INDUSTRY
COMMISSION

FIT: An Input-Output Data Update Facility for SALTER

by

Marianne James

and

Robert McDougall

SALTER Working Paper No. 17

JUNE 1993

INDUSTRY
COMMISSION

FIT: An Input-Output Data Update Facility for SALTER

by

Marianne James

and

Robert McDougall

SALTER Working Paper No. 17

JUNE 1993

SALTER working papers document work in progress on the development of the SALTER model of the world economy. They are made available to allow scrutiny of the work undertaken but should not be quoted without the permission of the author(s). Comments on the papers would be most welcome.

CONTENTS

FIT: AN INPUT-OUTPUT DATA UPDATE FACILITY FOR SALTER

This paper describes FIT, a computer facility for updating input-output tables. FIT is designed to assist in the later stage processing of the single-region input-output tables incorporated into the SALTER database.

1 Introduction

SALTER is a multi-region multi-sector model of the world economy first documented in Jomini *et al.* (1991). It is designed for policy analysis, in particular for analysing trade and industry policies in an international context.

The SALTER database includes a multi-region input-output table and various other data. It is assembled from several component data sets, including an input-output table for each SALTER region and an international trade database.

FIT is used in the second of three stages of SALTER database preparation. In the first stage (*early stage processing*) we collect statistics from various sources, arrange them in standard file structures, and convert them to standard sectoral classifications (Hambley 1993, Brown, Strzelecki and Watts forthcoming). In the second stage (*later stage processing*) we adjust the data to eliminate inconsistencies between sources (Hanslow 1993, Brown *et al.* forthcoming). In the third stage we assemble the component data sets to make the SALTER database (Brown *et al.* forthcoming).

FIT is designed to assist in the later stage processing of the single-region input-output tables. Its purpose is to adjust the tables to other data used in the SALTER database. These include international trade data (Hambley 1993, Hanslow 1993), assistance data (Gotch 1993), and macroeconomic data (Brown *et al.* forthcoming).

FIT is an input-output model extended to meet the requirements of the later stage processing. More precisely, FIT provides the model's theoretical structure; any one of the single region input-output tables can provide the database. The adjustments to be made to the table define the scenario for an *update simulation.*

The FIT update simulations form the main component of the later stage processing of the single-region input-output tables. There are two ancillary components: preparing the shocks files (Brown *et al.* forthcoming), and pre-processing the tables before running the simulations. The pre-processing is designed to eliminate from the tables zero values which could create difficulties in the simulations (Calder, McDougall and Strzelecki forthcoming).

Like the other SALTER facilities, FIT is designed to operate in the GEMPACK economic modelling environment (Codsi and Pearson 1988). It is implemented as a FORTRAN program using the GEMPACK code-writing utility, TABLO (Pearson and Codsi 1987, 1988a, 1991a, b). The program performs the database updates during the simulation runs as part of the GEMPACK multi-step solution procedure (Pearson and Codsi 1991a).

The remainder of the paper is organised as follows. Section 2 outlines the structure of the single-region input-output tables. Section 3 lists the objectives of the later stage processing of the input-output tables, and Section 4 explains our approach to those objectives. Section 5 describes the FIT model's theoretical structure, and Section 6 its implementation and operation.

2 The single-region input-output tables

This section describes the form of the SALTER single-region input-output tables. It covers the framework of the tables, restrictions on the signs of entries in the tables, and the sectoral balance identity. The sign restrictions influence certain details of the FIT theoretical structure (Section 5). Preserving the sectoral balance identity is a requirement for the update procedure (Section 4).

The tables represent each economy as a system of flows of commodities and primary factor services. There are three primary factors, labour, capital, and land. The number of commodities depends on the sectoral classification; we denote it by g (in the current SALTER sectoral classification, $g = 37$). Each commodity has two varieties distinguished by source, domestic products and imports.

The g domestic commodities are produced by g corresponding industries. Industries employ primary factors, and use domestic and imported commodities as intermediate inputs. Besides being used as intermediate inputs, commodities are used in five final demand categories: fixed investment, household consumption, government consumption, exports, and changes in stocks (inventory investment).

The tables thus contain (g + 5) use categories: production in each of the g industries, and five final demand categories. Domestic commodities are used in all categories. Imported commodities are used in all categories except exports: the tables do not provide directly for re-exports. Primary factors are used only as inputs into production.

The tables provide a detailed treatment of indirect taxes. These include production taxes, import duties, and commodity taxes. Production taxes are industry-specific, import duties are commodity-specific, and commodity taxes are specific to each combination of commodity, source, and use category.

For each commodity flow the tables provide two pieces of information, the value excluding commodity tax, or *basic value*, and the commodity tax. The sum of the basic value and the commodity tax is the *value at purchasers' prices*.

With one exception, basic values of commodity flows and values of flows of factor services may be positive or zero but not negative. The exception applies to changes in stocks, which may be positive, zero, or negative. Taxes likewise may be positive, zero, or negative. Taxes opposite in sign to corresponding pre-tax values are interpreted as subsidies. Subsidies may not be so large that values at purchasers' prices differ in sign from basic values. This restriction ensures that post-subsidy prices are positive.

Each industry's *total costs* include intermediate input costs, payments to primary factors, and production tax. Each commodity's *total sales* include usage at basic values in all use categories. The *sectoral balance identity* requires equality for each industry between its total costs and total sales of its output.

The tables are stored as computer files in the GEMPACK header array format (Mikkelsen and Pearson 1986). The array structure is listed in Table C1 in Appendix C.

3 The objectives of the later stage processing

The later stage processing of the single-region input-output tables has four objectives:

— adjusting the tables to agree with external data for international trade,

— adjusting the tables to agree with external data for industry assistance,

— adjusting the tables to agree with external macroeconomic data, and
— setting changes in stocks to zero.

Adjusting the input-output tables to data for international trade

The data files created in the first stage of database preparation include both the single-region input-output tables and an international trade database (Hambley 1993). Typically the trade data are for a more recent year than the input-output data. Even if the data are for the same year they are liable to be mutually inconsistent.

In the update simulations we adjust trade values in the input-output tables to agree with the international trade data. Specifically, we adjust the border values of exports and imports of each commodity in the input-output tables to agree with the trade data.

Besides being inconsistent with the input-output statistics, the international trade statistics contain internal inconsistencies. We revise the trade database to eliminate the internal inconsistencies (Hanslow 1993) before updating the input-output tables. We take the trade targets for the input-output tables from the revised, internally consistent trade data.

Adjusting the input-output tables to data for industry assistance

As described above (Section 2) the SALTER single-region input-output tables provide a detailed treatment of indirect taxes. They show for instance commodity tax on each intermediate input into each industry. Unfortunately the input-output source statistics are often less detailed. They may show for instance total commodity tax on inputs into each industry but not the taxes on individual inputs.

The source statistics also exclude some non-tax instruments we wish to treat as taxes in SALTER. They show for instance import tariffs but not the tariff equivalents of quantitative import restrictions.

Because of these limitations of the input-output data, we collect assistance estimates from other sources in an assistance database. The database covers assistance provided through both tax and non-tax instruments. The import protection estimates for instance cover not only import tariffs but also quantitative import restrictions (Gotch 1993).

In the update simulations we adjust indirect tax rates in the input-output tables to agree with the assistance database.

Adjusting the input-output tables to macroeconomic data

The source statistics for the single-region input-output tables are for various reference years. In the later stage processing we update the tables to the reference year for the SALTER database. For the current database this year is 1988.

For international trade we have sectoral data for the SALTER reference year from the international trade database. For domestic absorption we collect macroeconomic data from national accounts statistics. The data include aggregate expenditures in each region in three final demand categories, fixed investment, household consumption, and government consumption.

In the update simulations we adjust aggregate final demand expenditures in the input-output tables to agree with the macroeconomic data.

Eliminating changes in stocks

The single-region input-output tables, following their source statistics, include changes in stocks (inventory investment) as a use category. In the final assembly of the SALTER database we delete this category. The reason is that inventory investment reflects disequilibrium in the reference year, whereas SALTER assumes a database in equilibrium.

In the update simulations we set inventory investment usage of each commodity at zero. This prepares for the category's omission from the final database.

4 The approach to the task

This section describes the approach taken in FIT to the tasks described above. First we explain how most of the objectives can be achieved by input-output methods. Secondly we describe the special method used to update import use. Finally we explain the use of import price information in the import updates.

The the input-output approach

Most of the objectives of the later stage processing of the single-region input-output tables (Section 3) can be accomplished by input-output methods. Specifically, within an input-output model we can:

— adjust export values to the international trade data,

— adjust indirect tax rates to the assistance data,

— adjust aggregate final demand expenditures to the macroeconomic data, and

— set changes in stocks to zero.

This covers all the objectives except the adjustment of import values to the international trade data. As discussed below this objective requires a different method.

The input-output apparatus in FIT includes three components: an input-output quantity model, an input-output price model, and value equations. The value equations define value variables targeted in the update simulations. These include border values of exports and imports for each commodity, and aggregate expenditures for selected final demand categories.

The three components of the input-output apparatus interact to perform the update adjustments. Given changes in indirect tax rates, the price module determines their effects on prices. Given the price results and the value targets, the value equations determine real final demands. Given final demands, the quantity module determines commodity and factor flows.

We include the value equations in a *miscellaneous equations module*. This module also contains equations supporting the use of import price information in the import updates and is described shortly.

The import revision task: an information theory approach

One of the objectives in the update simulations is to adjust trade values in the input-output tables to the international trade data. The export adjustments are performed readily by input-output methods. The import adjustments however raise difficulties.

- To meet the import targets in the input-output model we need to revise the input-output coefficients.

- The import scenario does not contain enough information to determine the revised coefficients.
- The revision procedure must preserve the sectoral balance identity (Section 2), and must be compatible with the TABLO solution procedure.
- The procedure must handle extreme divergences between the input-output data and the international trade data.

In this section we describe our general approach to the import updates. Mathematical details are provided in Appendix A.

Setting import volumes in the quantity module

Import volume variables are normally endogenous in input-output models. The models determine import use and factor employment given exogenous final demands and fixed input-output coefficients. This would be the natural treatment to apply in the FIT quantity module.

In the update simulations however, import volumes are determined outside the quantity module. Import volumes must be consistent with exogenous import value targets and import prices. The volumes so determined must be imposed on the quantity module.

To enable the quantity module to meet these import volume targets we need to endogenize the input-output coefficients. This leads to the difficulty discussed below.

Underdetermination of the input-output coefficients

The difficulty in endogenizing the input-output coefficients arises from the detailed treatment of imports in the input-output tables. The tables include separate import data for each combination of commodity and use category. Each imported commodity has many different uses, each governed by its own input-output coefficients.

To achieve a set import target for each commodity we must endogenize these coefficients. But now for each commodity we have many coefficients to determine, and just one target to determine them. This leaves the coefficients underdetermined.

Since we cannot determine the revised input-output coefficients within the input-output model, we need to find some other method of revision. A natural starting point is the RAS.

RAS

RAS is one of the most commonly used methods for revising input-output data. It is an iterative algorithm for revising a two-dimensional array to meet constraints on row and column totals (UN 1973, ABS 1990 Appendix A).

To apply RAS to the import revision task we might define for each commodity a two-dimensional array showing expenditure by source and use category. We would take initial values for array elements from the input-output table, and a target value for total import use from the trade database. Applying RAS we would revise the array to meet the import target while fixing total expenditure in each use category.

This procedure would be unsuitable, for two reasons. First it would violate the sectoral balance identity (Section 2). Sales of domestic products would change to offset changes in imports, but industry costs would remain fixed. Secondly RAS, being an iterative algorithm, could not readily be implemented in GEMPACK.

Although RAS itself is not suitable for the import revision task, the principles underlying it may still be applicable. We therefore proceed to examine those principles.

Information-theoretic foundations for RAS

While RAS was originally devised as an *ad hoc* method (Stone 1962, University of Cambridge Department of Applied Economics 1962), a theoretical rationale was provided retrospectively by Bacharach (1970).

Bacharach showed that the array generated by RAS could be characterised as the solution to a certain optimisation problem. He showed further that the problem arose naturally in information theory.

Information theory is 'a general partitioning theory ... that ... presents measures for the way in which some set is divided into subsets' (Theil 1967 p. 19). It applies naturally to input-output structures expressed as arrays of shares (Uribe, de Leeuw and Theil 1965, Theil 1967).

An important concept in information theory is the *information content* of a revision to a share structure. The information content is a non-negative scalar measure. If the revised structure is identical with the original, the information content is zero, otherwise it is positive. The more the revised structure differs from the original the higher the information content.

We may regard RAS without loss of generality as a method for revising matrices of share coefficients to meet constraints on row and column totals. Besides the matrix generated by RAS, many other matrices exist which meet the same constraints. Each of these has some information content relative to the original matrix. We can interpret the information content as a measure of the extent to which the revised matrix differs from the original.

Of all the matrices that meet the constraints, the one generated by RAS has the lowest information content relative to the original matrix (Bacharach 1970). RAS may therefore be regarded as an algorithm for solving a constrained optimisation problem, in which the objective is to minimise the information content. RAS thus appears as an expression of information-theoretic principles.

We now apply those principles to the import revision task.

Applying information theory to the import revision task

Applying information theory to the import revision task involves four steps: deciding which aspects of the input-output structure should be subject to revision, defining a measure of information content for revisions to those aspects, determining the input-output structure that minimises this measure, and implementing the solution in FIT.

We can divide the input-output structure into two levels. The *upper level* includes the *commodity shares*, that is, shares of individual commodities or primary factors in total expenditure in each use category. The *lower level* includes the *source shares*, shares of domestic products or imports in total expenditure on each commodity in each use category.

In revising the input-output structure to meet the import constraints, it would seem natural to revise the source shares while fixing the commodity shares. Unfortunately, because of the sometimes extreme divergences between the input-output data and the international trade data, this approach would not always succeed. It would fail for commodities for which target usage of imports exceeds initial usage of imports and domestic products together. For these commodities, we cannot meet the import targets by revising only the source shares.

In general therefore we must revise not only the source but also the commodity shares. Nevertheless where revising source shares is sufficient we prefer this to revising the commodity shares. If for instance we need to increase usage of imported wheat, we prefer to do this by substituting imported for domestic wheat in the input-output structure, rather than substituting wheat for non-wheat commodities.

For each level of the input-output structure we can define a measure of information content. We can then define the overall information content of the structure, as a weighted sum of the contents for each level (Appendix A). The weights are arbitrary; but since we are more reluctant to revise the upper level, we attach a greater weight to that level.

By subjecting both levels of the input-output structure to revision, we ensure that we can always meet the import targets. By attaching more weight to the upper level, we ensure that where we have the choice we favour revisions to the lower level.

We can now determine the revised input-output structure as the solution to a constrained optimisation problem. The problem is to minimise the information content of the revision to the input-output structure, subject to constraints on imports of each commodity and adding-up constraints on commodity and source shares. Applying the Lagrangean technique we obtain first-order conditions for a solution (Appendix A).

With the solution conditions obtained, it remains only to implement them in FIT.

Implementing the import revision procedure in FIT

We implement the import revision procedure in FIT in a separate *optimisation module*. The equations in the module represent solution conditions for the optimisation problem. The variables are Lagrange multipliers and input-output coefficients.

With inputs and outputs measured in suitable units, the input-output coefficients are equivalent to commodity and source shares. The Lagrange multiplier associated with the import constraint for each commodity can be taken as an indicator of the direction and severity of the import revision.

The optimisation module interacts with the quantity module to perform the import revision. The optimisation module transmits changes in the Lagrange multipliers into changes in the input-output coefficients. These feed into the quantity module to generate changes in import volumes. The solution values for the Lagrange multipliers are those which generate the required changes in volumes.

This approach integrates the import revision procedure into the input-output model. In doing so it ensures that the revision preserves the sectoral balance identity. This is because the balance condition is already incorporated in the model (Section 5).

The import revision task: the import price scenario

As described above the FIT optimisation module meets the import value targets by adjusting import volumes. This procedure is appropriate often but not always. Whether it is or not depends on why the import values differ between the input-output tables and the international trade data.

The source statistics for the input-output tables and the international trade data are for different reference years. Differences in import values between these sources may reflect changes over time in prices, changes over time in volumes, or statistical inconsistencies. Where they reflect price changes, it may be inappropriate in the update simulations to rely on volume changes.

In the optimisation module, changes in import volumes entail offsetting changes in usage of the corresponding domestic products. The value of domestic output then varies inversely with the import value. This is reasonable where the import value changes arise in reality from volume changes, but not necessarily where they arise from price changes. For example, oil price reductions during the 1980s tended to lower oil import bills without inducing expansions in domestic oil production.

To avoid unreasonable outcomes we include import price changes in the update scenario. To the extent that these match the import value changes, the optimisation module is not called on to generate volume changes.

In practice we collect import price data for only a few commodities especially subject to price fluctuations. For other commodities we assume that import prices move in line with the general price level. This makes it convenient to define the scenario in terms of relative rather than absolute prices. We need then apply shocks only for commodities whose prices move significantly against the general price level.

Accordingly we provide relative import price variables for use in the import price scenario. We define these prices as border prices deflated by the price index for GDP. We include this definition in the miscellaneous equations module.

This completes the description of the approach taken in FIT to meeting the objectives of the later stage processing. The next section describes the theoretical structure that implements this approach.

5 The theoretical structure of FIT

This section describes the theoretical structure of the FIT model.

The model is divided into four modules:

— an input-output quantity model,

— an input-output price model,

— an optimisation module, implementing the import revision procedure, and

— a miscellaneous equations module, defining target variables for the update simulations.

Following the usual GEMPACK approach, the model is expressed mostly in percentage change form. Except where the contrary is indicated each variable in the model represents the percentage change in the underlying economic variable. For a guide to conversion to percentage change form, see Pearson and Codsi (1988b).

Exceptions to the percentage change formulation are made where the underlying economic variable is liable to change sign. Here the percentage change formulation is unsuitable, since it does not allow the underlying variables to change from zero to positive or zero to negative values. In these cases we either find a related non-negative variable or adopt an absolute change formulation.

In presenting the equations we adopt a typographical convention of writing variables in lower case and coefficients in upper case. We note in advance a potentially confusing but unavoidable feature of the terminology: the input-output coefficients are in fact variables rather than coefficients within the model.

The following subsections describe the four parts of the model. Summary tables are provided in Appendix B.

The input-output quantity model

The core of FIT consists of the input-output quantity and price models. This subsection describes the quantity module.

The quantity module contains two groups of equations, demand equations and market-clearing conditions. The demand equations determine commodity and factor usage in each use category. The market-clearing conditions determine output and imports of each commodity.

The demand equations determine commodity and factor usage in individual use categories in terms of input-output coefficients and activity levels. The activity level for each industry is its rate of output. The activity levels for the final demand categories are real aggregate final demands: aggregate fixed investment, aggregate household consumption, and aggregate government consumption.

We define two classes of input-output coefficients, corresponding to the two levels of the input-output structure (Section 4). The upper-level coefficients relate usage of commodities and primary factors to the level of activity in each use category. The lower-level coefficients relate usage of domestic products and imports to total usage of each commodity in use category.

We specify demand equations for intermediate usage and for three of the five final demand categories — fixed investment, household consumption, and government consumption. For the remaining two use categories — exports and inventory investment — demand equations are not needed. This is because the update simulations include commodity-specific shocks for these use categories.

We begin with the commodity demand equations. The demand equations for intermediate usage are:

$$uimdci(i,j) = aimdci(i,j) + aimci(i,j) + o(j) \qquad i = 1,\ldots,g, j = 1,\ldots,g \qquad (1)$$

$$uimmci(i,j) = aimmci(i,j) + aimci(i,j) + o(j) \qquad i = 1,\ldots,g, j = 1,\ldots,g \qquad (2)$$

Here the variables *uimdci(i,j)* and *uimmci(i,j)* represent (percentage changes in) intermediate usage by industry j of domestic and imported commodity i. The variable *aimci(i,j)* represents the input-output coefficient relating intermediate usage of commodity i to output of industry j; while *aimdci(i,j)* and *aimmci(i,j)* represent coefficients relating usage of domestic products and imports to total intermediate usage of commodity i by industry j. The variable $o(j)$ denotes output of sector j.

The demand equations for fixed investment usage are:

$$uivdc(i) = aivdc(i) + aivc(i) + iv \qquad i = 1,\ldots,g \quad (3)$$

$$uivmc(i) = aivmc(i) + aivc(i) + iv \qquad i = 1,\ldots,g \quad (4)$$

Here the variables $uivdc(i)$ and $uivmc(i)$ represent fixed investment usage of domestic and imported commodity i, while iv represents aggregate fixed investment. The variables $aivc(i)$, $aivdc(i)$, and $aivmc(i)$ represent input-output coefficients.

Similarly, the household consumption demand equations are:

$$uchdc(i) = achdc(i) + achc(i) + ch \qquad i = 1,\ldots,g \quad (5)$$

$$uchmc(i) = achmc(i) + achc(i) + ch \qquad i = 1,\ldots,g \quad (6)$$

Here the variables $uchdc(i)$ and $uchmc(i)$ represent household consumption of domestic and imported commodity i, while ch represents aggregate household consumption. The variables $achc(i)$, $achdc(i)$, and $achmc(i)$ represent input-output coefficients.

Finally, the government consumption demand equations are:

$$ucgdc(i) = acgdc(i) + acgc(i) + cg \qquad i = 1,\ldots,g \quad (7)$$

$$ucgmc(i) = acgmc(i) + acgc(i) + cg \qquad i = 1,\ldots,g \quad (8)$$

Here the variables $ucgdc(i)$ and $ucgmc(i)$ represent government consumption of domestic and imported commodity i, while cg represents aggregate government consumption. The variables $acgc(i)$, $acgdc(i)$, and $acgmc(i)$ represent input-output coefficients.

Besides these commodity demand equations, we specify demand equations for primary factors:

$$eli(j) = afi(j) + o(j) \qquad j = 1,\ldots,g \quad (9)$$

$$eki(j) = afi(j) + o(j) \qquad j = 1,\ldots,g \quad (10)$$

$$eni(j) = afi(j) + o(j) \qquad j = 1,\ldots,g \quad (11)$$

Here the variables *eli(j)*, *eki(j)*, and *eni(j)* represent employment of labour, capital, and land in industry *j*. The variable *afi(j)* represents the input-output coefficient relating primary factor usage to output of industry *j*.

There are two sets of market-clearing conditions, one for domestic products and the other for imports. The market-clearing condition for domestic products equates output and total usage of each domestic commodity:

$$\begin{aligned} o(i) = \; & SUM(j, IND, S\_O\_IMCI(i,j)*uimdci(i,j)) + S\_O\_IVC(i)*uivdc(i) \\ & + S\_O\_CHC(i)*uchdc(i) + S\_O\_CGC(i)*ucgdc(i) \\ & + S\_O\_XPC(i)*uxpc(i) + ustdc(i) + S\_O\_STC(i)*o(i) \qquad i = 1,\ldots,g \quad (12) \end{aligned}$$

Here the coefficients represent shares of each use category in total sales of each domestic commodity. Thus *S_O_IMCI(i,j)* denotes the share of intermediate usage by industry *j*, and *S_O_IVC(i)*, *S_O_CHC(i)*, *S_O_CGC(i)*, *S_O_XPC(i)*, and *S_O_STC(i)* the shares of investment usage, household consumption, government consumption, exports, and changes in stocks, in total sales of domestic commodity *i*.

The variables *uxpc(i)* and *ustdc(i)* represent exports and inventory investment usage of domestic commodity *i*. For inventory investment, where usage may be either positive or negative, we avoid the percentage change formulation. Instead we define *ustdc(i)* as the absolute change in the share of inventory investment in total usage of domestic commodity *i*, multiplied by 100.

The special formulation of the inventory investment variable affects the form of the market-clearing equation. The contribution of inventory investment to the percentage change in total usage of commodity *i* is represented by the expression *[(ustdc(i) + S_O_STC(i)*o(i)]*. If inventory investment is initially non-zero, this expression is equivalent to the product of the share of inventory investment in total sales, *S_O_STC(i)*, and the percentage change in inventory investment, *[(1/S_O_STC(i))*ustdc(i) + o(i)]*.

The market-clearing condition for imported commodities equates import volume and total usage of each imported commodity:

$$\begin{aligned} m(i) = \; & SUM(j, IND, S\_M\_IMCI(i,j)*uimmci(i,j)) + S\_M\_IVC(i)*uivmc(i) \\ & + S\_M\_CHC(i)*uchmc(i) + S\_M\_CGC(i)*ucgmc(i) + ustmc(i) \\ & + S\_M\_STC(i)*m(i) \qquad i = 1,\ldots,g \quad (13) \end{aligned}$$

Here the variables *m(i)* and *ustmc(i)* represent import volume and inventory investment usage of imported commodity *i*. As before we avoid the percentage change formulation for inventory investment: *ustmc(i)* represents the absolute change in the share of inventory investment usage in total usage of imported commodity *i*, multiplied by 100. Also as before, this affects the form of the equation.

The coefficients in equation (13) represent shares of each use category in total sales of each imported commodity. Thus *S_M_IMCI(i,j)* denotes the share of intermediate usage by industry *j* in total sales of imported commodity *i*, etc.

The input-output price model

Complementing the input-output quantity model is the price model. It contains three groups of equations. The zero pure profits condition for production relates the value of output to total costs of each industry. Other equations represent relations between pre-tax and post-tax prices and tax rates. The last group of equations determines the price of capital services (the user cost of capital) to each industry.

Each commodity flow can be valued at either of two prices, one excluding commodity tax and one including it. We call the price excluding commodity tax the *basic value price*, and the price including commodity tax the *purchasers' price*. Basic value prices of domestic products incorporate any production taxes on the supplying industries. Likewise, basic value prices of imports include import duties.

Each commodity from each source has just one basic price, applying in all uses. But it has many different purchasers' prices, one for each use category. Purchasers' prices differ between use categories because commodity taxes are use-specific.

For exports we call the price including commodity tax not the purchasers' price but the *border price*. We also define a border price for imports, as the price excluding both commodity tax and import duty.

All indirect taxes are treated as *ad valorem*. We represent them in the pricing equations by variables representing the *power of the tax*. This is defined as one plus the ad valorem tax rate, or equivalently as the ratio of the post-tax to the pre-tax price. We use this formulation because the power of the tax is always positive, whereas the tax rate may be positive or negative.

We present first the zero pure profits condition. This condition states that for each industry the basic value of output is equal to total costs, including the user cost of capital and land:

$$
\begin{aligned}
& pbadc(j) + o(j) \\
= \; & wtpi(j) + SUM(i,\ COM,\ S\_C\_DIC(i,j)*(ppuimdci(j,i) + uimdci(i,j))) \\
& + SUM(i,\ COM,\ S\_C\_MIC(i,j)*(ppuimmci(j,i) + uimmci(i,j))) \\
& + S\_C\_LI(j)*(vl + eli(j)) + S\_C\_KI(j)*(vki(j) + eki(j)) \\
& + S\_C\_NI(j)*(vn + eni(j)) \qquad j = 1,\ldots,g \quad (14)
\end{aligned}
$$

Here the variable $pbadc(j)$ represents the basic price of domestic commodity j, and $wtpi(j)$ the power of the production tax on industry j. The variables $ppuimdci(j,i)$ and $ppuimmci(j,i)$ represent the prices in intermediate usage by industry j of domestic and imported commodity i. The variable vl represents the wage rate, $vki(j)$ the price of capital services to industry j, and vn the price of land services (the land rental).

The coefficients in equation (14) represent shares in total costs excluding production tax. Thus $S\_C\_DIC(i,j)$ and $S\_C\_MIC(i,j)$ denote the shares of domestic and imported commodity i, and $S\_C\_LI(j)$, $S\_C\_KI(j)$, and $S\_C\_NI(j)$ the shares of labour, capital, and land, in costs of industry j.

The expression *pure profits* in the name of this equation refers to profits remaining after meeting the user cost of capital and land. The condition that pure profits are equal to zero is equivalent to the sectoral balance identity (Section 2).

We present next the equations relating post-tax prices to pre-tax prices and tax rates. First of these we present the equation for basic prices of imported commodities:

$$pbamc(i) = pbomc(i) + wtcmpc(i) \qquad i = 1,\ldots,g \quad (15)$$

Here $pbamc(i)$ denotes the basic price, $pbomc(i)$ the border price, and $wtcmpc(i)$ the power of the import tariff on imported commodity i.

Next we list the equations for purchasers' prices:

$$ppuimdci(j,i) = pbadc(i) + wtcimdc(j,i) \qquad i = 1,\ldots,g, j = 1,\ldots,g \quad (16)$$

$$ppuimmci(j,i) = pbamc(i) + wtcimmc(j,i) \qquad i = 1,\ldots,g, j = 1,\ldots,g \quad (17)$$

$$ppuivdc(i) = pbadc(i) + wtcivdc(i) \qquad i = 1,\ldots,g \quad (18)$$

$$ppuivmc(i) = pbamc(i) + wtcivmc(i) \qquad i = 1,\ldots,g \quad (19)$$

$$ppuchdc(i) = pbadc(i) + wtcchdc(i) \qquad i = 1,\ldots,g \quad (20)$$

$$ppuchmc(i) = pbamc(i) + wtcchmc(i) \qquad i = 1,\ldots,g \quad (21)$$

$$ppucgdc(i) = pbadc(i) + wtccgdc(i) \qquad i = 1,\ldots,g \quad (22)$$

$$ppucgmc(i) = pbamc(i) + wtccgmc(i) \qquad i = 1,\ldots,g \quad (23)$$

$$ppustdc(i) = pbadc(i) + wtcstdc(i) \qquad i = 1,\ldots,g \quad (24)$$

$$ppustmc(i) = pbamc(i) + wtcstmc(i) \qquad i = 1,\ldots,g \quad (25)$$

Here the variables *ppuivdc(i)* and *ppuivmc(i)* represent purchasers' prices in fixed investment usage of domestic and imported commodity *i*. Similarly *ppuchdc(i)* and *ppuchmc(i)* denote purchasers' prices in household consumption, *ppucgdc(i)* and *ppucgmc(i)* in government consumption, and *ppustdc(i)* and *ppustmc(i)* in inventory investment. The variables *wtcimdci(j,i)*, *wtcimmci(j,i)*, etc. represent the powers of the corresponding commodity taxes.

Last in this group we present the equation for border prices of exports:

$$pboxc(i) = pbadc(i) + wtcxpc(i) \qquad i = 1,\ldots,g \quad (26)$$

Here *pboxc(i)* denotes the border price of exports, and *wtcxpc(i)* the power of the commodity tax on exports of commodity *i*.

The last group of equations determines the user cost of capital. This is done in two steps. The first equation identifies the price of capital goods with the price index for fixed investment:

$$pk = ipiv \quad (27)$$

where *pk* denotes the price of capital goods, and *ipiv* the fixed investment price index, defined in the miscellaneous equations module. The second equation relates prices of capital services to the price of capital goods and rates of return:

$$vki(j) = pk + rri(j) \qquad j = 1,\ldots,g \quad (28)$$

where *rri(j)* denotes the rate of return in industry *j*.

The optimisation module

The optimisation module implements the import revision procedure (Section 4). The equations in the module represent conditions for a solution to a constrained optimisation problem formulated using information theory (Appendix A).

The module contains two groups of equations. The first-order conditions require that the derivatives of the Lagrangean (Appendix A) with respect to the input-output coefficients should equal zero. The adding-up constraints (in their original levels form) require various sets of input-output coefficients to sum to unity.

We list first the first-order conditions. The conditions derived by differentiating the Lagrangean with respect to the upper-level input-output coefficients are represented by the equations:

$$W1*aimci(i,j) = S\_UIMCI\_M(i,j)*lmpc(i) + lacimi(j) \qquad j = 1,\ldots,g,\ i = 1,\ldots,g \quad (29)$$

$$W1*aivc(i) = S\_UIVC\_M(i)*lmpc(i) + laciv \qquad i = 1,\ldots,g \quad (30)$$

$$W1*achc(i) = S\_UCHC\_M(i)*lmpc(i) + lacch \qquad i = 1,\ldots,g \quad (31)$$

$$W1*acgc(i) = S\_UCGC\_M(i)*lmpc(i) + laccg \qquad i = 1,\ldots,g \quad (32)$$

$$W1*afi(j) = lacimi(j) \qquad j = 1,\ldots,g \quad (33)$$

Here the variable *lmpc(i)* is a Lagrange multiplier associated with the constraint on imports of commodity *i*. The other new variables are Lagrange multipliers associated with the upper-level adding-up constraints. Thus *lacimi(j)* denotes the multiplier associated with the commodity composition constraint for industry *j*; and *laciv*, *lacch*, and *laccg* the multipliers associated with the constraints for fixed investment, household consumption, and government consumption.

The coefficient *W1* represents the weight attached to information about the upper level of the input-output structure. The other coefficients in equations (29)-(32) represent import shares in expenditures on each commodity. Thus *S_UIMCI_M(i,j)* denotes the share of imports in the cost of intermediate usage of commodity *i* to industry *j*, *S_UIVC_M(i)* the share of imports in fixed investment expenditure on commodity *i*, etc.

The conditions derived by differentiating the Lagrangean with respect to the lower-level input-output coefficients are represented by the equations:

$$W2*aimdci(i,j) = lasimci(i,j) \qquad j = 1,\dots,g,\ i = 1,\dots,g \quad (34)$$

$$W2*aimmci(i,j) = lmpc(i) + lasimci(i,j) \qquad j = 1,\dots,g,\ i = 1,\dots,g \quad (35)$$

$$W2*aivdc(i) = lasivc(i) \qquad i = 1,\dots,g \quad (36)$$

$$W2*aivmc(i) = lmpc(i) + lasivc(i) \qquad i = 1,\dots,g \quad (37)$$

$$W2*achdc(i) = laschc(i) \qquad i = 1,\dots,g \quad (38)$$

$$W2*achmc(i) = lmpc(i) + laschc(i) \qquad i = 1,\dots,g \quad (39)$$

$$W2*acgdc(i) = lascgc(i) \qquad i = 1,\dots,g \quad (40)$$

$$W2*acgmc(i) = lmpc(i) + lascgc(i) \qquad i = 1,\dots,g \quad (41)$$

Here the new variables represent the Lagrange multipliers associated with the lower-level adding-up constraints. Thus *lasimci(i,j)* denotes the multiplier associated with the source composition constraint for intermediate usage of commodity *i* by industry *j*; and *lasivc(i)*, *laschc(i)*, and *lascgc(i)* the multipliers associated with the constraints for fixed investment usage, household consumption, and government consumption of commodity *i*. The coefficient *W2* represents the weight attached to information about the lower level of the input-output structure.

Next we list the adding-up constraints. The upper-level adding-up constraints apply to the commodity composition of usage in each use category:

$$0 = SUM(i, COM, S\_C\_IC(i,j)*aimci(i,j)) + S\_C\_FI(j)*afi(j) \qquad j = 1,\dots,g \quad (42)$$

$$0 = SUM(i, COM, S\_IV\_C(i)*aivc(i)) \quad (43)$$

$$0 = SUM(i, COM, S\_CH\_C(i)*achc(i)) \quad (44)$$

$$0 = SUM(i, COM, S\_CG\_C(i)*acgc(i)) \quad (45)$$

Here the coefficients represent commodity shares in expenditure in each use category. Thus *S_C_IC(i,j)* denotes the share of commodity *i* and *S_C_FI(j)* the share of primary factors in total costs (excluding production tax) of industry *j*. *S_IV_C(i)*, *S_CH_C(i)*, and *S_CG_C(i)* denote the shares of commodity *i* in aggregate expenditure on fixed investment, household consumption, and government consumption.

The lower-level adding-up constraints apply to the source composition of usage of each commodity in each use category:

$$0 = S\_UIMCI\_D(i,j)*aimdci(i,j) + S\_UIMMCI\_M(i,j)*aimmci(i,j) \qquad j = 1,...,g,\ i = 1,...,g \quad (46)$$

$$0 = S\_UIVC\_D(i)*aivdc(i) + S\_UIVC\_M(i)*aivmc(i) \qquad i = 1,...,g \quad (47)$$

$$0 = S\_UCHC\_D(i)*achdc(i) + S\_UCHC\_M(i)*achmc(i) \qquad i = 1,...,g \quad (48)$$

$$0 = S\_UCGC\_D(i)*acgdc(i) + S\_UCGC\_M(i)*acgmc(i) \qquad i = 1,...,g \quad (49)$$

Some of the coefficients in these equations have appeared already, in the first-order conditions equations (29)-(32). These coefficients represent import shares in expenditures on each commodity in each use category. The new coefficients represent domestic product shares. Thus *S_UIMCI_D(i,j)* denotes the share of domestic products in the cost of intermediate usage of commodity *i* to industry *j*, *S_UIVC_D(i)* the share of domestic products in fixed investment expenditure on commodity *i*, etc.

The miscellaneous equations module

The model is completed by a number of descriptive equations defining various variables targeted in the update simulations.

- Aggregate final demand expenditures are targeted to match macroeconomic data (Section 3).
- Border values of exports and imports are targeted to match international trade data (Section 3).
- Relative import prices are shocked as part of the import revision (Section 4).

We list first the equations for aggregate final demand expenditures:

$$\begin{aligned} eiv = {} & SUM(i, COM, S\_IV\_DC(i)*(ppuivdc(i) + uivdc(i)) \\ & + SUM(i, COM, S\_IV\_MC(i)*(ppuivmc(i) + uivmc(i)) \end{aligned} \quad (50)$$

$$\begin{aligned} ech = {} & SUM(i, COM, S\_CH\_DC(i)*(ppuchdc(i) + uchdc(i)) \\ & + SUM(i, COM, S\_CH\_MC(i)*(ppuchmc(i) + uchmc(i)) \end{aligned} \quad (51)$$

$$\begin{aligned} ecg = {} & SUM(i, COM, S\_CG\_DC(i)*(ppucgdc(i) + ucgdc(i)) \\ & + SUM(i, COM, S\_CG\_MC(i)*(ppucgmc(i) + ucgmc(i)) \end{aligned} \quad (52)$$

Here the variables *eiv*, *ech*, and *ecg* represent aggregate expenditures on fixed investment, household consumption, and government consumption. The coefficients represent shares of domestic and imported commodities in expenditure in each use category. Thus *S_IV_DC(i)* denotes the share of domestic commodity *i* in aggregate fixed investment expenditure, *S_IV_MC(i)* the share of imported commodity *i* in aggregate fixed investment expenditure, etc.

Next we define border values of exports and imports:

$$expboc(i) = pboxc(i) + uxpc(i) \qquad i = 1,...,g \quad (53)$$

$$empboc(i) = pbomc(i) + m(i) \qquad i = 1,...,g \quad (54)$$

Here the variables *expboc(i)* and *empboc(i)* represent the border values of exports and imports of commodity *i*.

Last we define the relative import price variables. We do this in three steps. The first step is to define price indices for the major components of expenditure on GDP:

$$ipiv = SUM(i, COM, S\_IV\_DC(i)*ppuivdc(i)) + SUM(i, COM, S\_IV\_MC(i)*ppuivmc(i)) \quad (55)$$

$$ipch = SUM(i, COM, S\_CH\_DC(i)*ppuchdc(i)) + SUM(i, COM, S\_CH\_MC(i)*ppuchmc(i)) \quad (56)$$

$$ipcg = SUM(i, COM, S\_CG\_DC(i)*ppucgdc(i)) + SUM(i, COM, S\_CG\_MC(i)*ppucgmc(i)) \quad (57)$$

$$ipxp = SUM(i, COM, S\_XP\_C(i)*pboxc(i)) \quad (58)$$

$$ipmp = SUM(i, COM, S\_MP\_C(i)*pbomc(i)) \quad (59)$$

Here the variables *ipiv*, *ipch*, *ipcg*, *ipxp*, and *ipmp* represent price indices for fixed investment, household consumption, government consumption, exports, and imports. The coefficients *S_XP_C(i)* and *S_MP_C(i)* represent the shares of commodity *i* in aggregate border values for exports and imports.

We do not calculate a price index for changes in stocks. In this final demand category, unlike the others, aggregate expenditure is liable in practice to assume a zero value. But when aggregate expenditure is zero the price index is not well defined. Instead we define a variable representing the contribution of inventory investment prices to the price index for GDP:

$$cippdgst = SUM(i, COM, S\_PDG\_STDC(i)*ppustdc(i)) + SUM(i, COM, S\_PDG\_STMC(i)*ppustmc(i)) \quad (60)$$

Here the variable *cippdgst* represents the contribution of inventory investment prices to the price index for GDP. The coefficients *S_PDG_STDC(i)* and *S_PDG_STMC(i)* represent shares in expenditure on GDP of inventory investment usage of domestic and imported commodity *i*.

The second step is to use the component price indices to calculate the overall GDP price index:

$$ippdg = S\_PDG\_IV*ipiv + S\_PDG\_CH*ipch + S\_PDG\_CG*ipcg + S\_PDG\_XP*ipxp + cippdgst - S\_PDG\_MP*ipmp \quad (61)$$

Here the coefficients represent shares in expenditure on GDP. Thus *S_PDG_IV* denotes the share of fixed investment expenditure in expenditure on GDP, etc.

The last step is to use the GDP price index to calculate relative import prices:

$$premc(i) = pbomc(i) - ippdg \qquad i = 1,...,g \quad (62)$$

where *premc(i)* denotes the price of imports of commodity *i* relative to the GDP price index.

6 Implementation and operation

FIT is implemented as a FORTRAN program, written with the GEMPACK code-writing program TABLO. The TABLO source code is listed in Appendix D.

FIT reads two data files: a single-region input-output table, and a small data file containing data common to all regions. Both files are formatted as header array files (Mikkelsen and Pearson, 1986). The header arrays are listed in Appendix C.

In implementing FIT we use the TABLO condensation facility (Pearson and Codsi 1987, 1991a) to reduce the size of the model. We perform just one kind of condensation operation, elimination of variables by substitution. The eliminated variables and the equations used to substitute for them are shown in Table B2 in Appendix B.

One part of the condensation that calls for explanation is the elimination of the Lagrange multipliers associated with the adding-up constraints in the optimisation problem. As Table B2 shows, these are substituted out using the adding-up constraints, equations (42)-(49). The reason why this calls for explanation is that the multipliers do not appear in these equations.

The explanation is that before the Lagrange multipliers are eliminated, they are introduced into the adding-up constraints by previous substitution operations. These are the substitutions for the input-output coefficients using the first order conditions, equations (29)-(41). The expressions substituted for the input-output coefficients involve the Lagrange multipliers. Before these substitutions the adding-up constraints involve the input-output coefficients; so afterwards they involve the Lagrange multipliers.

This feature of the condensation means that the order of operations is important. To execute the condensation successfully, the user must eliminate the input-output coefficients before the Lagrange multipliers.

In running the model the user must specify the *closure*, that is the partitioning of the variables in the condensed model into exogenous and endogenous variables. Table 1 lists the exogenous variables in the standard FIT closure. Of these, the rate of return on capital, *rri*, the wage rate, *vl*, and the land rental, *vn*, are typically held fixed in the update simulations. The other exogenous variables represent targets and are typically shocked.

Holding wage rates and land rentals fixed may seem undesirable where the update simulations relate to a period of significant inflation. In fact it makes no difference to the updated database whether we hold these variables fixed or shock them by some common amount. With the selected closure all endogenous variables in the model are jointly homogeneous with respect to the wage rate and the land rental. Price variables are homogeneous of order plus one, quantity variables of order minus one, and value variables of order zero. Then the updated database is homogeneous of order zero.

TABLE 1: **Standard exogenous variables in FIT**

Variable	*Dimension*	*Description*
ecg	1	Government consumption expenditure.
ech	1	Household consumption expenditure.
eiv	1	Fixed investment expenditure.
empboc	*g*	Border value of imports, by commodity.
expboc	*g*	Border value of exports, by commodity.
premc	*g*	Ratio of border price of imports to GDP price index, by commodity.
rri	*g*	Rate of return on capital,by industry.
ustdc	*g*	Share of inventory investment in usage of domestic product, by commodity.
ustmc	*g*	Share of inventory investment in usage of imports, by commodity.
vl	1	Wage rate.
vn	1	Land rental.
wtccgdc	*g*	Power of commodity tax on government consumption of domestic product, by commodity.
wtccgmc	*g*	Power of commodity tax on government consumption of imports, by commodity.
wtcchdc	*g*	Power of commodity tax on household consumption of domestic product, by commodity.
wtcchmc	*g*	Power of commodity tax on household consumption of imports, by commodity.
wtcimdc	g^2	Power of commodity tax on intermediate usage of domestic product, by industry and commodity.
wtcimmc	g^2	Power of commodity tax on intermediate usage of imports, by industry and commodity.
wtcivdc	*g*	Power of commodity tax on fixed investment usage of domestic product, by commodity.
wtcivmc	*g*	Power of commodity tax on fixed investment usage of imports, by commodity.
wtcmpc	*g*	Power of import tariff, by commodity.
wtcstdc	*g*	Power of commodity tax on inventory investment usage of domestic product, by commodity.
wtcstmc	*g*	Power of commodity tax on inventory investment usage of imports, by commodity.
wtcxpc	*g*	Power of export tax, by commodity.
wtpi	*g*	Power of production tax, by industry.

g Number of sectors

Some of the exogenous variables listed in Table 1 would normally be endogenous in an input-output model. These variables represent targets in the update simulations. Likewise some of the endogenous variables in the standard closure would normally be exogenous in an input-output model. These include variables used as instruments for meeting the targets, and input-output coefficients endogenized in the optimisation module.

To meet the targets for aggregate final demand expenditures we exogenize the aggregate expenditure variables *eiv*, *ech*, and *ecg*, and endogenize the corresponding quantity variables *iv*, *ch*, and *cg*. To meet the targets for border values of exports we exogenize the border values *expboc(i)* and endogenize the corresponding volumes *uxpc(i)*.

To meet the import constraints we endogenize the associated Lagrange multipliers *lmpc(i)* and exogenize the import border values *empboc(i)*. We use each adding-up constraint in the optimisation module to endogenize its associated Lagrange multiplier, and use the first-order conditions to endogenize the input-output coefficients.

For the import price scenario, we exogenize relative prices *premc(i)* and endogenize absolute prices *pbomc(i)*.

The percentage change formulation of the model allows us to meet positive targets for export and import values only if the corresponding initial values are non-zero. To ensure that this condition is satisfied for the update simulations we pre-process the input-output tables to replace zero values with small positive values (Calder *et al.* forthcoming).

Appendix A: The information theory solution to the import revision problem

Let $S_i^j(0)$ denote the initial share of economic good i in expenditure on purpose j, $i = 1,\ldots,g+1$, $j = 1,\ldots, g+3$, where

— g denotes the number of commodities,

— $i = 1,\ldots,g$ indicates commodity i,

— $i = g+1$ indicates primary factor,

and

— $j = 1,\ldots,g$ indicates intermediate usage by industry j,

— $j = g+1$ indicates fixed investment usage,

— $j = g+2$ indicates household consumption, and

— $j = g+3$ indicates government consumption.

Let $S_s^{ji}(0)$ denote the initial share of source s in expenditure on economic good i for purpose j, $i = 1,\ldots, g$, $j = 1,\ldots, g+3$, $s = 1, 2$, where

— $s = 1$ indicates the domestic production, and

— $s = 2$ indicates importation.

The shares S_i^j define the upper level of the input-output structure, or the *commodity structure* of the input-output table; the shares S_s^{ji} define the lower level, or the *source structure*.

Now the initial value of imports of commodity i, $i = 1,\ldots,g$, is

$$\sum_{j=1}^{g+3} E_j \; S_i^j(0) \; S_2^{ji}(0)$$

where E_j denotes expenditure on purpose j, $j = 1,\ldots,g+3$. The objective is to impose a target value M_i for imports of each commodity i, $i = 1,\ldots,g$. To achieve this we need to find new shares $S_i^j(1)$, $S_s^{ji}(1)$ such that

$$\sum_{j=1}^{g+3} E_j \; S_i^j(1) \; S_2^{ji}(1) = M_i \qquad i = 1,\ldots,g$$

The shares must satisfy the adding-up constraints

$$\sum_{i=1}^{g+1} S_i^j(1) = 1 \qquad j = 1,\ldots,g+3$$

$$\sum_{s=1}^{2} S_s^{ji}(1) = 1 \qquad j = 1,\ldots,g+3,\ i = 1,\ldots,g$$

Following Theil (1967) we define the information content of a revision to the commodity structure for expenditure on purpose j,

$$I_{1j} = \sum_{i=1}^{g+1} S_i^j(1) \log \frac{S_i^j(1)}{S_i^j(0)} \qquad j = 1,\ldots,g+3$$

We define the total information content I_1 of the revision to the upper level of the input-output structure as a weighted sum of the information contents of the revisions to the commodity structure for each individual purpose,

$$\begin{aligned} I_1 &= \sum_{j=1}^{g+3} E_j I_{1j} \\ &= \sum_{j=1}^{g+3} E_j \sum_{i=1}^{g+1} S_i^j(1) \log \frac{S_i^j(1)}{S_i^j(0)} \end{aligned}$$

where the weight attached to the information content to the revision of the commodity structure for purpose j is just total expenditure E_j on purpose j, $j = 1,\ldots,g+3$.

Similarly we define the information content of the revision to the source structure of expenditure on commodity i for purpose j,

$$I_{2ji} = \sum_{s=1}^{2} S_s^{ji}(1) \log \frac{S_s^{ji}(1)}{S_s^{ji}(0)} \qquad j = 1,\ldots,g+3,\ i = 1,\ldots,g$$

We define the total information content I_2 of the revision to the lower level of the input-output structure as a weighted sum of the information contents of the revisions to the source structure for expenditure on each commodity for each purpose:

$$I_2 = \sum_{j=1}^{g+3}\sum_{i=1}^{g} E_{ji} I_{2ji}$$

$$= \sum_{j=1}^{g+3} E_j \sum_{i=1}^{g} S_i^j(1) \sum_{s=1}^{2} S_s^{ji} \log \frac{S_s^{ji}(1)}{S_s^{ji}(0)}$$

where the weight attached to the information content of the revision to the source structure for expenditure on commodity i for purpose j is just the value of expenditure on commodity i for purpose j,

$$E_{ji} = E_j S_i^j \qquad j = 1,\ldots,g+3,\ i = 1,\ldots,g$$

Finally we define the total information content of the revision to the input-output structure as a weighted sum of the information contents of the revisions to the upper and lower levels,

$$I = W_1 I_1 + W_2 I_2$$

where W_1 and W_2 are arbitrary weight parameters.

Thus we have converted the import revision problem to a constrained optimisation problem: minimise the information content I of the revision to the input-output structure, subject to the constraints

$$\sum_{j=1}^{g+3} E_j\ S_i^j(1)\ S_2^{ji}(1) = M_i \qquad i = 1,\ldots,g$$

$$\sum_{i=1}^{g+1} S_i^j(1) = 1 \qquad j = 1,\ldots,g+3$$

$$\sum_{s=1}^{2} S_s^{ji}(1) = 1 \qquad j = 1,\ldots,g+3,\ i = 1,\ldots,g$$

To solve this problem we begin by defining the Lagrangean,

$$L = I + \sum_{i=1}^{g} \lambda_i \left(M_i - \sum_{j=1}^{g+3} E_j S_i^j(1) S_2^{ji}(1) \right) + \sum_{j=1}^{g+3} \mu_j E_j \left(1 - \sum_{j=1}^{g+1} S_i^j(1) \right)$$

$$+\sum_{j=1}^{g+3}\sum_{i=1}^{g} \nu_{ji} E_j S_i^j(1)\left(1-\sum_{s=1}^{2} S_s^{ji}(1)\right)$$

Here

- λ_i denotes the Lagrange multiplier associated with the constraint on imports of commodity i,
- μ_j denotes the multiplier associated with the adding-up constraint for the commodity structure for purpose j, adjusted by a scaling factor E_j, and
- ν_{ji} denotes the multiplier associated with the adding-up constraint for the source structure for purpose j and commodity i, adjusted by a scaling factor $E_j S_i^j(1)$.

The scaling factors E_j and $E_j S_i^j(1)$ are introduced because they lead to simpler forms for the first-order conditions.

Then first-order conditions for a solution are

$$0 = \frac{\partial L}{\partial S_i^j(1)}$$

$$= W_1 E_j\left(1+\log\frac{S_i^j(1)}{S_i^j(0)}\right)+W_2 E_j\sum_{s=1}^{2} S_s^{ji}(1)\log\frac{S_s^{ji}(1)}{S_s^{ji}(0)}$$

$$-\lambda_i E_j S_2^{ji}(1) - \mu_j E_j \qquad j = 1,\ldots,g+3,\ i = 1,\ldots,g$$

$$0 = \frac{\partial L}{\partial S_{g+1}^j(1)}$$

$$= W_1 E_j\left(1+\log\frac{S_{g+1}^j(1)}{S_{g+1}^j(0)}\right) - \mu_j E_j \qquad j = 1,\ldots,g$$

$$0 = \frac{\partial L}{\partial S_1^{ji}(1)}$$

$$= \quad W_2 E_j S_i^j(1)\left(1+\log\frac{S_1^{ji}(1)}{S_1^{ji}(0)}\right) - \nu_{ji} E_j S_i^j(1) \qquad j = 1,\ldots,g+3,\ i = 1,\ldots,g$$

$$0 \quad = \quad \frac{\partial L}{\partial S_2^{ji}(1)}$$

$$= \quad W_2 E_j S_i^j(1)\left(1+\log\frac{S_2^{ji}(1)}{S_2^{ji}(0)}\right) - \lambda_i E_j S_i^j(1)$$

$$- \nu_{ji} E_j S_i^j(1) \qquad j = 1,\ldots, g+3,\ i = 1,\ldots,g$$

Differentiating the first-order conditions, we obtain

$$W_1 s_i^j + W_2 \sum_{s=1}^{2} S_s^{ji}(1)\left(1+\log\frac{S_s^{ji}(1)}{S_s^{ji}(0)}\right) s_s^{ji}$$

$$= \quad S_2^{ji}(1)d\lambda_i + d\mu_j + \lambda_i S_2^{ji}(1) s_2^{ji} \qquad j = 1,\ldots,g+3,\ i = 1,\ldots,g \qquad \text{(A1)}$$

$$W_1 s_{g+1}^j = d\mu_j \qquad j = 1,\ldots,g \qquad \text{(A2)}$$

$$W_2 s_1^{ji} = d\nu_{ji} \qquad j = 1,\ldots,g+3,\ i = 1,\ldots,g \qquad \text{(A3)}$$

$$W_2 s_2^{ji} = d\lambda_i + d\nu_{ji} \qquad j = 1,\ldots,g+3,\ i = 1,\ldots,g \qquad \text{(A4)}$$

where $s_i^j \equiv \dfrac{dS_i^j(1)}{S_i^j(1)}$, $j = 1,\ldots,g+3$, $i = 1,\ldots,g$, and $s_s^{ji} \equiv \dfrac{dS_s^{ji}(1)}{S_s^{ji}(1)}$, $j = 1,\ldots,g+3$, $i = 1,\ldots,g$.

Differentiating the adding-up constraints, we obtain

$$\sum_{j=1}^{g+3} S_j^{Mi}(s_i^j + s_s^{ji} + e_j) = m_i \qquad i = 1,\ldots,g \qquad \text{(A5)}$$

$$\sum_{i=1}^{g+1} S_i^j(1)s_i^j = 0 \qquad j = 1,\ldots,g+3 \qquad \text{(A6)}$$

$$\sum_{s=1}^{2} S_s^{ji}(1)s_s^{ji} = 0 \qquad j = 1,\ldots,g+3,\ i = 1,\ldots,g \qquad \text{(A7)}$$

where S_j^{Mi} denotes the share of purpose j in total usage of imported commodity i, and $m_i \equiv dM_i / M_i$, i = 1,...,g. Given e_j and m_i, the system (A1)-(A7) is solved for s_i^j, s_s^{ji}, $d\lambda_i$, $d\mu_j$, and dv_{ji}.

In most respects the equations (A1)-(A7) are suitable for implementation in FIT. The coefficients $S_i^j(1)$ and $S_s^{ji}(1)$ present no problem, since these can be calculated from the current database at each step of the solution procedure. The coefficients $S_s^{ji}(0)$ in equation (A1) do present a problem, since they can be calculated only from the original database. But these coefficients can be eliminated, as we now proceed to show.

Recall the first-order conditions (levels form)

$$0 = \frac{\partial L}{\partial S_1^{ji}(1)}$$

$$= W_2 E_j S_i^j(1)\left(1 + \log\frac{S_1^{ji}(1)}{S_1^{ji}(0)}\right) - v_{ji}E_j S_i^j(1) \qquad j = 1,\ldots,g+3,\ i = 1,\ldots,g$$

$$
\begin{aligned}
0 &= \frac{\partial L}{\partial S_2^{ji}(1)} \\
&= W_2 E_j S_i^j(1)\left(1+\log\frac{S_2^{ji}(1)}{S_2^{ji}(0)}\right) - \lambda_i E_j S_i^j(1) \\
&\quad - \nu_{ji} E_j S_i^j(1) \qquad\qquad j = 1,\ldots,g+3,\ i = 1,\ldots,g
\end{aligned}
$$

Rearranging, we have

$$
W_2\left(1+\log\frac{S_1^{ji}(1)}{S_1^{ji}(0)}\right) = \nu_{ji} \qquad j = 1,\ldots,g+3,\ i = 1,\ldots,g \qquad \text{(A8)}
$$

$$
W_2\left(1+\log\frac{S_2^{ji}(1)}{S_2^{ji}(0)}\right) = \lambda_i + \nu_{ji} \qquad j = 1,\ldots,g+3,\ i = 1,\ldots,g \qquad \text{(A9)}
$$

Recall the first-order condition (percentage-change form) (A1):

$$
\begin{aligned}
& W_1 s_i^j + W_2 \sum_{s=1}^{2} S_s^{ji}(1)\left(1+\log\frac{S_s^{ji}(1)}{S_s^{ji}(0)}\right) s_s^{ji} \\
= \;& S_2^{ji}(1)\,d\lambda_i + d\mu_j + \lambda_i S_2^{ji}(1) s_2^{ji} \qquad j = 1,\ldots,g+3,\ i = 1,\ldots,g
\end{aligned}
$$

Substituting from (A8) and (A9), obtain

$$
\begin{aligned}
& W_1 s_i^j + \nu_{ji} S_1^{ji}(1) s_1^{ji} + (\lambda_i + \nu_{ji}) S_2^{ji}(1) s_2^{ji} \\
= \;& S_2^{ji}(1)\,d\lambda_i + d\mu_j + \lambda_i S_2^{ji}(1) s_2^{ji} \qquad j = 1,\ldots,g+3,\ i = 1,\ldots,g \qquad \text{(A10)}
\end{aligned}
$$

Recall also the constraint (percentage-change form) equation (A7),

$$\sum_{s=1}^{2} S_s^{ji}(1) s_s^{ji} = 0$$

Applying this to (A10), and simplifying, we obtain

$$W_1 s_i^j = S_2^{ji}(1) d\lambda_i + d\mu_j \qquad j = 1,..,g+3,\ i = 1,...,g \quad \text{(A1}a\text{)}$$

This replaces equation (A1) above. Then the necessary conditions are (A1*a*), (A2)-(A7).

In implementing these conditions in FIT, equations (A1*a*) and (A2) of this appendix are rewritten as equations (29)-(33) of Section 4 above. Equations (A3)-(A4) become equations (34)-(41). The constraint on import usage, equation (A5), is redundant in FIT, since total import usage of each commodity is already calculated in equation (13) in the input-output quantity model. The adding-up constraint for the upper-level input-output coefficients, (A6), becomes equations (42)-(45), and the lower-level constraint (A7) becomes equations (46)-(49).

In deriving and implementing the solution we ignore two use categories, exports and inventory investment. We may ignore exports because of the assumption in the input-output tables that exports of imports are zero (Section 2). The reader can easily verify that, for use categories with zero import shares, the solution involves no changes in commodity shares (if for some use category j, for all commodities i, $S_2^{ji}(1)$ is equal to zero, then s_i^j is equal to zero).

In ignoring inventory investment, we rely on the fact that inventory investment flows are eliminated in the update simulations (Section 3). So inventory investment makes no contribution to import usage in the updated database.

In rewriting the equations for inclusion in FIT, we interpret the share variables s_i^j and s_s^{ij} in the optimisation problem as input-output coefficients. This means that in the input-output model, the adjustments in expenditure shares needed to satisfy the import constraints are brought about by quantity changes rather than price changes.

We interpret the share coefficients $S_i^j(1)$ and $S_s^{ji}(1)$ in the optimisation problem as current-price shares in FIT. This means that the measure of information content in the optimisation problem is given in FIT in terms of current-price rather than base-price expenditure shares.

Appendix B: The theoretical structure of FIT:summary tables

TABLE B1: **The FIT equation system**

Number	*Equation*	*Subscript Range*	*Description*
	Input-output quantity model		
(1)	$uimdci(i,j) = aimdci(i,j) + aimci(i,j) + o(j)$	$i = 1,\ldots,g,$ $j = 1,\ldots,g.$	Intermediate usage of domestic commodity *i* by industry *j*.
(2)	$uimmci(i,j) = aimmci(i,j) + aimci(i,j) + o(j)$	$i = 1,\ldots,g,$ $j = 1,\ldots,g.$	Intermediate usage of imported commodity *i* by industry *j*.
(3)	$uivdc(i) = aivdc(i) + aivc(i) + iv$	$i = 1,\ldots,g.$	Fixed investment usage of domestic commodity *i*.
(4)	$uivmc(i) = aivmc(i) + aivc(i) + iv$	$i = 1,\ldots,g.$	Fixed investment usage of imported commodity *i*.
(5)	$uchdc(i) = achdc(i) + achc(i) + ch$	$i = 1,\ldots,g.$	Household consumption of domestic commodity *i*.
(6)	$uchmc(i) = achmc(i) + achc(i) + ch$	$i = 1,\ldots,g.$	Household consumption of imported commodity *i*.
(7)	$ucgdc(i) = acgdc(i) + acgc(i) + cg$	$i = 1,\ldots,g.$	Government consumption of domestic commodity *i*.
(8)	$ucgmc(i) = acgmc(i) + acgc(i) + cg$	$i = 1,\ldots,g.$	Government consumption of imported commodity *i*.
(9)	$eli(j) = afi(j) + o(j)$	$j = 1,\ldots,g.$	Employment of labour by industry *j*.
(10)	$eki(j) = afi(j) + o(j)$	$j = 1,\ldots,g.$	Employment of capital by industry *j*.
(11)	$eni(j) = afi(j) + o(j)$	$j = 1,\ldots,g.$	Employment of land by industry *j*.
(12)	$o(i) = SUM(j, IND, S\_O\_IMCI(i,j)*uimdci(i,j) + S\_O\_IVC(i)*uivdc(i) + S\_O\_CHC(i)*uchdc(i) + S\_O\_CGC(i)*ucgdc(i) + S\_O\_XPC(i)*uxpc(i) + ustdc(i) + S\_O\_STC(i)*o(i)$	$i = 1,\ldots g.,$	Aggregate usage of domestic commodity *i*.
(13)	$m(i) = SUM(j, IND, S\_M\_IMCI(i,j)*uimmci(i,j) + S\_M\_IVC(i)*uivmc(i) + S\_M\_CHC(i)*uchmc(i) + S\_M\_CGC(i)*ucgmc(i) + ustmc(i) + S\_M\_STC(i)*m(i)$	$i = 1,\ldots,g.$	Aggregate usage of imported commodity *i*.

TABLE B1: **The FIT equation system** (continued)

Number	Equation	Subscript Range	Description
	<u>Input-output price model</u>		
(14)	pbadc(j) + o(j) = SUM(i, COM, S_C_DIC(i,j)*(ppuimdci(j,i) + uimdci(i,j))) + SUM(i, COM, S_C_MIC(i,j)*(ppuimmci(j,i) + uimmci(i,j))) + S_C_LI(j)*(vl + eli(j)) + S_C_KI(j)*(vki(j) + eki(j)) + S_C_NI(j)*(vn + eni(j)) + wtpi(j)	j = 1,...,g.	Zero pure profits condition for industry *j*.
(15)	pbamc(i) = pbomc(i) + wtcmpc(i)	i = 1,...,g.	Basic price of imported commodity *i*.
(16)	ppuimdci(j,i) = pbadc(i) + wtcimdc(j,i)	i = 1,...,g, j = 1,...,g.	Purchasers' price of domestic commodity *i* in intermediate usage by industry *j*.
(17)	ppuimmci(j,i) = pbamc(i) + wtcimmc(j,i)	i = 1,...,g, j = 1,...,g.	Purchasers' price of imported commodity *i* in intermediate usage by industry *j*.
(18)	ppuivdc(i) = pbadc(i) + wtcivdc(i)	i = 1,...,g.	Purchasers' price of domestic commodity *i* in fixed investment.
(19)	ppuivmc(i) = pbamc(i) + wtcivmc(i)	i = 1,...,g.	Purchasers' price of imported commodity *i* in fixed investment.
(20)	ppuchdc(i) = pbadc(i) + wtcchdc(i)	i = 1,...,g	Purchasers' price of domestic commodity *i* in household consumption.
(21)	ppuchmc(i) = pbamc(i) + wtcchmc(i)	i = 1,...,g.	Purchasers' price of imported commodity *i* in household consumption.
(22)	ppucgdc(i) = pbadc(i) + wtccgdc(i)	i = 1,...,g.	Purchasers' price of domestic commodity *i* in government consumption.
(23)	ppucgmc(i) = pbamc(i) + wtccgmc(i)	i = 1,...,g.	Purchasers' price of imported commodity *i* in government consumption.
(24)	ppustdc(i) = pbadc(i) + wtcstdc(i)	i = 1,...,g.	Purchasers' price of domestic commodity *i* in inventory investment.

TABLE B1: **The FIT equation system** (continued)

Number	*Equation*	*Subscript Range*	*Description*
(25)	*ppustmc(i) = pbamc(i) + wtcstmc(i)*	*i = 1,...,g.*	Purchasers' price of imported commodity *i* in inventory investment.
(26)	*pboxc(i) = pbadc(i) + wtcxpc(i)*	*i = 1,...,g.*	Border price of exports of commodity *i*.
(27)	*pk = ipiv*		Price of capital goods.
(28)	*vki(j) = pk + rri(j)*	*j = 1,...,g.*	Rental price of capital in industry *j*.
	<u>First-order conditions and constraints for the optimisation problem</u>		
(29)	*W1*aimci(i,j) = S_UIMCI_M(i,j)*lmpc(i) + lacimi(j)*	*j = 1,...,g,* *i = 1,...,g.*	Input-output coefficient for intermediate usage of commodity *i* by industry *j*.
(30)	*W1*aivc(i) = S_UIVC_M(i)*lmpc(i) + laciv*	*i = 1,...,g.*	Input-output coefficient for fixed investment usage of commodity *i*.
(31)	*W1*achc(i) = S_UCHC_M(i)*lmpc(i) + lacch*	*i = 1,...,g.*	Input-output coefficient for household consumption of commodity *i*.
(32)	*W1*acgc(i) = S_UCGC_M(i)*lmpc(i) + laccg*	*i = 1,...,g.*	Input-output coefficient for government consumption of commodity *i*.
(33)	*W1*afi(j) = lacimi(j)*	*j = 1,...,g.*	Input-output coefficient for primary factor employment by industry *j*.
(34)	*W2*aimdci(i,j) = lasimci(i,j)*	*j = 1,...,g,* *i = 1,...,g.*	Input-output coefficient for intermediate usage of domestic commodity *i* by industry *j*.
(35)	*W2*aimmci(i,j) = lmpc(i) + lasimci(i,j)*	*j = 1,...,g,* *i = 1,...,g.*	Input-output coefficient for intermediate usage of imported commodity *i* by industry *j*.
(36)	*W2*aivdc(i) = lasivc(i)*	*i = 1,...,g.*	Input-output coefficient for fixed investment usage of domestic commodity *i*.

TABLE B1: **The FIT equation system** (continued)

Number	*Equation*	*Subscript Range*	*Description*
(37)	*W2*aivmc(i) = lmpc(i) + lasivc(i)*	*i = 1,...,g.*	Input-output coefficient for fixed investment usage of imported commodity *i*.
(38)	*W2*achdc(i) = laschc(i)*	*i = 1,...,g.*	Input-output coefficient for household consumption of domestic commodity *i*.
(39)	*W2*achmc(i) = lmpc(i) + laschc(i)*	*i = 1,...,g.*	Input-output coefficient for household consumption of imported commodity *i*.
(40)	*W2*acgdc(i) = lascgc(i)*	*i = 1,...,g.*	Input-output coefficient for government consumption of domestic commodity *i*.
(41)	*W2*acgmc(i) = lmpc(i) + lascgc(i)*	*i = 1,...,g.*	Input-output coefficient for government consumption of imported commodity *i*.
(42)	*0 = SUM(i, COM, S_C_IC(i,j)*aimci(i,j)) + S_C_FI(j)*afi(j)*	*j = 1,...,g.*	Adding-up constraint for commodity composition of production in industry *j*.
(43)	*0 = SUM(i, COM, S_IV_C(i)*aivc(i))*		Adding-up constraint for commodity composition of fixed investment.
(44)	*0 = SUM(i, COM, S_CH_C(i)*achc(i))*		Adding-up constraint for commodity composition of household consumption.
(45)	*0 = SUM(i, COM, S_CG_C(i)*acgc(i))*		Adding-up constraint for commodity composition of government consumption.
(46)	*0 = S_UIMCI_D(i,j)*aimdci(i,j) + S_UIMCI_M(i,j)*aimmci(i,j)*	*j = 1,...,g,* *i = 1,...,g.*	Adding-up constraint for source composition of intermediate usage of commodity *i* by industry *j*.
(47)	*0 = S_UIVC_D(i)*aivdc(i) + S_UIVC_M(i)*aivmc(i)*	*i = 1,...,g.*	Adding-up constraint for source composition of fixed investment usage of commodity *i*.

TABLE B1: **The FIT equation system** (continued)

Number	*Equation*	*Subscript Range*	*Description*
(48)	0 = S_UCHC_D(i)*achdc(i) + S_UCHC_M(i)*achmc(i)	i = 1,...,g.	Adding-up constraint for source composition of household consumption of commodity *i*.
(49)	0 = S_UCGC_D(i)*acgdc(i) + S_UCGC_M(i)*acgmc(i)	i = 1,...,g.	Adding-up constraint for source composition of government consumption of commodity *i*.
	<u>Miscellaneous equations</u>		
(50)	eiv = SUM(i, COM, S_IV_DC(i)*(ppuivdc(i) + uivdc(i))) + SUM(i, COM, S_IV_MC(i)*(ppuivmc(i) + uivmc(i)))		Aggregate fixed investment expenditure.
(51)	ech = SUM(i, COM, S_CH_DC(i)*(ppuchdc(i) + uchdc(i))) SUM(i, COM, S_CH_MC(i)*(ppuchmc(i) + uchmc(i)))		Aggregate household consumption expenditure.
(52)	ecg = SUM(i, COM, S_CG_DC(i)*(ppucgdc(i) + ucgdc(i))) + SUM(i, COM, S_CG_MC(i)*(ppucgmc(i) + ucgmc(i)))		Aggregate government consumption expenditure.
(53)	expboc(i) = pboxc(i) + uxpc(i)	i = 1,...,g.	Border value of exports of commodity *i*.
(54)	empboc(i) = pbomc(i) + m(i)	i = 1,...,g.	Border value of imports of commodity *i*.
(55)	ipiv = SUM(i, COM, S_IV_DC(i)*ppuivdc(i)) + SUM(i, COM, S_IV_MC(i)*ppuivmc(i))		Price index for fixed investment.
(56)	ipch = SUM(i, COM, S_CH_DC(i)*ppuchdc(i)) + SUM(i, COM, S_CH_MC(i)*ppuchmc(i))		Price index for household consumption.

TABLE B1: **The FIT equation system** (continued)

Number	*Equation*	*Subscript Range*	*Description*
(57)	*ipcg* = *SUM(i, COM, S_CG_DC(i)*ppucgdc(i))* + *SUM(i, COM, S_CG_MC(i)*ppucgmc(i))*		Price index for government consumption.
(58)	*ipxp = SUM(i, COM, S_XP_C(i)*pboxc(i))*		Price index for exports.
(59)	*ipmp = SUM(i, COM, S_MP_C(i)*pbomc(i))*		Price index for imports.
(60)	*cippdgst* = *SUM(i, COM, S_PDG_STDC(i)*ppustdc(i))* + *SUM(i, COM, S_PDG_STMC(i)*ppustmc(i))*		Contribution of inventory investment prices to price index for gdp.
(61)	*ippdg* = *S_PDG_IV*ipiv + S_PDG_CH*ipch + S_PDG_CG*ipcg* + *S_PDG_XP*ipxp + cippdgst - S_PDG_MP*ipmp*		Price index for gdp.
(62)	*premc(i) = pbomc(i) - ippdg*	*i = 1,...,g.*	Price of imported commodity *i*, relative to gdp price index.

g Number of sectors

TABLE B2: Variables of the FIT equation system

Variable	*Subscript range*	*Description*	*Variable type*	*Treatment in condensation*
acgc(i)	*i = 1,...,g.*	Input-output coefficient for government consumption of commodity *i*.		S, (32)
acgdc(i)	*i = 1,...,g.*	Input-output coefficient for government consumption of domestic commodity *i*.		S, (40)
acgmc(i)	*i = 1,...,g.*	Input-output coefficient for government consumption of imported commodity *i*.		S, (41)
achc(i)	*i = 1,...,g.*	Input-output coefficient for household consumption of commodity *i*.		S, (31)
achdc(i)	*i = 1,...,g.*	Input-output coefficient for household consumption of domestic commodity *i*.		S, (38)
achmc(i)	*i = 1,...,g.*	Input-output coefficient for household consumption of imported commodity *i*.		S, (39)
afi(j)	*j = 1,...,g.*	Input-output coefficient for employment of primary factors by industry *j*.		S, (33)
aimci(i,j)	*i = 1,...,g,* *j = 1,...,g.*	Input-output coefficient for intermediate usage of commodity *i* in industry *j*.		S, (29)
aimdci(i,j)	*i = 1,...,g,* *j = 1,...,g.*	Input-output coefficient for intermediate usage of domestic commodity *i* in industry *j*.		S, (34)
aimmci(i,j)	*i = 1,...,g,* *j = 1,...,g.*	Input-output coefficient for intermediate usage of imported commodity *i* in industry *j*.		S, (35)
aivc(i)	*i = 1,...,g.*	Input-output coefficient for fixed investment usage of commodity *i*.		S, (30)
aivdc(i)	*i = 1,...,g.*	Input-output coefficient for fixed investment usage of domestic commodity *i*.		S, (36)
aivmc(i)	*i = 1,...,g.*	Input-output coefficient for fixed investment usage of imported commodity *i*.		S, (37)
cippdgst		Contribution of inventory investment prices to gdp price index.		
ecg		Government consumption expenditure.		
ech		Household consumption expenditure.		
eiv		Fixed investment expenditure.		
empboc(i)	*i = 1,...,g.*	Border value of imports of commodity *i*.		
expboc(i)	*i = 1,...,g.*	Border value of exports of commodity *i*.		
eki(j)	*j = 1,...,g.*	Employment of capital by industry *j*.		

TABLE B2: **Variables of the FIT equation system** (continued)

Variable	*Subscript range*	*Description*	*Variable type*	*Treatment in condensation*
eli(j)	*j = 1,...,g.*	Employment of labour by industry *j*.		
eni(j)	*j = 1,..,g.*	Employment of land by industry *j*.		
ipcg		Price index for government consumption.		
ipch		Price index for household consumption.		
ipiv		Price index for fixed investment.		
ippdg		Price index for gdp.		
ipxp		Price index for exports.		
ipmp		Price index for imports.		
laccg		Lagrange multiplier associated with adding-up constraint on commodity composition of government consumption.	A	S, (45)
lacch		Lagrange multiplier associated with adding-up constraint on commodity composition of household consumption.	A	S, (44)
lacimi(j)	*j = 1,...,g.*	Lagrange multiplier associated with adding-up constraint on commodity structure of production in industry *j*.	A	S, (42)
laciv		Lagrange multiplier associated with adding-up constraint on commodity composition of fixed investment.	A	S, (43)
lascgc(i)	*i = 1,...,g.*	Lagrange multiplier associated with adding-up constraint on source composition of government consumption of commodity *i*.	A	S, (49)
laschc(i)	*i = 1,...,g.*	Lagrange multiplier associated with adding-up constraint on source composition of household consumption of commodity *i*.	A	S, (48)
lasimci(i,j)	*j = 1,...,g,* *i = 1,...,g.*	Lagrange multiplier associated with adding-up constraint on source composition of intermediate usage of commodity *i* in industry *j*.	A	S, (46)
lasivc(i)	*i = 1,...,g.*	Lagrange multiplier associated with adding-up constraint on source composition of fixed investment usage of commodity *i*.	A	S, (47)
lmpc(i)	*i = 1,...,g.*	Lagrange multiplier associated with constraint on imports of commodity *i*.	A	
m(i)	*i = 1,...,g.*	Imports of commodity *i*.		

TABLE B2: **Variables of the FIT equation system** (continued)

Variable	*Subscript range*	*Description*	*Variable type*	*Treatment in condensation*
o(i)	*i = 1,...,g.*	Domestic output of commodity *i*.		
pbadc(i)	*i = 1,...,g.*	Basic price of domestic commodity *i*.		
pbamc(i)	*i = 1,...,g.*	Basic price of imported commodity *i*.		
pboxc(i)	*i = 1,...,g.*	Border price of exports of commodity *i*.		
pbomc(i)	*i = 1,...,g.*	Border price of imports of commodity *i*.		
pk		Price of capital goods.		
ppucgdc(i)	*i = 1,...,g.*	Purchasers' price of domestic commodity *i* in government consumption.		S, (22)
ppucgmc(i)	*i = 1,...,g.*	Purchasers' price of imported commodity *i* in government consumption.		S, (23)
ppuchdc(i)	*i = 1,...,g.*	Purchasers' price of domestic commodity *i* in household consumption.		S, (20)
ppuchmc(i)	*i = 1,...,g.*	Purchasers' price of imported commodity *i* in household consumption.		S, (21)
ppuimdci(j,i)	*j = 1,...,g,* *i = 1,...,g.*	Purchasers' price of domestic commodity *i* in intermediate usage by industry *j*.		S, (16)
ppuimmi(j,i)	*j = 1,...,g,* *i = 1,...,g.*	Purchasers' price of imported commodity *i* in intermediate usage by industry *j*.		S, (17)
ppuivdc(i)	*i = 1,...,g.*	Purchasers' price of domestic commodity *i* in fixed investment.		S, (18)
ppuivmc(i)	*i = 1,...,g.*	Purchasers' price of imported commodity *i* in fixed investment.		S, (19)
ppustdc(i)	*i = 1,...,g.*	Purchasers' price of domestic commodity *i* in inventory investment.		S, (24)
ppustmc(i)	*i = 1,...,g.*	Purchasers' price of imported commodity *i* in inventory investment.		S, (25)
premc(i)	*i = 1,...,g.*	Ratio of border price of imports of commodity *i* to gdp price index.		
rri(j)	*j = 1,...,g.*	Rate of return on capital in industry *j*.		
ucgdc(i)	*i = 1,...,g.*	Government consumption of domestic commodity *i*.		
ucgmc(i)	*i = 1,...,g.*	Government consumption of imported commodity *i*.		

TABLE B2: **Variables of the FIT equation system** (continued)

Variable	*Subscript range*	*Description*	*Variable type*	*Treatment in condensation*
uchdc(i)	*i = 1,...,g.*	Household consumption of domestic commodity *i*.		
uchmc(i)	*i = 1,...,g.*	Household consumption of imported commodity *i*.		
uimdci(i,j)	*i = 1,...,g,* *j = 1,...,g.*	Intermediate usage of domestic commodity *i* by industry *j*.		S, (1)
uimmci(i,u)	*i = 1,...,g,* *j = 1,...,g.*	Intermediate usage of imported commodity *i* by industry *j*.		S, (2)
ustdc(i)	*i = 1,...,g.*	Ratio of inventory investment usage to total usage of domestic commodity *i*.	A	
ustmc(i)	*i = 1,...,g.*	Ratio of inventory investment usage to total usage of imported commodity *i*.	A	
uxpc(i)	*i = 1,...,g.*	Exports of commodity *i*.		
vki(j)	*j = 1,...,g.*	Price of capital services employed by industry *j*.		
vl		Wage rate.		
vn		Price of land services.		
wtccgdc(i)	*i = 1,...,g.*	Power of commodity tax on government consumption of domestic commodity *i*.		
wtccgmc(i)	*i = 1,...,g.*	Power of commodity tax on government consumption of imported commodity *i*.		
wtcchdc(i)	*i = 1,...,g.*	Power of commodity tax on household consumption of domestic commodity *i*.		
wtcchmc(i)	*i = 1,...,g.*	Power of commodity tax on household consumption of imported commodity *i*.		
wtcimdc(j,i)	*j = 1,...,g,* *i = 1,...,g.*	Power of commodity tax on intermediate usage of domestic commodity *i* by industry *j*.		
wtcimmc(j,i)	*j = 1,...,g,* *i = 1,...,g.*	Power of commodity tax on intermediate usage of imported commodity *i* by industry *j*.		
wtcivdc(i)	*i = 1,...,g.*	Power of commodity tax on fixed investment usage of domestic commodity *i*.		
wtcivmc(i)	*i = 1,...,g.*	Power of commodity tax on fixed investment usage of imported commodity *i*.		

TABLE B2: **Variables of the FIT equation system** (continued)

Variable	*Subscript range*	*Description*	*Variable type*	*Treatment in condensation*
wtcmpc(i)	*i = 1,...,g.*	Power of the import tariff on commodity *i*.		
wtpi(j)	*j = 1,...,g.*	Power of the production tax on industry *j*.		

A Absolute change variable

g Number of sectors

S, (*n*) Eliminated by substitution using equation (*n*)

TABLE B3: Coefficients and parameters of the FIT equation system

Equation(s)	*Coefficient or parameter*	*Description*
(12)	*S_O_IMCI(i,j)*	Share of intermediate usage by industry *j* in usage of domestic commodity *i*.
(12)	*S_O_IVC(i)*	Share of fixed investment in usage of domestic commodity *i*.
(12)	*S_O_CHC(i)*	Share of household consumption in usage of domestic commodity *i*.
(12)	*S_O_CHG(i)*	Share of government consumption in usage of domestic commodity *i*.
(12)	*S_O_XPC(i)*	Share in exports in usage of domestic commodity *i*.
(12)	*S_O_STC(i)*	Share of inventory investment in usage of domestic commodity *i*.
(13)	*S_M_IMCI(i,j)*	Share of intermediate usage by industry *j* in usage of imported commodity *i*.
(13)	*S_M_IVC(i)*	Share of fixed investment in usage of imported commodity *i*.
(13)	*S_M_CHC(i)*	Share of household consumption in usage of imported commodity *i*.
(13)	*S_M_CHG(i)*	Share of government consumption in usage of imported commodity *i*.
(13)	*S_M_STC(i)*	Share of inventory investment in usage of imported commodity *i*.
(14)	*S_C_DIC(i,j)*	Share of intermediate usage of domestic commodity *i* in costs of industry *j*.
(14)	*S_C_MIC(i,j)*	Share of intermediate usage of imported commodity *i* in costs of industry *j*.
(14)	*S_C_LI(j)*	Share of employment of labour in costs of industry *j*.
(14)	*S_C_KI(j)*	Share of employment of capital in costs of industry *j*.
(14)	*S_C_NI(j)*	Share of employment of land in costs of industry *j*.
(29-33)	*W1*	Weight attached to information about the upper level of the input-output structure.
(29, 46)	*S_UIMCI_M(i,j)*	Share of imports in cost of intermediate usage of commodity *i* by industry *j*.
(30, 47)	*S_UIVC_M(i)*	Share of imports in fixed investment expenditure on commodity *i*.
(31, 48)	*S_UCHC_M(i)*	Share of imports in household consumption expenditure on commodity *i*.
(32, 49)	*S_UCGC_M(i)*	Share of imports in government consumption expenditure on commodity *i*.
(34-41)	*W2*	Weight attached to information about the lower level of the input-output structure.

TABLE B3: **Coefficients and parameters of the FIT equation system (continued)**

Equation(s)	*Coefficient or parameter*	*Description*
(42)	*S_C_IC(i,j)*	Share of intermediate usage of commodity *i* in costs of industry *j*.
(42)	*S_C_FI(j)*	Share of employment of primary factors in costs of industry *j*.
(43)	*S_IV_C(i)*	Share of commodity *i* in fixed investment expenditure.
(44)	*S_CH_C(i)*	Share of commodity *i* in household consumption expenditure.
(45)	*S_CG_C(i)*	Share of commodity *i* in government consumption expenditure.
(46)	*S_UIMCI_D(i,j)*	Share of domestic product in cost of intermediate usage of commodity *i* by industry *j*.
(47)	*S_UIVC_D(i)*	Share of domestic product in fixed investment expenditure on commodity *i*.
(48)	*S_UCHC_D(i)*	Share of domestic product in household consumption expenditure on commodity *i*.
(49)	*S_UCGC_D(i)*	Share of domestic product in government consumption expenditure on commodity *i*.
(50, 55)	*S_IV_DC(i)*	Share of domestic commodity *i* in fixed investment expenditure.
(50, 55)	*S_IV_MC(i)*	Share of imported commodity *i* in fixed investment expenditure.
(51, 56)	*S_CH_DC(i)*	Share of domestic commodity *i* in household consumption expenditure.
(51, 56)	*S_CH_MC(i)*	Share of imported commodity *i* in household consumption expenditure.
(52, 57)	*S_CG_DC(i)*	Share of domestic commodity *i* in government consumption expenditure.
(52, 57)	*S_CG_MC(i)*	Share of imported commodity *i* in government consumption expenditure.
(58)	*S_XP_C(i)*	Share of commodity *i* in border value of exports.
(59)	*S_MP_C(i)*	Share of commodity *i* in border value of imports.
(60)	*S_PDG_STDC(i)*	Share of inventory investment usage of domestic commodity *i* in expenditure on gross domestic product.
(60)	*S_PDG_STMC(i)*	Share of inventory investment usage of imported commodity *i* in expenditure on gross domestic product.
(61)	*S_PDG_IV*	Share of fixed investment in expenditure on gross domestic product.

TABLE B3: **Coefficients and parameters of the FIT equation system (continued)**

Equation(s)	*Coefficient or parameter*	*Description*
(61)	*S_PDG_CH*	Share of household consumption in expenditure on gross domestic product.
(61)	*S_PDG_CG*	Share of government consumption in expenditure on gross domestic product.
(61)	*S_PDG_X*	Share of exports in expenditure on gross domestic product.
(61)	*S_PDG_MP*	Ratio of border value of imports to expenditure on gross domestic product.

g Number of sectors

Appendix C: Header array structures for files input into FIT

This appendix describes the structure of the two files read by FIT: the single-region input-output table and the region-generic data file. Both these files are formatted as header-array files (Mikkelsen and Pearson, 1986). Table C1 lists the headers in the single-region input-output tables, and Table C2 the headers in the region-generic data file.

Table C1: Header arrays for single-region input-output tables

Header	*Dimension*	*Description*
AI01	g * g	Intermediate usage of domestic products, by commodity and industry
AI02	g * g	Intermediate usage of imports, by commodity and industry
AI03	g	Investment usage of domestic products, by commodity
AI04	g	Investment usage of imports, by commodity
AI05	g	Household consumption of domestic products, by commodity
AI06	g	Household consumption of imports, by commodity
AI07	g	Government consumption of domestic products, by commodity
AI08	g	Government consumption of imports, by commodity
AI09	g	Change in stocks of domestic products, by commodity
AI10	g	Change in stocks of imports, by commodity
AI11	g	Exports, by commodity
AI12	g	Non-commodity indirect taxes, net, by industry
AI13	g	Employment of labour, by industry
AI14	g	Employment of capital, by industry
AI15	g	Employment of land, by industry
AI16	g * g	Commodity tax on intermediate usage of domestic products, by commodity and industry
AI17	g * g	Commodity tax on intermediate usage of imports, by commodity and industry
AI18	g	Commodity tax on household consumption of domestic products, by commodity
AI19	g	Commodity tax on household consumption of imports, by commodity
AI20	g	Commodity tax on investment usage of domestic products, by commodity
AI21	g	Commodity tax on investment usage of imports, by commodity
AI22	g	Commodity tax on government usage of domestic products, by commodity
AI23	g	Commodity tax on government usage of imports, by commodity
AI24	g	Commodity tax on exports, by commodity
AI25	g	Commodity tax on change in stocks of domestic products, by commodity
AI26	g	Commodity tax on change in stocks of imports, by commodity
AI27	g	Import duty, by commodity

g Number of sectors.

Table C2: Header arrays for the region-generic data file

Header	*Dimension*	*Element*	*Description*	*Comment*
G001	1	1	Number of sectors.	
G002	2	1	Weight attached to the original individual-region input-output structure.	Not used in FIT.[a]
		2	Weight attached to the representative input-output structure.	Not used in FIT.[a]
G003	2	1	Weight attached to information about the upper level of the input-output structure.	
		2	Weight attached to information about the lower level of the input-output structure.	

[a] Used in program AVERAGE (Calder *et al.*, forthcoming).

Appendix D: TABLO source code for FIT

```
!*****************************************************************************
******************************************************************************
**                                                                          **
**                                                                          **
**          FIT: AN INPUT-OUTPUT DATA UPDATE FACILITY FOR SALTER            **
**                                                                          **
**                                                                          **
******************************************************************************
*****************************************************************************!


! This file contains the TABLO source code for FIT, a facility for updating
  input-output tables. FIT is designed to assist in the later stage
  processing of the single-region input-output tables incorporated into the
  SALTER database.

  The code was written for use with GEMPACK version 4.3. It was written
  originally by Marianne James in February 1992, and revised for publication
  by Robert McDougall in December 1992.

  Contents:
  1. Files
  2. Sets
  3. Coefficients read from the database
  4. Intermediate coefficients
  5. Coefficients appearing in equations or update statements
  6. Variables
  7. Equations
  8. Updates                                                                 !


!*****************************************************************************

  1. FILES

*****************************************************************************!


FILE                                              DATIO
  # single-region input-output table #;
```

```
FILE                                                    GEN
   # region-generic data #;

!*******************************************************************************

   2.  SETS

*******************************************************************************!

COEFFICIENT (INTEGER)                                   NO_IND
   # number of sectors #;
READ NO_IND FROM FILE GEN HEADER                                    "G001";
SET                                                     IND
   # sectors # MAXIMUM SIZE 40 SIZE NO_IND;

SET                                                     LEVEL
   # levels of the input-output structure #
   (upper, lower);
   ! The upper level of the input-output structure relates commodity and
     primary factor usage to industry outputs and aggregate final demands.
     The lower level relates domestic product and import usage to
     commodity usage. !

!*******************************************************************************

   3.  COEFFICIENTS READ FROM THE DATABASE

*******************************************************************************!

!  Contents:
   3.1.  Commodity usage
   3.2.  Factor employment
   3.3.  Indirect taxes
   3.4.  Weights used in defining the objective function in the
         optimisation module                                !
```

```
!==========================================================================

   3.1. Commodity usage

==========================================================================!


!  Data are for basic values.                                  !

COEFFICIENT (ALL, i, IND) (ALL, j, IND)                 DINT(i,j)
   # intermediate usage of domestic commodity i by industry j #;
READ DINT FROM FILE DATIO HEADER                        "AI01";

COEFFICIENT (ALL, i, IND) (ALL, j, IND)                 IINT(i,j)
    # intermediate usage of imported commodity i by industry j #;
READ IINT FROM FILE DATIO HEADER                                      "AI02";

COEFFICIENT (ALL, i, IND)                               DINV(i)
   # fixed investment usage of domestic commodity i #;
READ DINV FROM FILE DATIO HEADER                                      "AI03";

COEFFICIENT (ALL, i, IND)                               IINV(i)
   #  fixed investment usage of imported commodity i #;
READ IINV FROM FILE DATIO HEADER                                      "AI04";

COEFFICIENT (ALL, i, IND)                               DCON(i)
   # household consumption of domestic commodity i #;
READ DCON FROM FILE DATIO HEADER                                      "AI05";

COEFFICIENT (ALL, i, IND)                               ICON(i)
   # household consumption of imported commodity i #;
READ ICON FROM FILE DATIO HEADER                                      "AI06";

COEFFICIENT (ALL, i, IND)                               DGOV(i)
   # government consumption of domestic commodity i #;
READ DGOV FROM FILE DATIO HEADER                                      "AI07";

COEFFICIENT (ALL, i, IND)                               IGOV(i)
   # government consumption of imported commodity i #;
READ IGOV FROM FILE DATIO HEADER                                      "AI08";

COEFFICIENT (ALL, i, IND)                               EXP_(i)
   # exports of commodity i #;
READ EXP_ FROM FILE DATIO HEADER                                      "AI11";
```

```
COEFFICIENT (ALL, i, IND)                                  DSTK(i)
    # change in stocks of domestic commodity i #;
READ DSTK FROM FILE DATIO HEADER                                      "AI09";

COEFFICIENT (ALL, i, IND)                                  ISTK(i)
    # change in stocks of imported commodity i #;
READ ISTK FROM FILE DATIO  HEADER                                     "AI10";


!========================================================================

   3.2.  Factor employment

========================================================================!


COEFFICIENT (ALL, j, IND)                                  LAB(j)
    # employment of labour by industry j #;
READ LAB FROM FILE DATIO HEADER                                       "AI13";

COEFFICIENT (ALL, j, IND)                                  CAP(j)
    # employment of capital by industry j #;
READ CAP FROM FILE DATIO HEADER                                       "AI14";

COEFFICIENT (ALL, j, IND)                                  LAND(j)
    # employment of land by industry j #;
READ LAND FROM FILE DATIO HEADER                                      "AI15";


!========================================================================

   3.3.  Indirect taxes

========================================================================!


!  Abbreviation:
   CT  commodity tax                                       !

COEFFICIENT (ALL, i, IND)                                  TSR(i)
   # production tax on industry j #;
READ TSR FROM FILE DATIO HEADER                                       "AI12";
```

```
COEFFICIENT (ALL, i, IND) (ALL, j, IND)              TRD(i,j)
   # CT on intermediate usage of domestic commodity i by industry j #;
READ TRD FROM FILE DATIO HEADER                                    "AI16";

COEFFICIENT (ALL, i, IND) (ALL, j, IND)              TRI(i,j)
   # CT on intermediate usage of imported commodity i by industry j #;
READ TRI FROM FILE  DATIO HEADER                                   "AI17";

COEFFICIENT (ALL, i, IND)                            TCRD(i)
   # CT on household consumption of domestic commodity i #;
READ TCRD FROM FILE DATIO HEADER                                   "AI18";

COEFFICIENT (ALL, i, IND)                            TCRI(i)
   # CT on household consumption of imported commodity i #;
READ TCRI FROM FILE DATIO HEADER                                   "AI19";

COEFFICIENT (ALL, i, IND)                            TIRD(i)
   # CT on fixed investment usage of domestic commodity i #;
READ TIRD FROM FILE DATIO HEADER                                   "AI20";

COEFFICIENT (ALL, i, IND)                            TIRI(i)
   # CT on fixed investment usage of imported commodity i #;
READ TIRI FROM FILE DATIO HEADER                                   "AI21";

COEFFICIENT (ALL, i, IND)                            TGRD(i)
   # CT on government consumption of domestic commodity i #;
READ TGRD FROM FILE DATIO HEADER                                   "AI22";

COEFFICIENT (ALL, i, IND)                            TGRI(i)
   # CT on government consumption of imported commodity i #;
READ TGRI FROM FILE DATIO HEADER                                   "AI23";

COEFFICIENT (ALL, i, IND)                            TER(i)
   # CT on exports of commodity i #;
READ TER FROM FILE DATIO HEADER                                    "AI24";

COEFFICIENT (ALL, i, IND)                            TDSTK(i)
   # CT on inventory investment usage of domestic commodity i #;
READ TDSTK FROM FILE DATIO  HEADER                                 "AI25";

COEFFICIENT (ALL, i, IND)                            TISTK(i)
   # CT on inventory investment usage of imported commodity i #;
READ TISTK FROM FILE DATIO  HEADER                                 "AI26";
```

```
COEFFICIENT (ALL, i, IND)                                  DTY(i)
    # duty on imports of commodity i #;
READ DTY FROM FILE DATIO HEADER                                      "AI27";


!==========================================================================

   3.4. Weights used in defining the objective function in the
        optimisation module

==========================================================================!


!  Abbreviation:
   IO  input-output                                       !

COEFFICIENT (ALL, W, LEVEL)                                WT(W);
READ WT FROM FILE GEN HEADER                                         "G003";

COEFFICIENT                                                W1
   # weight on information about the upper level of the IO structure #;
FORMULA
   W1 = WT("upper");

COEFFICIENT                                                W2
   # weight on information about the lower level of the IO structure #;
FORMULA
   W2 = WT("lower");


!**************************************************************************

   4.  INTERMEDIATE COEFFICIENTS

**************************************************************************!


!  Contents:
   4.1.  Values at purchasers' prices
   4.2.  Values aggregated over sources
   4.3.  Sector aggregates
   4.4.  Macroeconomic aggregates                           !
```

```
!==========================================================================

    4.1. Values at purchasers' prices

==========================================================================!


!   These coefficients are used in:
    - formulae for values aggregated over sources,
    - formulae for macroeconomic aggregates,
    - formulae for shares of domestic and imported commodities in industry
      costs,
    - formulae for import and domestic sales shares,
    - formulae for shares of domestic and imported commodities in final demand
      expenditures,
    - formulae for inventory investment shares in expenditure on GDP,
      and
    - updates for indirect taxes.

    Abbreviation:
    VPP   value at purchasers' prices                       !

COEFFICIENT (ALL, j, IND) (ALL, i, IND)             DINTUSE(i,j)
    # VPP of intermediate usage of domestic commodity i by industry j #;
FORMULA (ALL, j, IND) (ALL, i, IND)
    DINTUSE(i,j) = DINT(i,j) + TRD(i,j);

COEFFICIENT (ALL, j, IND) (ALL, i, IND)             MINTUSE(i,j)
    # VPP of intermediate usage of imported commodity i by industry j #;
FORMULA (ALL, j, IND) (ALL, i, IND)
    MINTUSE(i,j) = IINT(i,j) + TRI(i,j);

COEFFICIENT (ALL, i, IND)                           DINVUSE(i)
    # VPP of fixed investment usage of domestic commodity i #;
FORMULA (ALL, i, IND)
    DINVUSE(i) = DINV(i) + TIRD(i);

COEFFICIENT (ALL, i, IND)                           MINVUSE(i)
    # VPP of fixed investment usage of imported commodity i #;
FORMULA (ALL, i, IND)
    MINVUSE(i) = IINV(i) + TIRI(i);

COEFFICIENT (ALL, i, IND)                           DCHUSE(i)
    # VPP of household consumption of domestic commodity i #;
```

```
FORMULA (ALL, i, IND)
   DCHUSE(i) = DCON(i) + TCRD(i);

COEFFICIENT (ALL, i, IND)                                   MCHUSE(i)
   # VPP of household consumption of imported commodity i #;
FORMULA (ALL, i, IND)
   MCHUSE(i) = ICON(i) + TCRI(i);

COEFFICIENT (ALL, i, IND)                                   DCGUSE(i)
   # VPP of government consumption of domestic commodity i #;
FORMULA (ALL, i, IND)
   DCGUSE(i) = DGOV(i) + TGRD(i);

COEFFICIENT (ALL, i, IND)                                   MCGUSE(i)
   # VPP of government consumption of imported commodity i #;
FORMULA (ALL, i, IND)
   MCGUSE(i) = IGOV(i) + TGRI(i);

COEFFICIENT (ALL, i, IND)                                   DXPUSE(i)
   # value at border prices of exports of commodity i #;
FORMULA (ALL, i, IND)
   DXPUSE(i) = EXP_(i) + TER(i);

COEFFICIENT (ALL, i, IND)                                   DSTUSE(i)
   # VPP of change in stocks of domestic commodity i #;
FORMULA (ALL, i, IND)
   DSTUSE(i) = DSTK(i) + TDSTK(i);

COEFFICIENT (ALL, i, IND)                                   MSTUSE(i)
   # VPP of change in stocks of imported commodity i #;
FORMULA (ALL, i, IND)
   MSTUSE(i) = ISTK(i) + TISTK(i);


!==========================================================================

   4.2. Values aggregated over sources

==========================================================================!


! Abbreviation:
  VPP   value at purchasers' prices                       !
```

```
COEFFICIENT (ALL, j, IND) (ALL, i, IND)                    INTUSE(i,j)
   # VPP of intermediate usage of commodity i by industry j #;
FORMULA (ALL, j, IND) (ALL, i, IND)
   INTUSE(i,j) = DINTUSE(i,j) + MINTUSE(i,j);

COEFFICIENT (ALL, i, IND)                                  INVUSE(i)
   # VPP of fixed investment usage of commodity i #;
FORMULA (ALL, i, IND)
   INVUSE(i) = DINVUSE(i) + MINVUSE(i);

COEFFICIENT (ALL, i, IND)                                  CHUSE(i)
   # VPP of household consumption of commodity i #;
FORMULA (ALL, i, IND)
   CHUSE(i) = DCHUSE(i) + MCHUSE(i);

COEFFICIENT (ALL, i, IND)                                  CGUSE(i)
   # VPP of government consumption of commodity i #;
FORMULA (ALL, i, IND)
   CGUSE(i) = DCGUSE(i) + MCGUSE(i);

COEFFICIENT (ALL, i, IND)                                  STUSE(i)
   # VPP of change in stocks of commodity i #;
FORMULA (ALL, i, IND)
   STUSE(i) = DSTUSE(i) + MSTUSE(i);


!==============================================================================

   4.3. Sector aggregates

==============================================================================!


COEFFICIENT (ALL, i, IND)                                  DOMPN(i)
   # total usage of domestic commodity i, basic value #;
FORMULA (ALL, i, IND)
   DOMPN(i)
  = SUM(j, IND, DINT(i,j)) + DINV(i) + DCON(i) + DGOV(i) + EXP_(i) +
    DSTK(i);

COEFFICIENT (ALL, i, IND)                                  VALIMP(i)
   # total usage of imported commodity i, basic value #;
FORMULA (ALL, i, IND)
   VALIMP(i)
```

```
  = SUM(j, IND, IINT(i,j)) + IINV(i) + ICON(i) + IGOV(i) + ISTK(i);

COEFFICIENT (ALL, i, IND)                                    VALIMPBOR(i)
   # imports of commodity i, border value #;
FORMULA (ALL, i, IND)
   VALIMPBOR(i)
  = VALIMP(i) - DTY(i);

COEFFICIENT (ALL, j, IND)                                    COSTINPFAC(j)
   # primary factor employment by industry j #;
FORMULA (ALL, j, IND)
   COSTINPFAC(j) = LAB(j) + CAP(j) + LAND(j);

COEFFICIENT (ALL, j, IND)                                    COSTINP(j)
   # total costs of industry j, excluding production tax #;
FORMULA (ALL, j, IND)
   COSTINP(j)
  = SUM(i, IND, INTUSE(i,j)) + COSTINPFAC(j);


!===============================================================================

   4.4. Macroeconomic aggregates

===============================================================================!


COEFFICIENT                                                  INVTT
   # fixed investment expenditure #;
FORMULA
   INVTT
  = SUM(i, IND, INVUSE(i));

COEFFICIENT                                                  ECHL
   # household consumption expenditure #;
FORMULA
   ECHL
  = SUM(i, IND, CHUSE(i));

COEFFICIENT                                                  ECGL
   # government consumption expenditure #;
FORMULA
   ECGL
  = SUM(i, IND, CGUSE(i));
```

```
COEFFICIENT                                                  EXPL
   # border value of exports #;
FORMULA
   EXPL = SUM(i, IND, DXPUSE(i));

COEFFICIENT                                                  ESTL
   # inventory investment expenditure #;
FORMULA
   ESTL
  = SUM(i, IND, STUSE(i));

COEFFICIENT                                                  EMPL
   # border value of imports #;
FORMULA
   EMPL
  = SUM(i, IND, VALIMPBOR(i));

COEFFICIENT                                                  EPDGL
   # expenditure on GDP #;
FORMULA
   EPDGL = INVTT + ECHL + ECGL + EXPL + ESTL - EMPL;


!*******************************************************************************

   5. COEFFICIENTS APPEARING IN EQUATIONS OR UPDATE STATEMENTS

*******************************************************************************!


!  Coefficients are grouped according to the equations or updates in
   which they appear.

   Contents:
   5.1. Shares in total usage of domestic and imported commodities
   5.2. Shares of domestic and imported commodities and individual
        primary factors in industry costs
   5.3. Import and domestic sales shares
   5.4. Shares of commodities and total primary factors in industry
        costs and final demand expenditures
   5.5. Shares of domestic and imported commodities in final demand
        expenditures
   5.6. Inventory investment shares in expenditure on GDP
```

```
    5.7. Final demand shares in expenditure on GDP
    5.8. Coefficients introduced for update statements              !


!==============================================================================

    5.1. Shares in total usage of domestic and imported commodities

==============================================================================!


!  These shares are used in the equations for total usage of each
   domestic and imported commodity, equations (12) and (13) of the input-
   output quantity model.

   The shares are calculated using basic values.

   Abbreviations:
   comm.  commodity
   dom.   domestic
   imp.   imported
   ind.   industry                                  !

COEFFICIENT                                              INVNOINDPF
   # zerodivide default value for shares in total usage of domestic comm's #;
FORMULA
 INVNOINDPF = 1/( NO_IND + 5);
ZERODIVIDE (ZERO_BY_ZERO) DEFAULT INVNOINDPF;

COEFFICIENT (ALL, i, IND) (ALL, j, IND)                  S_O_IMCI(i,j)
   # share of intermediate usage by ind. j in total sales of dom. comm. i #;
FORMULA (ALL, i, IND) (ALL, j, IND)
   S_O_IMCI(i,j) = DINT(i,j)/DOMPN(i);

COEFFICIENT (ALL, i, IND)                                S_O_IVC(i)
   # share of fixed investment in total sales of domestic commodity i #;
FORMULA (ALL, i, IND)
   S_O_IVC(i) = DINV(i)/DOMPN(i);

COEFFICIENT (ALL, i, IND)                                S_O_CHC(i)
   # share of household consumption in total sales of domestic commodity i #;
FORMULA (ALL, i, IND)
   S_O_CHC(i) = DCON(i)/DOMPN(i);
```

```
COEFFICIENT (ALL, i, IND)                                    S_O_XPC(i)
   # share of exports in total sales of domestic commodity i #;
FORMULA (ALL, i, IND)
   S_O_XPC(i) = EXP_(i)/DOMPN(i);

COEFFICIENT (ALL, i, IND)                                    S_O_CGC(i)
   # share of government consumption in total sales of domestic commodity i #;
FORMULA (ALL, i, IND)
   S_O_CGC(i) = DGOV(i)/DOMPN(i);

COEFFICIENT (ALL, i, IND)                                    S_O_STC(i)
   # share of inventory investment in total sales of domestic commodity i #;
FORMULA (ALL, i, IND)
   S_O_STC(i) = DSTK(i)/DOMPN(i);

COEFFICIENT                                                  INVNOINDPFR
   # zerodivide default value for shares in total usage of imported comm's #;
FORMULA
   INVNOINDPFR = 1/(NO_IND + 4);
ZERODIVIDE (ZERO_BY_ZERO) DEFAULT INVNOINDPFR;

COEFFICIENT (ALL, i, IND) (ALL, j, IND)                      S_M_IMCI(i,j)
   # share of intermediate usage by ind. j in total sales of imp. comm. i #;
FORMULA (ALL, i, IND) (ALL, j, IND)
   S_M_IMCI(i,j) = IINT(i,j)/VALIMP(i);

COEFFICIENT (ALL, i, IND)                                    S_M_IVC(i)
   # share of fixed investment in total sales of imported commodity i #;
FORMULA (ALL, i, IND)
   S_M_IVC(i) = IINV(i)/VALIMP(i);

COEFFICIENT (ALL, i, IND)                                    S_M_CHC(i)
   # share of household consumption in total sales of imported commodity i #;
FORMULA (ALL, i, IND)
   S_M_CHC(i) = ICON(i)/VALIMP(i);

COEFFICIENT (ALL, i, IND)                                    S_M_CGC(i)
   # share of government consumption in total sales of imported commodity i #;
FORMULA (ALL, i, IND)
   S_M_CGC(i) = IGOV(i)/VALIMP(i);

COEFFICIENT (ALL, i, IND)                                    S_M_STC(i)
   # share of inventory investment in total sales of imported commodity i #;
FORMULA (ALL, i, IND)
```

```
   S_M_STC(i) = ISTK(i)/VALIMP(i);

!=========================================================================

   5.2. Shares of domestic and imported commodities and individual
        primary factors in industry costs

=========================================================================!

! These shares are used in the zero profits condition for domestic
  production, equation (14) in the input-output price model.

  The shares are calculated as shares in costs excluding production tax.
  Commodity usage is valued at purchasers' prices.

  Abbreviations:
  comm.  commodity
  dom.  domestic
  imp.  imported
  ind.  industry                                  !

COEFFICIENT                                               INVNOINDTT
   # zerodivide default value for shares in production costs #;
FORMULA
   INVNOINDTT = 1/(2*NO_IND + 3);
ZERODIVIDE (ZERO_BY_ZERO) DEFAULT INVNOINDTT;

COEFFICIENT (ALL, i, IND) (ALL, j, IND)                   S_C_DIC(i,j)
   # share of intermediate usage of dom. comm. i in total costs of ind. j #;
FORMULA (ALL, i, IND) (ALL, j, IND)
   S_C_DIC(i,j) = DINTUSE(i,j)/COSTINP(j);

COEFFICIENT (ALL, i, IND) (ALL, j, IND)                   S_C_MIC(i,j)
   # share of intermediate usage of imp. comm. i in total costs of ind. j #;
FORMULA (ALL, i, IND) (ALL, j, IND)
   S_C_MIC(i,j) = MINTUSE(i,j)/COSTINP(j);

COEFFICIENT (ALL, j, IND)                                 S_C_LI(j)
   # share of employment of labour in total costs of industry j #;
FORMULA (ALL, j, IND)
   S_C_LI(j) = LAB(j)/COSTINP(j);
```

```
COEFFICIENT (ALL, j, IND)                              S_C_KI(j)
   # share of employment of capital in total costs of industry j #;
FORMULA (ALL, j, IND)
   S_C_KI(j) = CAP(j)/COSTINP(j);

COEFFICIENT (ALL, j, IND)                              S_C_NI(j)
   # share of employment of land in total costs of industry j #;
FORMULA (ALL, j, IND)
   S_C_NI(j) = LAND(j)/COSTINP(j);


!============================================================================

   5.3. Import and domestic sales shares

============================================================================!


!  These shares are used in the upper-level first-order conditions and
   the lower-level adding-up constraints, equations (29)-(32) and (46)-(49)
   in the optimisation module.

   The shares are calculated using values at purchasers' prices.

   Abbreviations:
   comm.      commodity
   dom. prod.  domestic product
   expend.    expenditure
   ind.       industry                                  !

ZERODIVIDE (ZERO_BY_ZERO) DEFAULT 0.5;

COEFFICIENT (ALL, i, IND) (ALL, j, IND)                S_UIMCI_D(i,j)
   # share of dom. prod. in cost of intermediate usage of comm. i by ind. j #;
FORMULA (ALL, i, IND) (ALL, j, IND)
   S_UIMCI_D(i,j) = DINTUSE(i,j)/INTUSE(i,j);

COEFFICIENT (ALL, i, IND) (ALL, j, IND)                S_UIMCI_M(i,j)
   # share of imports in cost of intermediate usage of comm. i by ind. j #;
FORMULA (ALL, i, IND) (ALL, j, IND)
   S_UIMCI_M(i,j) = MINTUSE(i,j)/INTUSE(i,j);

COEFFICIENT (ALL, i, IND)                              S_UIVC_D(i)
   # share of domestic product in fixed investment expenditure on comm. i #;
```

```
FORMULA (ALL, i, IND)
    S_UIVC_D(i) = DINVUSE(i)/INVUSE(i);

COEFFICIENT  (ALL, i, IND)                              S_UIVC_M(i)
    # share of imports in fixed investment expenditure on commodity i #;
FORMULA (ALL, i, IND)
    S_UIVC_M(i) = MINVUSE(i)/INVUSE(i);

COEFFICIENT  (ALL, i, IND)                              S_UCHC_D(i)
    # share of domestic product in household consumption expend. on comm. i #;
FORMULA (ALL, i, IND)
    S_UCHC_D(i) = DCHUSE(i)/CHUSE(i);

COEFFICIENT (ALL, i, IND)                               S_UCHC_M(i)
    # share of imports in household consumption expenditure on commodity i #;
FORMULA (ALL, i, IND)
    S_UCHC_M(i) = MCHUSE(i)/CHUSE(i);

COEFFICIENT (ALL, i, IND)                               S_UCGC_D(i)
    # share of domestic product in government consumption expend. on comm. i #;
FORMULA (ALL, i, IND)
    S_UCGC_D(i) = DCGUSE(i)/CGUSE(i);

COEFFICIENT  (ALL, i, IND)                              S_UCGC_M(i)
    # share of imports in government consumption expenditure on commodity i #;
FORMULA (ALL, i, IND)
    S_UCGC_M(i) = MCGUSE(i)/CGUSE(i);


!==========================================================================

    5.4. Shares of commodities and total primary factors in industry
         costs and final demand expenditures

==========================================================================!


!   These shares are used in the adding-up constraints for the upper-
    level input-output coefficients, equations (42)-(45) in the
    optimisation module.

    The shares are calculated using values at purchasers' prices. Shares in
    industry costs are calculated as shares in costs excluding production tax.
```

```
   Abbreviation:
   ind.  industry                                   !

COEFFICIENT                                                  INVNOINDPO
   # zerodivide default value for shares in industry costs #;
FORMULA
   INVNOINDPO = 1.0/(NO_IND + 1);
ZERODIVIDE (ZERO_BY_ZERO) DEFAULT INVNOINDPO;

COEFFICIENT (ALL, i, IND) (ALL, j, IND)                      S_C_IC(i,j)
   # share of intermediate usage of commodity i in total costs of ind. j #;
FORMULA (ALL, i, IND) (ALL, j, IND)
   S_C_IC(i,j) = INTUSE(i,j)/COSTINP(j);

COEFFICIENT (ALL, j, IND)                                    S_C_FI(j)
   # share of employment of primary factors in total costs of industry j #;
FORMULA (ALL, j, IND)
   S_C_FI(j) = COSTINPFAC(j)/COSTINP(j);

COEFFICIENT                                                  INVNOIND
   # zerodivide default value for commodity shares #;
FORMULA
   INVNOIND = 1.0/NO_IND;
ZERODIVIDE (ZERO_BY_ZERO) DEFAULT INVNOIND;

COEFFICIENT (ALL, i, IND)                                    S_IV_C(i)
   # share of commodity i in fixed investment expenditure #;
FORMULA (ALL, i, IND)
   S_IV_C(i) = INVUSE(i)/INVTT;

COEFFICIENT (ALL, i, IND)                                    S_CH_C(i)
   # share of commodity i in household consumption expenditure #;
FORMULA (ALL, i, IND)
   S_CH_C(i) = CHUSE(i)/ECHL;

COEFFICIENT  (ALL, i, IND)                                   S_CG_C(i)
   # share of commodity i in government consumption expenditure #;
FORMULA (ALL, i, IND)
   S_CG_C(i) = CGUSE(i)/ECGL;
```

```
!===========================================================================

   5.5. Shares of domestic and imported commodities in final demand
        expenditures

===========================================================================!


!  These shares are used in the equations for aggregate final demand
   expenditures and final demand price indices, equations (50)-(52) and
   (55)-(59) in the miscellaneous equations module.

   The shares are calculated using values at purchasers' prices.        !

ZERODIVIDE DEFAULT 0.0;

COEFFICIENT (ALL, i, IND)                                   S_IV_DC(i)
   # share of domestic commodity i in fixed investment expenditure #;
FORMULA (ALL, i, IND)
   S_IV_DC(i) = DINVUSE(i)/INVTT;

COEFFICIENT  (ALL, i, IND)                                  S_IV_MC(i)
   # share of imported commodity i in fixed investment expenditure #;
FORMULA (ALL, i, IND)
   S_IV_MC(i) = MINVUSE(i)/INVTT;

COEFFICIENT  (ALL, i, IND)                                  S_CH_DC(i)
   # share of domestic commodity i in household consumption expenditure #;
FORMULA (ALL, i, IND)
   S_CH_DC(i) = DCHUSE(i)/ECHL;

COEFFICIENT  (ALL, i, IND)                                  S_CH_MC(i)
   # share of imported commodity i in household consumption expenditure #;
FORMULA (ALL, i, IND)
   S_CH_MC(i) = MCHUSE(i)/ECHL;

COEFFICIENT  (ALL, i, IND)                                  S_CG_DC(i)
   # share of domestic commodity i in government consumption expenditure #;
FORMULA (ALL, i, IND)
   S_CG_DC(i) = DCGUSE(i)/ECGL;
```

```
COEFFICIENT  (ALL, i, IND)                                  S_CG_MC(i)
   # share of imported commodity i in government consumption expenditure #;
FORMULA (ALL, i, IND)
   S_CG_MC(i) = MCGUSE(i)/ECGL;

COEFFICIENT  (ALL, i, IND)                                  S_XP_C(i)
   # share of commodity i in border value of exports #;
FORMULA (ALL, i, IND)
   S_XP_C(i) = DXPUSE(i)/EXPL;

COEFFICIENT  (ALL, i, IND)                                  S_MP_C(i)
   # share of commodity i in border value of imports #;
FORMULA (ALL, i, IND)
   S_MP_C(i) = VALIMPBOR(i)/EMPL;


!=========================================================================

   5.6. Inventory investment shares in expenditure on GDP

=========================================================================!


!  These shares are used in the equation for the contribution of
   inventory investment prices to the price index for GDP, equation (60)
   in the miscellaneous equations module.

   Abbreviation:
   IIU  inventory investment usage                         !

COEFFICIENT  (ALL, i, IND)                                  S_PDG_STDC(i)
   # share of IIU of domestic commodity i in expenditure on GDP #;
FORMULA (ALL, i, IND)
   S_PDG_STDC(i) = DSTUSE(i)/EPDGL;

COEFFICIENT  (ALL, i, IND)                                  S_PDG_STMC(i)
   # share of IIU of imported commodity i in expenditure on GDP #;
FORMULA (ALL, i, IND)
   S_PDG_STMC(i) = MSTUSE(i)/EPDGL;
```

```
!==========================================================================

     5.7. Final demand shares in expenditure on GDP

==========================================================================!


!  These shares are used in the equation for the GDP price index,
   equation (61) in the miscellaneous equations module.          !

ZERODIVIDE DEFAULT 0.0;

COEFFICIENT                                              S_PDG_IV
   # share of fixed investment in expenditure on GDP #;
FORMULA
   S_PDG_IV = INVTT/EPDGL;

COEFFICIENT                                              S_PDG_CH
   # share of household consumption in expenditure on GDP #;
FORMULA
   S_PDG_CH = ECHL/EPDGL;

COEFFICIENT                                              S_PDG_CG
   # share of government consumption in expenditure on GDP #;
FORMULA
   S_PDG_CG = ECGL/EPDGL;

COEFFICIENT                                              S_PDG_XP
   # share of exports in expenditure on GDP #;
FORMULA
   S_PDG_XP = EXPL/EPDGL;

COEFFICIENT                                              S_PDG_MP
   # ratio of border value of imports to expenditure on GDP #;
FORMULA
   S_PDG_MP = EMPL/EPDGL;


!==========================================================================

     5.8. Coefficients introduced for update statements

==========================================================================!
```

```
!  Abbreviation:
   RCT  rate of commodity tax                              !

ZERODIVIDE (ZERO_BY_ZERO) DEFAULT 0.0;
ZERODIVIDE (NONZERO_BY_ZERO) OFF;

COEFFICIENT (ALL, i, IND)                         TDSKODSK(i)
   # RCT on inventory investment usage of commodity i #;
FORMULA (ALL, i, IND)
   TDSKODSK(i) = TDSTK(i)/DSTK(i);

COEFFICIENT (ALL, i, IND)                         TISKOISK(i)
   # RCT on inventory investment usage of imported commodity i #;
FORMULA (ALL, i, IND)
   TISKOISK(i) = TISTK(i)/ISTK(i);


!**************************************************************************

   6. VARIABLES

**************************************************************************!


!  Variables are grouped according to the part of the model in which
   they first appear.

   Contents:
   6.1. Variables appearing in the input-output quantity model
   6.2. Variables introduced in the input-output price model
   6.3. Variables introduced in the optimisation module
   6.4. Variables introduced in the miscellaneous equations module      !


!==========================================================================

   6.1.  Variables appearing in the input-output quantity model

==========================================================================!
```

```
! Contents:
  6.1.1. Commodity usage for individual use categories
  6.1.2. Factor employment
  6.1.3. Final demands
  6.1.4. Input-output coefficients
  6.1.5. Output and imports by commodity                    !

!------------------------------------------------------------------------

  6.1.1. Commodity usage for individual use categories

-------------------------------------------------------------------------!

VARIABLE (ALL, i, IND) (ALL, j, IND)                   uimdci(i,j)
  # intermediate usage by industry j of domestic commodity i #;

    (ALL, i, IND) (ALL, j, IND)                        uimmci(i,j)
  # intermediate usage by industry j of imported commodity i #;

    (ALL, i, IND)                                      uivdc(i)
  # fixed investment usage of domestic commodity i #;

    (ALL, i, IND)                                      uivmc(i)
  # fixed investment usage of imported commodity i #;

    (ALL, i, IND)                                      uchdc(i)
  # household consumption of domestic commodity i #;

    (ALL, i, IND)                                      uchmc(i)
  # household consumption of imported commodity i #;

    (ALL, i, IND)                                      ucgdc(i)
  # government consumption of domestic commodity i #;

    (ALL, i, IND)                                      ucgmc(i)
  # government consumption of imported commodity i #;

    (ALL, i, IND)                                      uxpc(i)
  # exports of commodity i #;
```

(ALL, i, IND) (CHANGE) ustdc(i)
change in stocks of domestic commodity i #;
! share of inventory investment in total usage of domestic commodity i, multiplied by 100 !

(ALL, i, IND) (CHANGE) ustmc(i)
change in stocks of imported commodity i #;
! share of inventory investment in total usage of imported commodity i, multiplied by 100 !

!---

6.1.2. Factor employment

---!

(ALL, j, IND) eli(j)
employment of labour by industry j #;

(ALL, j, IND) eki(j)
employment of capital by industry j #;

(ALL, j, IND) eni(j)
employment of land by industry j #;

!---

6.1.3. Final demands

---!

iv
fixed investment #;

cg
government consumption #;

ch
household consumption #;

!--

6.1.4. Input-output coefficients

--!

! Abbreviation:
IOC input-output coefficient !

(ALL, i, IND) (ALL, j, IND) aimci(i,j)
IOC for intermediate usage of commodityi by industry j #;

(ALL, i, IND) (ALL, j, IND) aimdci(i,j)
IOC for intermediate usage by industry j of domestic commodity i #;

(ALL, i, IND) (ALL, j, IND) aimmci(i,j)
IOC for intermediate usage by industry j of imported commodity i #;

(ALL, i, IND) aivc(i)
IOC for fixed investment usage of commodity i #;

(ALL, i, IND) aivdc(i)
IOC for fixed investment usage of domestic commodity i #;

(ALL, i, IND) aivmc(i)
IOC for fixed investment usage of imported commodity i #;

(ALL, i, IND) achc(i)
IOC for household consumption of commodity i #;

(ALL, i, IND) achdc(i)
IOC for household consumption of domestic commodity i #;

(ALL, i, IND) achmc(i)
IOC for household consumption of imported commodity i #;

(ALL, i, IND) acgc(i)
IOC for government consumption of commodity i #;

(ALL, i, IND) acgdc(i)
IOC for government consumption of domestic commodity i #;

(ALL, i, IND) acgmc(i)
IOC for government consumption of imported commodity i #;

(ALL, j, IND) afi(j)
IOC for employment of primary factors by industry j #;

!--

6.1.5. Output and imports by commodity

--!

(ALL, i, IND) o(i)
domestic production of commodity i #;

(ALL, i, IND) m(i)
imports of commodity i #;

!==

6.2. Variables introduced in the input-output price model

==!

! Contents:
6.2.1. Basic prices
6.2.2. Purchasers' prices
6.2.3. Border prices
6.2.4. Factor prices
6.2.5. Powers of indirect taxes
6.2.6. Variables used in determining the price of capital services !

!--

6.2.1. Basic prices

--!

(ALL, i, IND) pbadc(i)
basic price of domestic commodity i #;

(ALL, i, IND) pbamc(i)
basic price of imported commodity i #;

!---

6.2.2. Purchasers' prices

---!

! Abbreviation:
PP purchasers' price !

(ALL, i, IND) (ALL, j, IND) ppuimdci(j,i)
PP of domestic commodity i in intermediate usage by industry j #;

(ALL, i, IND) (ALL, j, IND) ppuimmci(j,i)
PP of imported commodity i in intermediate usage by industry j #;

(ALL, i, IND) ppuivdc(i)
PP of domestic commodity i in fixed investment #;

(ALL, i, IND) ppuivmc(i)
PP of imported commodity i in fixed investment #;

(ALL, i, IND) ppuchdc(i)
PP of domestic commodity i in household consumption #;

(ALL, i, IND) ppuchmc(i)
PP of imported commodity i in household consumption #;

(ALL, i, IND) ppucgdc(i)
PP of domestic commodity i in government consumption #;

(ALL, i, IND) ppucgmc(i)
PP of imported commodity i in government consumption #;

(ALL, i, IND) ppustdc(i)
PP of domestic commodity i in inventory investment #;

(ALL, i, IND) ppustmc(i)
PP of imported commodity i in inventory investment #;

!---

6.2.3. Border prices

---!

(ALL, i, IND) pbomc(i)
border price of imports of commodity i #;

(ALL, i, IND) pboxc(i)
border price of exports of commodity i #;

!---

6.2.4. Factor prices

---!

vl
wage rate #;

(ALL, i, IND) vki(i)
price of capital services employed by industry j #;

vn
price of land services #;

!---

6.2.5. Powers of indirect taxes

---!

! Abbreviation:
PCT power of the commodity tax !

(ALL, j, IND) wtpi(j)
power of the production tax on industry j #;

(ALL, i, IND) wtcmpc(i)
power of the import duty on commodity i #;

(ALL, i, IND) (ALL, j, IND) wtcimdc(j,i)
PCT on intermediate usage by industry j of domestic commodity i #;

(ALL, i, IND) (ALL, j, IND) wtcimmc(j,i)
PCT on intermediate usage by industry j of imported commodity i #;

(ALL, i, IND) wtcivdc(i)
PCT on fixed investment usage of domestic commodity i #;

(ALL, i, IND) wtcivmc(i)
PCT on fixed investment usage of imported commodity i #;

(ALL, i, IND) wtcchdc(i)
PCT on household consumption of domestic commodity i #;

(ALL, i, IND) wtcchmc(i)
PCT on household consumption of imported commodity i #;

(ALL, i, IND) wtccgdc(i)
PCT on government consumption of domestic commodity i #;

(ALL, i, IND) wtccgmc(i)
PCT on government consumption of imported commodity i #;

(ALL, i, IND) wtcxpc(i)
PCT on exports of commodity i #;

(ALL, i, IND) wtcstdc(i)
PCT on inventory investment usage of domestic commodity i #;

(ALL, i, IND) wtcstmc(i)
PCT on inventory investment usage of imported commodity i #;

!--

6.2.6. Variables used in determining the price of capital services

--!

ipiv
price index for fixed investment #;

pk
price of capital goods #;

(ALL, j, IND) rri(j)
rate of return on capital in industry j #;

!==

6.3. Variables introduced in the optimisation module

==!

! Contents:
6.3.1. Lagrange multiplier associated with constraint on imports
6.3.2. Lagrange multipliers associated with upper-level adding-up constraints
6.3.3. Lagrange multipliers associated with lower-level adding-up constraints !

!--

6.3.1. Lagrange multiplier associated with constraint on imports

--!

(ALL, i, IND) (CHANGE) lmpc(i)
Lagrange multiplier for constraint on imports of commodity i #;

!---

6.3.2. Lagrange multipliers associated with upper-level adding-up constraints

---!

! Abbreviation:
LMAAUC: Lagrange multiplier associated with adding-up constraint !

(ALL, j, IND) (CHANGE) lacimi(j)
LMAAUC on commodity composition of production in industry j #;

(CHANGE) laciv
LMAAUC on commodity composition of fixed investment #;

(CHANGE) lacch
LMAAUC on commodity composition of household consumption #;

(CHANGE) laccg
LMAAUC on commodity composition of government consumption #;

!---

6.3.3. Lagrange multipliers associated with lower-level adding-up constraints

---!

! Abbreviation:
LMAAUC: Lagrange multiplier associated with adding-up constraint !

(ALL, i, IND) (ALL, j, IND) (CHANGE) lasimci(i,j)
LMAAUC on source composition of intermed. usage of comm. i by ind. j #;

(ALL, i, IND) (CHANGE) lasivc(i)
LMMAAUC on source composition of fixed investment usage of commodity i #;

(ALL, i, IND) (CHANGE) laschc(i)
LMMAAUC on source composition of household consumption of commodity i #;

(ALL, i, IND) (CHANGE) lascgc(i)
LMMAAUC on source composition of government consumption of commodity i #;

!==

6.4. Variables introduced in the miscellaneous equations module

==!

! Contents:
6.4.1. Aggregate final demand expenditures
6.4.2. Border values of trade flows
6.4.3. Macroeconomic price indices
6.4.4. Relative import prices !

!--

6.4.1. Aggregate final demand expenditures

--!

eiv
fixed investment expenditure #;

ech
household consumption expenditure #;

ecg
government consumption expenditure #;

!--

6.4.2. Border values of trade flows

--!

(ALL, i, IND) expboc(i)
border value of exports of commodity i #;

(ALL, i, IND) empboc(i)
border value of imports of commodity i #;

!--

6.4.3. Macroeconomic price indices

--!

ipch
price index for household consumption #;

ipcg
price index for government consumption #;

ipxp
export price index #;

cippdgst
contribution of inventory investment prices to GDP price index #;

ipmp
import price index #;

ippdg
price index for GDP #;

!--

6.4.4. Relative import prices

--!

(ALL, i, IND) premc(i)
ratio of border price of imports of commodity i to GDP price index #;

```
!*****************************************************************************

   7. EQUATIONS

*****************************************************************************!


!  Contents:

   7.1.  Input-output quantity model
   7.2.  Input-output price model
   7.3.  The optimisation module
   7.4.  Miscellaneous equations                           !


!============================================================================

   7.1.  Input-output quantity model

============================================================================!


!  Contents:
   7.1.1.  Commodity demand equations
   7.1.2.  Factor demand equations
   7.1.3.  Market-clearing conditions                        !


!----------------------------------------------------------------------------

   7.1.1.  Commodity demand equations

----------------------------------------------------------------------------!


EQUATION
                                                     INT_DEM_DOM
   # 1: intermediate usage of domestic commodity i by industry j #
   (ALL, i, IND) (ALL, j, IND)
   uimdci(i,j) = aimdci(i,j) + aimci(i,j) + o(j);

                                                     INT_DEM_IMP
   # 2: intermediate usage of imported commodity i by industry j #
   (ALL, i, IND) (ALL, j, IND)
```

uimmci(i,j) = aimmci(i,j) + aimci(i,j) + o(j);

INV_USE_DOM
3: fixed investment usage of domestic commodity i
(ALL, i, IND)
uivdc(i) = aivdc(i) + aivc(i) + iv;

INV_USE_IMP
4: fixed investment usage of imported commodity i
(ALL, i, IND)
uivmc(i) = aivmc(i) + aivc(i) + iv;

CON_DEM_DOM
5: household consumption of domestic commodity i
(ALL, i, IND)
uchdc(i) = achdc(i) + achc(i) + ch;

CON_DEM_IMP
6: household consumption of imported commodity i
(ALL, i, IND)
uchmc(i) = achmc(i) + achc(i) + ch;

GOV_USE_DOM
7: government consumption of domestic commodity i
(ALL, i, IND)
ucgdc(i) = acgdc(i) + acgc(i) + cg;

GOV_USE_IMP
8: government consumption of imported commodity i
(ALL, i, IND)
ucgmc(i) = acgmc(i) + acgc(i) + cg;

!---

7.1.2. Factor demand equations

---!

DEM_LAB
9: employment of labour by industry j
(ALL, j, IND)
eli(j) = afi(j) + o(j);

```
                                                  DEM_CAP
# 10: employment of capital by industry j #
(ALL, j, IND)
eki(j) = afi(j) + o(j);

                                                  DEM_LAND
# 11: employment of land by industry j #
(ALL, j, IND)
eni(j) = afi(j) + o(j);


!-----------------------------------------------------------------------

7.1.3. Market-clearing conditions

-----------------------------------------------------------------------!


                                                  EQDOMCOM
# 12: total usage of domestic commodity i #
(ALL, i, IND)
o(i)
 = SUM(j, IND, S_O_IMCI(i,j)*uimdci(i,j)) + S_O_IVC(i)*uivdc(i)
 + S_O_CHC(i)*uchdc(i) + S_O_CGC(i)*ucgdc(i) + S_O_XPC(i)*uxpc(i)
 + S_O_STC(i)*o(i) + ustdc(i);

                                                  IMPORTDEMAND
# 13: total usage of imported commodity i #
(ALL, i, IND)
m(i)
 = SUM(j, IND, S_M_IMCI(i,j)*uimmci(i,j)) + S_M_IVC(i)*uivmc(i)
 + S_M_CHC(i)*uchmc(i) + S_M_CGC(i)*ucgmc(i) + S_M_STC(i)*m(i) +
   ustmc(i);


!=======================================================================

7.2. Input-output price model

=======================================================================!
```

```
! Contents:
  7.2.1. Equations determining basic prices
  7.2.2. Equations determining purchasers' prices
  7.2.3. Equations determining the rental price of capital          !


!------------------------------------------------------------------------

  7.2.1. Equations determining basic prices

------------------------------------------------------------------------!


                                                   ZEROPROFITS
 # 14: zero pure profits condition for industry j #
 (ALL, j, IND)
 pbadc(j) + o(j)
 =  wtpi(j)
 + SUM(i, IND, S_C_DIC(i,j)*(ppuimdci(j,i) + uimdci(i,j)))
 + SUM(i, IND, S_C_MIC(i,j)*(ppuimmci(j,i) + uimmci(i,j)))
 + S_C_LI(j)*(vl + eli(j)) + S_C_KI(j)*(vki(j) + eki(j))
 + S_C_NI(j)*(vn + eni(j));

                                                   BASICIMP
 # 15: basic price of imported commodity i #
 (ALL, i, IND)
 pbamc(i) = wtcmpc(i) + pbomc(i);


!------------------------------------------------------------------------

  7.2.2. Equations determining purchasers' prices

------------------------------------------------------------------------!


! Abbreviation:
  PP   purchasers' price                          !

                                                   PPR_INT_DOM
 # 16: PP of domestic commodity i in intermediate usage by industry j #
 (ALL, i, IND) (ALL, j, IND)
 ppuimdci(j,i) = wtcimdc(j,i) + pbadc(i);
```

PPR_INT_IMP

17: PP of imported commodity i in intermediate usage by industry j
(ALL, i, IND) (ALL, j, IND)
ppuimmci(j,i) = wtcimmc(j,i) + pbamc(i);

PPR_DOM_INV

18: PP of domestic commodity i in fixed investment
(ALL, i, IND)
ppuivdc(i) = wtcivdc(i) + pbadc(i);

PPR_IMP_INV

19: PP of imported commodity i in fixed investment
(ALL, i, IND)
ppuivmc(i) = wtcivmc(i) + pbamc(i);

PPR_DOM_HC

20: PP of domestic commodity i in household consumption
(ALL, i, IND)
ppuchdc(i) = wtcchdc(i) + pbadc(i);

PPR_IMP_HC

21: PP of imported commodity i in household consumption
(ALL, i, IND)
ppuchmc(i) = wtcchmc(i) + pbamc(i);

PPR_DOM_GC

22: PP of domestic commodity i in government consumption
(ALL, i, IND)
ppucgdc(i) = wtccgdc(i) + pbadc(i);

PPR_IMP_GC

23: PP of imported commodity i in government consumption
(ALL, i, IND)
ppucgmc(i) = wtccgmc(i) + pbamc(i);

PPR_DOM_ST

24: PP of domestic commodity i in inventory investment
(ALL, i, IND)
ppustdc(i) = wtcstdc(i) + pbadc(i);

PPR_IMP_ST

25: PP of imported commodity i in inventory investment
(ALL, i, IND)
ppustmc(i) = wtcstmc(i) + pbamc(i);

PREXPORT

```
# 26: border price of exports of commodity i #
(ALL, i, IND)
pboxc(i) = wtcxpc(i) + pbadc(i);


!---------------------------------------------------------------------------

 7.2.3. Equations determining the rental price of capital

---------------------------------------------------------------------------!
```

PURPCAP

```
# 27: price of capital goods #
pk = ipiv;
```

PRCAPITAL

```
# 28: rental price of capital in industry j #
(ALL, j, IND)
vki(j) = rri(j) + pk;


!==========================================================================

 7.3. The optimisation module

==========================================================================!


! This module enables users to exogenize imports of each commodity
  by endogenizing input-output coefficients. An optimisation problem
  determines the allocation of imports across use categories. The
  equations in the module represent the necessary conditions for a
  a solution.

  Contents:
  7.3.1. First-order conditions obtained by differentiating the
            Lagrangean with respect to the upper-level input-output
            coefficients
  7.3.2. First-order conditions obtained by differentiating the
            Lagrangean with respect to the lower-level input-output
            coefficients
```

7.3.3. Adding-up constraints on the upper-level input-output coefficients
7.3.4. Adding-up constraints on the lower-level input-output coefficients !

!--

7.3.1. First-order conditions obtained by differentiating the Lagrangean with respect to the upper-level input-output coefficients

--!

```
!  Abbreviation:
   IOC  input-output coefficient                                   !

                                                          CTI_MCOND
   # 29: IOC for intermediate usage of commodity i by industry j #
   (ALL, i, IND) (ALL, j, IND)
   W1*aimci(i,j) = S_UIMCI_M(i,j)*lmpc(i) + lacimi(j);

                                                          IVTAG_MCOND
   # 30: IOC for fixed investment usage of commodity i #
   (ALL, i, IND)
   W1*aivc(i) = S_UIVC_M(i)*lmpc(i) + laciv;

                                                          CHTAG_MCOND
   # 31: IOC for household consumption of commodity i #
   (ALL, i, IND)
   W1*achc(i) = S_UCHC_M(i)*lmpc(i) + lacch;

                                                          CGTAG_MCOND
   # 32: IOC for government consumption of commodity i #
   (ALL, i, IND)
   W1*acgc(i) = S_UCGC_M(i)*lmpc(i) + laccg;

                                                          PFTIND_MCOND
   # 33: IOC for primary factor employment by industry j #
   (ALL, j, IND)
   W1*afi(j) = lacimi(j);
```

! --

7.3.2. First-order conditions obtained by differentiating the Lagrangean with respect to the lower-level input-output coefficients

-- !

! Abbreviation:
IOC input-output coefficient !

IUTU_COND
34: IOC for intermediate usage of domestic commodity i by industry j
(ALL, i, IND) (ALL, j, IND)
W2*aimdci(i,j) = lasimci(i,j);

MUTU_COND
35: IOC for intermediate usage of imported commodity i by industry j
(ALL, i, IND) (ALL, j, IND)
W2*aimmci(i,j) = lmpc(i) + lasimci(i,j);

DIVTAG_COND
36: IOC for fixed investment usage of domestic commodity i
(ALL, i, IND)
W2*aivdc(i) = lasivc(i);

MIVTAG_COND
37: IOC for fixed investment usage of imported commodity i
(ALL, i, IND)
W2*aivmc(i) = lmpc(i) + lasivc(i);

DCHTAG_COND
38: IOC for household consumption of domestic commodity i
(ALL, i, IND)
W2*achdc(i) = laschc(i);

MCHTAG_COND
39: IOC for household consumption of imported commodity i
(ALL, i, IND)
W2*achmc(i) = lmpc(i) + laschc(i);

DCGTAG_COND
40: IOC for government consumption of domestic commodity i

```
(ALL, i, IND)
W2*acgdc(i) = lascgc(i);

                                          MCGTAG_COND
# 41: IOC for government consumption of imported commodity i #
(ALL, i, IND)
W2*acgmc(i) = lmpc(i) + lascgc(i);


!-----------------------------------------------------------------------

7.3.3. Adding-up constraints on the upper-level input-output
       coefficients

-----------------------------------------------------------------------!


! Abbreviation:
  AAC  adding-up constraint                           !

                                          ITC_CONST
# 42: AAC for commodity composition of production in industry j #
(ALL, j, IND)
0 = SUM(i, IND, S_C_IC(i,j)*aimci(i,j)) + S_C_FI(j)*afi(j);

                                          CTIV_CONST
# 43: AAC for commodity composition of fixed investment #
0 = SUM(i, IND, S_IV_C(i)*aivc(i));

                                          CTCH_CONST
# 44: AAC for commodity composition of household consumption #
0 = SUM(i, IND, S_CH_C(i)*achc(i));

                                          CTCG_CONST
# 45: AAC for commodity composition of government consumption #
0 = SUM(i, IND, S_CG_C(i)*acgc(i));


!-----------------------------------------------------------------------

7.3.4. Adding-up constraints on the lower-level input-output
       coefficients

-----------------------------------------------------------------------!
```

! Abbreviations:
AAC adding-up constraint
comm. commodity
ind. industry
intermed. intermediate !

SCTCG_CONST
46: AAC for source composition of intermed. usage of comm. i by ind. j
(ALL, i, IND) (ALL, j, IND)
0 = S_UIMCI_D(i,j)*aimdci(i,j) + S_UIMCI_M(i,j)*aimmci(i,j);

SCTIV_CONST
47: AAC for source composition of fixed investment usage of commodity i
(ALL, i, IND)
0 = S_UIVC_D(i)*aivdc(i) + S_UIVC_M(i)*aivmc(i);

SCTHC_CONST
48: AAC for source composition of household consumption of commodity i
(ALL, i, IND)
0 = S_UCHC_D(i)*achdc(i) + S_UCHC_M(i)*achmc(i);

SCTGC_CONST
49: AAC for source consumption of government consumption of commodity i
(ALL, i, IND)
0 = S_UCGC_D(i)*acgdc(i) + S_UCGC_M(i)*acgmc(i);

!===

7.4. Miscellaneous equations

===!

! This module defines several variables targeted in the update simulations.

Contents:
7.4.1. Final demand expenditures summed over sources and commodities
7.4.2. Border values of exports and imports, by commodity
7.4.3. Calculation of relative import prices !

```
!----------------------------------------------------------------------

7.4.1. Final demand expenditures summed over sources and commodities

----------------------------------------------------------------------!

                                                    EXPD_INV
 # 50: fixed investment expenditure #
 eiv
=  SUM(i, IND, S_IV_DC(i)*(ppuivdc(i) + uivdc(i)))
 + SUM(i, IND, S_IV_MC(i)*(ppuivmc(i) + uivmc(i)));

                                                    EXPD_HSC
 # 51: household consumption expenditure #
 ech
=  SUM(i, IND, S_CH_DC(i)*(ppuchdc(i) + uchdc(i)))
 + SUM(i, IND, S_CH_MC(i)*(ppuchmc(i) + uchmc(i)));

                                                    EXPD_GOV
 # 52: government consumption expenditure #
 ecg
=  SUM(i, IND, S_CG_DC(i)*(ppucgdc(i) + ucgdc(i)))
 + SUM(i, IND, S_CG_MC(i)*(ppucgmc(i) + ucgmc(i)));


!----------------------------------------------------------------------

7.4.2. Border values of exports and imports, by commodity

----------------------------------------------------------------------!

                                                    VAL_BE
 # 53: border value of exports of commodity i #
 (ALL, i, IND)
 expboc(i) = pboxc(i) + uxpc(i);

                                                    VAL_BI
 # 54: border value of imports of commodity i #
 (ALL, i, IND)
 empboc(i) = pbomc(i) + m(i);
```

!---

7.4.3. Calculation of relative import prices

---!

! Equations (55)-(62) calculate relative import prices by commodity. The relative import price is defined as the border price of the commodity relative to the price index for GDP.

The calculation is performed in three steps. First equations (55)-(60) define price indices for components of GDP. Next equation (61) defines the overall GDP price index. Finally equation (62) defines relative import prices. !

```
                                                  IP_INV
# 55: price index for fixed investment #
ipiv
= SUM(i, IND, S_IV_DC(i)*ppuivdc(i)) + SUM(i, IND, S_IV_MC(i)*ppuivmc(i));

                                                  IP_CH
# 56: household consumption price index #
ipch
= SUM(i, IND, S_CH_DC(i)*ppuchdc(i)) + SUM(i, IND,
  S_CH_MC(i)*ppuchmc(i));

                                                  IP_CG
# 57: government consumption price index #
ipcg
= SUM(i, IND, S_CG_DC(i)*ppucgdc(i)) + SUM(i, IND,
  S_CG_MC(i)*ppucgmc(i));

                                                  IP_EXPT
# 58: export price index #
ipxp = SUM(i, IND, S_XP_C(i)*pboxc(i));

                                                  IP_IMP
# 59:import price index #
ipmp = SUM(i, IND, S_MP_C(i)*pbomc(i));

                                                  CPI_STK
# 60: contribution of inventory investment prices to GDP price index #
cippdgst
```

```
  =  SUM(i, IND, S_PDG_STDC(i)*ppustdc(i))
   + SUM(i, IND, S_PDG_STMC(i)*ppustmc(i));

                                                   IP_GDP
   # 61: price index for gdp #
   ippdg
  =  S_PDG_IV*ipiv + S_PDG_CH*ipch + S_PDG_XP*ipxp + S_PDG_CG*ipcg +
    cippdgst
   - S_PDG_MP*ipmp;

                                                   RELP_IMP
   # 62: price of imported commodity i, relative to GDP price index #
   (ALL, i, IND)
   premc(i) = pbomc(i) - ippdg;

!*****************************************************************************

   8.  UPDATES

*****************************************************************************!


!  Contents:
   8.1.  Commodity usage
   8.2.  Factor employment
   8.3.  Indirect taxes                          !


!=============================================================================

   8.1.  Commodity usage

=============================================================================!


UPDATE (ALL, i, IND) (ALL, j, IND)
   DINT(i,j) = pbadc(i)*uimdci(i,j);

UPDATE (ALL, i, IND) (ALL, j, IND)
   IINT(i,j) = pbamc(i)*uimmci(i,j);

UPDATE (ALL, i, IND)
   DINV(i) = pbadc(i)*uivdc(i);
```

```
UPDATE (ALL, i, IND)
    IINV(i) = pbamc(i)*uivmc(i);

UPDATE (ALL, i, IND)
    DCON(i) = pbadc(i)*uchdc(i);

UPDATE (ALL, i, IND)
    ICON(i) = pbamc(i)*uchmc(i);

UPDATE (ALL, i, IND)
    DGOV(i) = pbadc(i)*ucgdc(i);

UPDATE (ALL, i, IND)
    IGOV(i) = pbamc(i)*ucgmc(i);

UPDATE (ALL, i, IND)
    EXP_(i) = pbadc(i)*uxpc(i);

UPDATE (EXPLICIT) (ALL, i, IND)
    DSTK(i)
  = DSTK(i) + [DSTK(i)*(pbadc(i) + o(i)) + DOMPN(i)*ustdc(i)]/100;


!==============================================================================

    8.2. Factor employment

==============================================================================!


UPDATE (EXPLICIT) (ALL, i, IND)
    ISTK(i)
  = ISTK(i) + [ISTK(i)*(pbamc(i) + m(i)) + VALIMP(i)*ustmc(i)]/100;

UPDATE (ALL, i, IND)
    LAB(i) = vl*eli(i);

UPDATE (ALL, i, IND)
    CAP(i) = vki(i)*eki(i);

UPDATE (ALL, i, IND)
    LAND(i) = vn*eni(i);
```

```
!==============================================================================

   8.3. Indirect taxes

==============================================================================!


UPDATE (EXPLICIT) (ALL, i, IND)
   TSR(i)
  = TSR(i) + [COSTINP(i)*wtpi(i) + TSR(i)*(pbadc(i) + o(i))]/100;

UPDATE (EXPLICIT) (ALL, i, IND) (ALL, j, IND)
   TRD(i,j)
  =  TRD(i,j)
   + [DINTUSE(i,j)*wtcimdc(j,i) + TRD(i,j)*(pbadc(i) + uimdci(i,j))]/100;

UPDATE (EXPLICIT) (ALL, i, IND) (ALL, j, IND)
   TRI(i,j)
  =  TRI(i,j)
   + [MINTUSE(i,j)*wtcimmc(j,i) + TRI(i,j)*(pbamc(i) + uimmci(i,j))]/100;

UPDATE (EXPLICIT) (ALL, i, IND)
   TIRD(i)
  = TIRD(i) + [DINVUSE(i)*wtcivdc(i) + TIRD(i)*(pbadc(i) + uivdc(i))]/100;

UPDATE (EXPLICIT) (ALL, i, IND)
   TIRI(i)
  = TIRI(i) + [MINVUSE(i)*wtcivmc(i) + TIRI(i)*(pbamc(i) + uivmc(i))]/100;

UPDATE (EXPLICIT) (ALL, i, IND)
   TCRD(i)
  = TCRD(i) + [DCHUSE(i)*wtcchdc(i) + TCRD(i)*(pbadc(i) + uchdc(i))]/100;

UPDATE (EXPLICIT) (ALL, i, IND)
   TCRI(i)
  = TCRI(i) + [MCHUSE(i)*wtcchmc(i) + TCRI(i)*(pbamc(i) + uchmc(i))]/100;

UPDATE (EXPLICIT) (ALL, i, IND)
   TGRD(i)
  = TGRD(i) + [DCGUSE(i)*wtccgdc(i) + TGRD(i)*(pbadc(i) + ucgdc(i))]/100;

UPDATE (EXPLICIT) (ALL, i, IND)
   TGRI(i)
  = TGRI(i) + [MCGUSE(i)*wtccgmc(i) + TGRI(i)*(pbamc(i) + ucgmc(i))]/100;
```

```
UPDATE (EXPLICIT) (ALL, i, IND)
   TER(i)
  = TER(i) + [DXPUSE(i)*wtcxpc(i) + TER(i)*(pbadc(i) + uxpc(i))]/100;

UPDATE (EXPLICIT) (ALL, i, IND)
   TDSTK(i)
  =  TDSTK(i)
   + [  DSTUSE(i)*wtcstdc(i) + TDSTK(i)*(pbadc(i) + o(i))
     + TDSKODSK(i)*DOMPN(i)*ustdc(i)]/100;

UPDATE (EXPLICIT) (ALL, i, IND)
   TISTK(i)
  =  TISTK(i)
   + [  MSTUSE(i)*wtcstmc(i) + TISTK(i)*(pbamc(i) + m(i))
     + TISKOISK(i)*VALIMP(i)*ustmc(i)]/100;

UPDATE (EXPLICIT) (ALL, i, IND)
   DTY(i)
  = DTY(i) + [VALIMPBOR(i)*wtcmpc(i) + DTY(i)*(pbamc(i) + m(i))]/100;


!*******************************************************************************

   END OF TABLO INPUT

*******************************************************************************!
```

References

Australian Bureau of Statistics 1990, *Australian National Accounts, Input-Output Tables, 1986-87*, Cat. No. 5209.0, Canberra.

Bacharach, M. 1970, *Biproportional Matrices & Input-Output Change*, Cambridge.

Brown, S., Strzelecki, A. and Watts, G. forthcoming, *Matching Input-Output Data to International Trade Data and Assembling a SALTER Database*, SALTER Working Paper, Industry Commission, Canberra.

Calder, W., McDougall, R. and Strzelecki, A. forthcoming, *Procedures for Later Stage Processing of Single-Region Input-Output Data for SALTER*, SALTER Working Paper, Industry Commission, Canberra.

Codsi, G. and Pearson, K.R. 1988, 'GEMPACK: General-Purpose Software for Applied General Equilibrium and Other Economic Modellers', *Computer Science in Economics and Management*, Vol. 1, pp. 189-207.

Gotch, M. 1993, *Industry Assistance Data for SALTER*, SALTER Working Paper No. 14, Industry Commission, Canberra.

Hambley, J. 1993, *Early Stage Processing of International Trade and Input-Output Data for SALTER*, SALTER Working Paper No. 15, Industry Commission, Canberra.

Hanslow, K. 1993, *Later Stage Processing of International Trade Data for SALTER*, SALTER Working Paper No. 16, Industry Commission, Canberra.

Jomini, P., Zeitsch, J.F., McDougall, R., Welsh, A., Brown, S., Hambley, J. and Kelly, J. 1991, *SALTER: A General Equilibrium Model of the World Economy, Volume 1, Model Structure, Database and Parameters*, Industry Commission, Canberra.

Mikkelsen, A. and Pearson, K.R. 1986, *How to Use Header Array Files to Access Data for Economic Models*, GEMPACK Document No. GED-16, Impact Project, Melbourne.

Pearson, K. and Codsi, G. 1987, *Implementing Economic Models Using TABLO*, GEMPACK Document No. GED-20, Impact Project, Melbourne.

—— 1988a, *Update of "Implementing Economic Models Using TABLO" (GED-20)*, GEMPACK Document No. GED-20a, Impact Project, Melbourne.

—— 1988b, *Stylised Johansen — An Illustrative CGE Model*, GEMPACK Document No. GED-23, Impact Project, Melbourne.

—— 1991a, *The Update and Multi-Step Version of TABLO: User Guidelines*, GEMPACK Document No. GED-30, Impact Project, Melbourne.

—— 1991b, *The Update and Multi-Step Version of TABLO: Syntax and Semantic Description*, GEMPACK Document No. GED-31, Impact Project, Melbourne.

Stone R. 1962, 'Multiple Classifications in Social Accounting', *Bulletin de l'Institut International de Statistique* vol. 39 no. 3, pp. 215-33.

Theil, H. 1967, *Economics and Information Theory*, North-Holland, Amsterdam.

United Nations 1973, *Input-Output Tables and Analysis*, Studies in Methods, Series F, No. 4, Rev. 1, New York.

University of Cambridge Department of Applied Economics 1962, *A Computable Model of Economic Growth*, A Programme for Growth, No. 1, Chapman and Hall, London.

Uribe, P., de Leeuw, C.G. and Theil H. 1965, *The Information Approach to the Prediction of Interregional Trade Flows*, Econometric Institute of the Netherlands School of Economics Report No. 6507, Rotterdam.