textiles	3.6	4.4
17	Wearing apparel	Apparel	6.2	8.8
18	Leather, fur and their products	Apparel	6.2	8.8
19	Lumber and wood products	Manufactures	4.4	5.6
20	Pulp, paper and printing	Pulp and paper	2.8	3.6
21	Chemicals, rubber and plastic	Chemicals	3.8	3.8
22	Petroleum and coal products	Chemicals	3.8	3.8
23	Non-metallic mineral products	Manufactures	4.4	5.6
24	Primary iron and steel	Manufactures	4.4	5.6
25	Other metals and products	Manufactures	4.4	5.6
26	Transport industries	Vehicles	6.0	10.4
27	Other machinery and equipment	Manufactures	4.4	5.6
28	Other manufacturing	Manufactures	4.4	5.6
29	Electricity, gas and water	Manufactures	4.4	5.6
30	Construction	Construction	3.8	3.8
31	Trade and transport	Construction	3.8	3.8
32	Other services (private)	Construction	3.8	3.8
33	Other services (government)	Construction	3.8	3.8
34	Other services (ownership of dwellings)	Construction	3.8	3.8

Import elasticities by the rest of the world

A rest of the world aggregate is often used in general equilibrium single-country and multicountry models to account for the trade flows that do not occur between explicitly modelled regions. In the SALTER model, the net import demands from the rest of the world are a function of world prices relative to costs at the rest of the world border. The rest of the world is therefore assumed to choose between importing or using internally supplied commodities. An import price elasticity is specified for each commodity.

Given the heterogeneity of the regions included in the rest of the world, it is difficult to specify its behaviour. The WALRAS and ORANI models specify large export demand elasticities of the order of –10 to –20. This is reasonable when a single country is modelled and facing demand for its exports by the rest of the world. However, the SALTER model explicitly accounts for a large part of world production, and countries in the rest of the world will presumably not be able to switch demand for products very easily. In this respect, Whalley's (1985) models are similar to the SALTER model. These models used the average price elasticities in the modelled regions as the import price elasticities for the rest of the world.

In the SALTER model, we use the Mansur and Whalley (1984) argument that if the share of imports in the rest of the world's use of a commodity is small, expansion effects are small and the price elasticity is approximately equal to the corresponding substitution elasticity. It is expected that production in the rest of the world provides for the bulk of most commodity uses. Hence, the share of imports in aggregation demand in the rest of the world is small, and the Mansur and Whalley (1984) argument is applied: the *elasticity of substitution* estimates in table 3.5 are used to specify the import *price elasticities* for the rest of the world for both the short run and the medium run. The resulting price elasticities of imports by the rest of the world are therefore higher than the price elasticities in other regions in the model since the latter result from the product of the share of imports in aggregate use (which are less than or equal to 1.0) and the substitution elasticities specified in table 3.5.

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:

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

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;

$\tilde{\omega}$ is the 'Frisch parameter', the reciprocal of the marginal utility of income, or the money flexibility; and

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

Hence the I^2 or 1156 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:

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

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 of income elasticities for specifying 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

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).

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, beverages, clothing, housing) whereas expenditures 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. This set of estimates is preferred because they present an internal consistency across countries and are based on relatively recent (1980) consumption information.

The 34 SALTER commodities are allocated among the ten commodity groups in table 3.10 for which expenditure elasticities are available. The correspondence between the 10-commodity and 34-commodity classifications is shown in table 3.11. Through the Tulpulé and Powell (1978) argument presented earlier, the expenditure elasticities in the 34-commodity classification correspond directly to those in the 10-commodity classification. The values for the ASEAN countries are the simple average of the values for the Philippines and

Table 3.10: **Expenditure elasticities used in the SALTER model**

	United States[a]	*Korea*	*Japan*	*European Community*[b]	*ASEAN*[c]
Food	0.14	0.64	0.39	0.35	0.69
Beverages	1.02	1.02	1.02	1.02	1.02
Clothing	0.96	0.96	0.96	0.96	0.96
Gross rent, fuel	1.12	1.15	1.13	1.13	1.16
Durables	1.16	1.22	1.18	1.18	1.25
Medical care	1.24	1.39	1.27	1.27	1.50
Transport	1.24	1.38	1.27	1.27	1.48
Recreation	1.26	1.45	1.30	1.30	1.60
Education	1.08	1.09	1.08	1.08	1.09
Miscellaneous	1.25	1.40	1.28	1.28	1.52

[a] Elasticities for Australia, New Zealand and Canada are assumed to be the same as those in the United States. [b] Elasticities for the European Community are calculated as the simple linear average of Portugal, Greece, Ireland, Spain, Italy, the United Kingdom, the Netherlands, France, Denmark, Belgium, Luxembourg and Germany. [c] Elasticities for ASEAN are the simple linear average of elasticities for Indonesia and the Philippines.
Source: Adapted from Theil et al. (1989).

Indonesia on the grounds that the most populated countries of the ASEAN group are developing economies in which food constitutes a large share of consumers' budgets and food consumption is in large part rice based. Values for the European Community are the simple average of expenditure elasticities for European Community members included in the Theil et al. (1989) study. Expenditure elasticities for the United States are applied to Canada, New Zealand and Australia. Thus, for each modelled region, there is a set of 34 expenditure elasticities. These elasticities are further normalised using the benchmark data set. Values used in the SALTER model are found in appendix 3A.

Table 3.11: **Correspondence between the SALTER 34-commodity classification and a 10-commodity classification for allocating consumption expenditure elasticities**

No.	*34-commodity classification*	*10-commodity classification*
1	Paddy rice	Food
2	Non-grain crops	Food
3	Wheat	Food
4	Other grains	Food
5	Wool	Miscellaneous
6	Other livestock products	Miscellaneous
7	Forestry	Miscellaneous
8	Fishing	Miscellaneous
9	Coal	Miscellaneous
10	Oil and gas	Miscellaneous
11	Other minerals	Miscellaneous
12	Meat products	Food
13	Milk products	Food
14	Other food products	Food
15	Beverages and tobacco	Beverages
16	Spinning, weaving, dyeing, made-up goods	Miscellaneous
17	Wearing apparel	Clothing
18	Leather, fur and their products	Clothing
19	Lumber and wood products	Miscellaneous
20	Pulp, paper and printing	Miscellaneous
21	Chemicals, rubber and plastic	Miscellaneous
22	Petroleum and coal products	Miscellaneous
23	Non-metallic mineral products	Miscellaneous
24	Primary iron and steel	Miscellaneous
25	Other metals and products	Miscellaneous
26	Transport industries	Durables
27	Other machinery and equipment	Durables
28	Other manufacturing	Durables
29	Electricity, gas and water	Miscellaneous
30	Construction	Miscellaneous
31	Trade and transport	Transport
32	Other services (private)	Recreation
33	Other services (government)	Miscellaneous
34	Other services (ownership of dwellings)	Miscellaneous

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 by specifying only $I + 1$ or 35 parameter values 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 $\tilde{\omega}$ would be characteristic of lower income consumers and $\tilde{\omega}$ would decrease as a function of consumers' incomes. In testing this conjecture, Selvanathan (1988) concludes that:

- the income flexibility $\tilde{\omega}$ is not related to real income, and
- estimates of the income flexibility for 18 countries are centred around −0.5, which results in an estimate for $\tilde{\omega} = -2$, 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 income flexibility. Peter (1990) suggests a set of values for $\tilde{\omega}$ based on a relationship between this parameter and gross national product per person derived by Lluch et al. (1977). These values are given in table 3.12 and used to

Table 3.12: **Values assumed for income flexibility in the SALTER model**

	Income flexibility
Australia	−1.46[a]
New Zealand	−2.51[a]
Canada	−1.95[a]
United States	−1.85[a]
Japan	−2.47[a]
Korea	−3.24[b]
European Community	−2.07[a]
ASEAN	−5.25[c]

[a] *Source*: Peter (1990). [b] Calculated according to Lluch et al. (1977) and United Nations (1990). [c] Linear average of values for Singapore, Malaysia, the Philippines and Indonesia from Peter (1990).

generate the set of consumer price elasticities for each country. Thus 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 3A.

The elasticity of labour supply

Changes in the labour supply may be specified as a linear function of changes in the real after-tax wage rate in the SALTER model. This requires the specification of an elasticity of labour supply to the real after-tax wage (χ_1^z) for each region modelled (eight parameters). The SALTER model includes Western developed economies as well as developed economies such as Japan where a different work ethic has been observed, the Republic of Korea which is a middle income country (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 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). Also, 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 also 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 0. 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 the ASEAN region labour supply is expected not to be affected by the negative income effect observed in more developed countries. In 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 semisubsistence 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 shown in table 3.13.

Table 3.13: **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 in relation to 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).

Labour supply elasticities in the SALTER model

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 $\chi_1^z = -0.06$ for the elasticity of aggregate labour supply.

Luskin (1990) suggests that only pure wage effects should be reflected in the SALTER model parametrisation. 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 labour supply 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.

APPENDIX 3A: CONSUMER DEMAND ELASTICITIES

Consumer demand elasticities used in the SALTER model are listed in tables 3A.1 and 3A.2. Their origin is outlined in chapter 3. Price elasticities are calculated using the Frisch

Table 3A.1: **Expenditure elasticities used in the SALTER model**

Commodity number	*Australia*	*New Zealand*	*Canada*	*United States*	*Japan*	*Korea*	*European Community*	*ASEAN*
1	0.14	0.14	0.14	0.14	0.39	0.64	0.35	0.69
2	0.14	0.14	0.14	0.14	0.39	0.64	0.35	0.69
3	0.14	0.14	0.14	0.14	0.39	0.64	0.35	0.69
4	0.14	0.14	0.14	0.14	0.39	0.64	0.35	0.69
5	1.25	1.25	1.25	1.25	1.28	1.40	1.28	1.52
6	1.25	1.25	1.25	1.25	1.28	1.40	1.28	1.52
7	1.25	1.25	1.25	1.25	1.28	1.40	1.28	1.52
8	1.25	1.25	1.25	1.25	1.28	1.40	1.28	1.52
9	1.25	1.25	1.25	1.25	1.28	1.40	1.28	1.52
10	1.25	1.25	1.25	1.25	1.28	1.40	1.28	1.52
11	1.25	1.25	1.25	1.25	1.28	1.40	1.28	1.52
12	0.14	0.14	0.14	0.14	0.39	0.64	0.35	0.69
13	0.14	0.14	0.14	0.14	0.39	0.64	0.35	0.69
14	0.14	0.14	0.14	0.14	0.39	0.64	0.35	0.69
15	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02
16	0.14	0.14	0.14	0.14	0.39	0.64	0.35	0.69
17	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96
18	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96
19	1.25	1.25	1.25	1.25	1.28	1.40	1.28	1.52
20	1.25	1.25	1.25	1.25	1.28	1.40	1.28	1.52
21	1.25	1.25	1.25	1.25	1.28	1.40	1.28	1.52
22	1.25	1.25	1.25	1.25	1.28	1.40	1.28	1.52
23	1.25	1.25	1.25	1.25	1.28	1.40	1.28	1.52
24	1.25	1.25	1.25	1.25	1.28	1.40	1.28	1.52
25	1.25	1.25	1.25	1.25	1.28	1.40	1.28	1.52
26	1.16	1.16	1.16	1.16	1.18	1.22	1.18	1.25
27	1.16	1.16	1.16	1.16	1.18	1.22	1.18	1.25
28	1.16	1.16	1.16	1.16	1.18	1.22	1.18	1.25
29	1.25	1.25	1.25	1.25	1.28	1.40	1.28	1.52
30	1.25	1.25	1.25	1.25	1.28	1.40	1.28	1.52
31	1.24	1.24	1.24	1.24	1.27	1.38	1.27	1.48
32	1.26	1.26	1.26	1.26	1.3	1.45	1.30	1.60
33	1.25	1.25	1.25	1.25	1.28	1.40	1.28	1.52
34	1.25	1.25	1.25	1.25	1.28	1.40	1.28	1.52

parameter and the assumptions underlying the linear expenditure system. The cross-price elasticities (not reported here) generated by this system are all negative (the linear expenditure system does not allow for complementarity between commodities). In general, they are very small and the larger values do not exceed 30 per cent of the own-price elasticities.

Table 3A.2: **Own-price elasticities used in the SALTER model**

Commodity number	*Australia*	*New Zealand*	*Canada*	*United States*	*Japan*	*Korea*	*European Community*	*ASEAN*
1	–0.0885	–0.0522	–0.0635	–0.0657	–0.1380	–0.1673	–0.1486	–0.1064
2	–0.0893	–0.0540	–0.0641	–0.0663	–0.1419	–0.1993	–0.1504	–0.1434
3	–0.0885	–0.0525	–0.0638	–0.0657	–0.1380	–0.1673	–0.1489	–0.1063
4	–0.0886	–0.0527	–0.0636	–0.0657	–0.1380	–0.1675	–0.1488	–0.1142
5	–0.7906	–0.4680	–0.5665	–0.5865	–0.4528	–0.3661	–0.5436	–0.2342
6	–0.7914	–0.4733	–0.5683	–0.5872	–0.4537	–0.3707	–0.5486	–0.2449
7	–0.7906	–0.4667	–0.5674	–0.5866	–0.4528	–0.3677	–0.5438	–0.2391
8	–0.7911	–0.4684	–0.5666	–0.5866	–0.4556	–0.3796	–0.5443	–0.2650
9	–0.7906	–0.4703	–0.5666	–0.5866	–0.4528	–0.3661	–0.5444	–0.2362
10	–0.7907	–0.4664	–0.5683	–0.5865	–0.4528	–0.3661	–0.5446	–0.2342
11	–0.7906	–0.4663	–0.5671	–0.5866	–0.4528	–0.3661	–0.5436	–0.2348
12	–0.0930	–0.0551	–0.0660	–0.0674	–0.1415	–0.1806	–0.1582	–0.1186
13	–0.0905	–0.0549	–0.0655	–0.0667	–0.1398	–0.1740	–0.1526	–0.1105
14	–0.0946	–0.0588	–0.0678	–0.0700	–0.1645	–0.2156	–0.1606	–0.1604
15	–0.6616	–0.4025	–0.4720	–0.4851	–0.3758	–0.3010	–0.4512	–0.1878
16	–0.0897	–0.0543	–0.0640	–0.0662	–0.1399	–0.1717	–0.1556	–0.1174
17	–0.6158	–0.3801	–0.4441	–0.4600	–0.3562	–0.2700	–0.4144	–0.1690
18	–0.6099	–0.3662	–0.4381	–0.4529	–0.3431	–0.2523	–0.4129	–0.1529
19	–0.7935	–0.4750	–0.5715	–0.5895	–0.4548	–0.3686	–0.5513	–0.2393
20	–0.7932	–0.4783	–0.5737	–0.5921	–0.4569	–0.3730	–0.5502	–0.2451
21	–0.7952	–0.4883	–0.5746	–0.5942	–0.4614	–0.3984	–0.5551	–0.2635
22	–0.7917	–0.4737	–0.5733	–0.5969	–0.4590	–0.3839	–0.5495	–0.2405
23	–0.7911	–0.4682	–0.5678	–0.5870	–0.4539	–0.3675	–0.5454	–0.2383
24	–0.7906	–0.4664	–0.5667	–0.5865	–0.4528	–0.3661	–0.5443	–0.2343
25	–0.7918	–0.4713	–0.5697	–0.5877	–0.4554	–0.3684	–0.5468	–0.2446
26	–0.7461	–0.4569	–0.5405	–0.5596	–0.4266	–0.3260	–0.5152	–0.2187
27	–0.7458	–0.4543	–0.5392	–0.5546	–0.4310	–0.3424	–0.5123	–0.2402
28	–0.7388	–0.4377	–0.5295	–0.5489	–0.4236	–0.3254	–0.5057	–0.2073
29	–0.7954	–0.4801	–0.5827	–0.6032	–0.4715	–0.3806	–0.5532	–0.2440
30	–0.7906	–0.4670	–0.5672	–0.5865	–0.4528	–0.3661	–0.5481	–0.2368
31	–0.8419	–0.5930	–0.6704	–0.6831	–0.5843	–0.5011	–0.6399	–0.4254
32	–0.8246	–0.5714	–0.6901	–0.6820	–0.5891	–0.4572	–0.7043	–0.3477
33	–0.8138	–0.5042	–0.5954	–0.6490	–0.5147	–0.4648	–0.5581	–0.2816
34	–0.8308	–0.5431	–0.6386	–0.6537	–0.5451	–0.4235	–0.6007	–0.2835

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