Centre for International Economic Studies

July 2000

Adelaide University • SA 5005 • AUSTRALIA

The Australian Wine Industry During a Period of Boom and Tax Changes

Glyn Wittwer

Centre for International Economic Studies and
School of Economics
Adelaide University
SA 5005 AUSTRALIA

Email: glyn.wittwer@adelaide.edu.au

For details of the CIES Wine Economics Project and to download publications, visit the Centre's website at http://www.adelaide.edu.au/cies/wine.htm

CENTRE FOR INTERNATIONAL ECONOMIC STUDIES

The Centre was established in 1989 by the Economics Department of the Adelaide University to strengthen teaching and research in the field of international economics and closely related disciplines. Its specific objectives are:

- to promote individual and group research by scholars within and outside the Adelaide University
- to strengthen undergraduate and post-graduate education in this field
- to provide shorter training programs in Australia and elsewhere
- to conduct seminars, workshops and conferences for academics and for the wider community
- to publish and promote research results
- to provide specialised consulting services
- to improve public understanding of international economic issues, especially among policy makers and shapers

Both theoretical and empirical, policy-oriented studies are emphasised, with a particular focus on developments within, or of relevance to, the Asia-Pacific region. The Centre's Director is Professor Kym Anderson (Email kym.anderson@adelaide.edu.au) and Deputy Director, Dr Randy Stringer (Email randy.stringer@adelaide.edu.au)

Further details and a list of publications are available from:

Executive Assistant
Centre for International Economic Studies
School of Economics
Adelaide University
SA 5005 AUSTRALIA
Telephone: (08) 8303 5672
Facsimile: (08) 8223 1460
[International prefix: (+61 8)]
Email: cies@adelaide.edu.au

Most publications can be downloaded from our Home page: http://www.adelaide.edu.au/cies

Abstract

The Australian Wine Industry During a Period of Boom and Tax Changes

Glyn Wittwer

PhD Thesis submitted July 2000

The Australian wine industry is presently experiencing a sustained boom. Unlike previous booms, this one is being overwhelmingly driven by export growth without policy intervention. With the unprecedented premium winegrape plantings of the late 1990s, some commentators fear that the industry is once again heading for a period of depressed returns — especially since wine is one of the few products whose wholesale sales tax was not removed when Australia introduced a goods-and-services tax (GST) package on 1 July 2000. Indeed, wine taxation increased on that day.

One of the two main tasks of this study is to use a computable general equilibrium (CGE) model of the economies of South Australia and the rest of Australia, FEDSA-WINE, to explain wine industry growth between 1987 and 1999, and to project the industry ahead to 2003. The recent accelerated plantings appear to have been a rational response to what were, for premium red winegrapes, seven successive vintages of rising prices in the 1990s. Such plantings are a consequence of an outstanding success story: they need not mean an impending winegrape glut is ahead.

With the CGE model's database updated to 2003, the other key part of this study is an analysis of the impacts of the GST package, on both the premium and non-premium segments of the grape and wine industry. Through input cost reductions, the premium wine segment is expected to gain from the GST tax package. For this reason, up to a certain point, the industry can still gain if wine consumption is taxed more heavily than prior to the introduction of the GST. For some non-premium grape growers, the opportunity to switch between sales to wineries and sales of dried and table grapes reduces the impact on them of the higher wine tax. For premium wine producers, exports provide an outlet.

Three obvious areas for further research within an economic modelling framework emerge from this study: further analysis of the supply response of grape growers; further disaggregation of the existing FEDSA-WINE model; and development of a disaggregated world wine model with either two or three segments, as in the single-country model of the present study.

Appendix A

The theoretical structure of FEDSA-WINE

A.1. Introduction

FEDSA-WINE, the CGE model used in this study, is in the ORANI family of general equilibrium models described in Dixon et al. (1982) and is based on the FEDERAL two-region model of the Australian economy (Madden 1992; Madden 1995). The model has been revised extensively to reduce the code required to implement the model. This has been achieved by converting shares within equations to levels to reduce the number of calculations within the model. Extensive modifications have been based on the theory of ORANI-G (Horridge, Parmenter and Pearson 1998) and some variants of that model.

FEDSA-WINE is implemented using GEMPACK software, which spares the modeller from writing a tailor-made program for each model. General-purpose software in the form of the 'TABLO' program is used to prepare an executable computer program. TABLO code closely resembles ordinary algebra. This appendix provides details of the model using TABLO notation. With the exception of the variables and coefficients in the model, which appear in appendices B and C, this appendix contains the entire TABLO code of FEDSA-WINE. The diskette in the inside cover includes a software version of the model, while the model is downloadable from the internet address given in the table of contents

Figure A.1: The FEDSA-WINE database

		Absorption matrix					
		1	2	3	4	5	6
		Production	**Investment**	**Household**	**Export**	**C'wealth govt.**	**State govts.**
	Size	← I →	← I →	← I →	← I →	← I →	← I →
Basic flows	↑ **CxSxR** ↓	BAS1	BAS2	BAS3	BAS4	BAS5	BAS6
Margins	↑ **CxSxRxM** ↓	MAR1	MAR2	MAR3	MAR4	MAR5	MAR6
Taxes: CG	↑ **CxSxR** ↓	TAX1CG	TAX2CG	TAX3CG	TAX4CG	n.a.	n.a.
Taxes: St.	↑ **CxSxR** ↓	TAX1ST	TAX2ST	TAX3ST	TAX4ST	n.a.	n.a.
Labour	↑ OxR ↓	WAGE					
	↑ OxR ↓	INCTAX					
	↑ OxR ↓	PAYROLL					
Capital	↑ R ↓	KAPRENT					
	↑ R ↓	KAPTAX					
	↑ R ↓	LNDTAX					
Land	↑ R ↓	AGLND					
	↑ R ↓	AGRITAX					
Other	↑ R ↓	OTHCOST					
	↑ R ↓	CO1TAX					
	↑ R ↓	ST1TAX					

I = number of industries

C = number of commodities

S = number of sources

R= number of regional destinations

M = number of commodities used as margins

O = number of occupations

CG = Commonwealth government

ST = state governments

	Joint production matrix
Size	← I →
↑ CxR ↓	SHOIRJ

	Import duty
Size	← 1 →
↑ C ↓	VIMPORT

A.2. FEDSA-WINE’s database

Before explaining key parts of the TABLO code, we turn to the database of the model. Figure A.1 illustrates the absorption matrix or flows database of FEDSA-WINE. The column headings identify the agents who buy ‘C’ commodities.

The source ‘S’ of these commodities may be either domestic industries, located in two regions, South Australia or the rest of Australia, or foreign suppliers. The agents for sales are producers, investors, households, overseas exports, Commonwealth and state governments and changes in inventories.

Examining the row headings, in addition to the basic sale flow, each transaction includes four different sorts of margins ‘M’. These include wholesale and retail markups, restaurant and hotel markups imposed on on-premise sales of beverages, transport costs and insurance. An important part of margins usage in a CGE model is to distinguish between different prices by type of transaction. In addition, there are two types of commodity taxes: both the Commonwealth and state governments may impose a tax on each transaction. To complete the production column, there are primary inputs of labour, capital and agricultural land, and associated income taxes.

Each cell in figure A.1 contains the name of a data matrix. *MAR1* is a 5-dimensional matrix containing the costs of margin services ‘M’ on sales of commodities C from sources S to industries I for intermediate usage in region ‘R’. Each industry within the structure of the model may produce any of ‘C’ commodities. The MAKE matrix shows the value of output of each commodity by each industry. By assumption, import tariff rates vary by commodity but not sale type, completing the database.

A.3. Dimensions of the model

Excerpt 1 of the TABLO code contains a list of 'SET' statements. These essentially define the dimensions of the model. 'Ind', comprising the 29 industries of the model, includes three different grape industries that provide inputs into three different wine industries. Each industry produces a corresponding output or commodity, listed under 'Com'.

Excerpt 1: Files and sets in FEDSA-WINE

```
SET
        Com                          #commodities#
(C1WhiGrapes, C2RedGrapes, C3TabGrapes, C4Softdrink,    C5Beer,
C6WhiWine,    C7RedWine,   C8BulkWine,  C9Spirits,      C10AgForFish,
C11Mining,C12ProcMin,      C13Foodproc, C14Cars,                C15Textiles,
C16TCFs,      C17ChemProd, C18Otherman, C19Utilities,   C20Construct,
C21Trade,     C22Hotels,   C23Transport, C24Communic, C25Insurance,
C26ComServ,   C27PubAdmin, C28PerServ,  C29OwnDwell);
Exp     #set of traditional exports# Maximum Size 15
Read Elements from file PARAMETERS Header "EXPO";
        Sou              #sources of commodities#       (SA,ROA,ROW);
        Reg              #region #                      (SA,ROA);
        Twosou           #national source#              (domestic,foreign);
        Ind              #industries#
(C1WhiGrapes, C2RedGrapes, C3TabGrapes, C4Softdrink,    C5Beer,
C6WhiWine,    C7RedWine,   C8BulkWine,  C9Spirits,      C10AgForFish,
C11Mining,    C12ProcMin,  C13Foodproc, C14Cars,        C15Textiles,
C16TCFs,      C17ChemProd, C18Otherman, C19Utilities,   C20Construct,
C21Trade,     C22Hotels,   C23Transport, C24Communic, C25Insurance,
C26ComServ,   C27PubAdmin, C28PerServ,  C29OwnDwell);
        Occ                      #Occupation Types#(O1-O8);
        Mar                      #margin Commodities#
                                 (C21Trade,C22Hotels,C23Transport,C25Insurance);
        Fac                      #Primary Factors#              (Lab,Cap,Land);
        Notj                     # investment industries with government component#
                                 (C19Utilities,    C26ComServ,    C27PubAdmin);
        Agg                       #Set of agri Industries#
(C1WhiGrapes,C2RedGrapes,C3TabGrapes,C10AgForFish);
        Wine (C6WhiWine,C7RedWine,C8BulkWine);
        GDP #expenditure side of GDP# (B2-B4,B4I,B5,BS,BM,BMI);
SUBSET
        Exp                      is subset of COM;
        Mar                      is subset of COM;
        Notj                     is subset of IND;
        Agg                      is subset of IND;
        Reg                      is subset of SOU;
        Wine                     is subset of COM;
        Wine                     is subset of IND;
```

```
SET     Nonmar                            = Com - Mar;
        Imp                               = Com - Exp;
        Jset #endogenous private#         = Ind - Notj;
        Nonagg                            = Ind - Agg;
SUBSET Wine              is subset of Nonmar;
FILE MRIOPT             # regional IO data#;
FILE PARAMETERS         #marg. budg. shares, exp.demand & Armington elasticities#;
```

The remaining sets include ‘Occ’, defined as ‘#Occupation Types# (O1-O8)’, meaning that there eight different occupational types of labour. The ‘File’ statements at the end of excerpt 1 list the logical names of files containing the database and model parameters. On the companion diskette, these are io2003.upd and par2903c.har.

A.4. Variables and coefficients

Excerpt 2 of the code (shown separately in a table in appendix B) contains the variables, that is, the expressions that usually denote percentage changes within the equations of the model. Exceptions include the variables *delb* (national balance of trade) and *cb1r* and *cb2* (the public sector borrowing requirements for the state and Commonwealth governments respectively). They are reported as changes in the level value ($ million) rather than as percentage changes, as the level to which they apply may pass through zero.

To reduce the memory requirements of the user, variables also follow naming conventions. If the first letter of a variable is ‘x’, it refers to a change in quantity. Similarly, ‘p’ refers to prices, ‘v’ to values, ‘a’ to technical or taste changes, and ‘f’ to shift expressions. When a variable or coefficient (i.e., a levels term) name includes a number, it refers to the type of sale: 1 refers to intermediate inputs to production, 2 to investment purchases, 3 to household purchases, 4 to exports, 5 to the Commonwealth government purchases and 6 to the state government purchases.

Excerpt 3 of the TABLO code reads in levels data, denoted by ‘Coefficient’, shown separately in appendix C and illustrated in figure A.1. ‘Update’ statements are included in the code for each database coefficient. Such statements serve two purposes. First, they allow the model to generate solutions from multistep shocks: this allows the modeller to ascribe relatively large shocks to the linearised model without generating large linearisation errors, while retaining the relative simplicity of linearised algebra (Hertel, Horridge and Pearson 1992). Second, a by-product of the update command is that a new database can be created including the changes as a result of the simulation. This post-simulation database could be due to a comparative static simulation, such as generated by imposing a policy shock on the model. Alternatively, the post-simulation database could be used to project the database for the whole economy to a different time period, as in chapter 3.

Excerpt 3: update statements

```
Update
        (All,i,Com)(All,s,Sou)(All,j,Ind)(All,r,Reg) BAS1(i,s,j,r) =
                                        p0(i,s)*x1_q(i,s,j,r);
        (All,i,Com)(All,s,Sou)(All,j,Ind)(All,r,Reg) BAS2(i,s,j,r) =
                                        p0(i,s)*x2_q(i,s,j,r);
        (All,i,Com)(All,s,Sou)(All,r,Reg)                BAS3(i,s,r)=
                                        p0(i,s)*x3_qr(i,s,r);
        (All,i,Com)(All,r,Reg)                           BAS4(i,r) =
                                        p0(i,r)*x4r(i,r);
        (All,i,Com)(All,s,Sou)(All,r,Reg)                BAS5(i,s,r)=
                                        p0(i,s)*x5(i,s,r);
        (All,i,Com)(All,s,Sou)(All,r,Reg)                BAS6(i,s,r)=
                                        p0(i,s)*x6(i,s,r);
(All,i,Com)(All,s,Sou)(All,r,Reg)LEVP0(i,s,r) = p0(i,s);
(change) (All,i,Com)(All,s,Sou)(All,r,Reg)
        BAS7(i,s,r) = BAS7(i,s,r)*p0(i,s)/100 + LEVP0(i,s,r)*delx7(i,s,r);
(All,i,Com)(All,s,Sou)(All,j,Ind)(All,r,Reg)(All,u,Mar)          MAR1(i,s,j,r,u)=
                p0(u,s)*x_mar1(i,s,j,r,u);
(All,i,Com)(All,s,Sou)(All,j,Ind)(All,r,Reg)(All,u,Mar)          MAR2(i,s,j,r,u)=
                p0(u,s)*x_mar2(i,s,j,r,u);
(All,i,Com)(All,s,Sou)(All,r,Reg)(All,u,Mar)                     MAR3(i,s,r,u)=
                p0(u,s)*x_mar3(i,s,r,u);
(All,i,Com)(All,r,Reg)(All,u,Mar)                                MAR4(i,r,u)=
                p0(u,r)*x_mar4(i,r,u);
(All,i,Com)(All,s,Sou)(All,r,Reg)(All,u,Mar)                     MAR5(i,s,r,u)=
                p0(u,s)*x_mar5(i,s,r,u);
```

```
(All,i,Com)(All,s,Sou)(All,r,Reg)(All,u,Mar)                              MAR6(i,s,r,u)=
                    p0(u,s)*x_mar6(i,s,r,u);
          (Change) (All,i,Com)(All,s,Sou)(All,j,Ind)(All,r,Reg) TAX1CG(i,s,j,r)=
                                    TAX1CG(i,s,j,r)*( p0(i,s)+ x1_q(i,s,j,r))/100+
                          {TAX1ST(i,s,j,r)+TAX1CG(i,s,j,r)+BAS1(i,s,j,r)}* t1_com(i,s,j,r) /100;
         (Change) (All,i,Com)(All,s,Sou)(All,j,Ind)(All,r,Reg) TAX1ST(i,s,j,r)=
                                    TAX1ST(i,s,j,r)*( p0(i,s)+ x1_q(i,s,j,r))/100+
                          {TAX1ST(i,s,j,r)+TAX1CG(i,s,j,r)+BAS1(i,s,j,r)}* t1_state(i,s,r) /100;
          (Change) (All,i,Com)(All,s,Sou)(All,j,Ind)(All,r,Reg) TAX2CG(i,s,j,r)=
                                    TAX2CG(i,s,j,r)*( p0(i,s)+ x2_q(i,s,j,r))/100+
                          {TAX2ST(i,s,j,r)+TAX2CG(i,s,j,r)+BAS2(i,s,j,r)}* t2_com(i,s,j,r) /100;

         (Change) (All,i,Com)(All,s,Sou)(All,j,Ind)(All,r,Reg) TAX2ST(i,s,j,r)=
                                    TAX2ST(i,s,j,r)*( p0(i,s)+ x2_q(i,s,j,r))/100+
                   {TAX2ST(i,s,j,r)+TAX2CG(i,s,j,r)+BAS2(i,s,j,r)}* t2_state(i,s,r) /100;
         (Change)(All,i,Com)(All,s,Sou)(All,r,Reg)            TAX3CG(i,s,r)=
                                    TAX3CG(i,s,r)*( p0(i,s)+x3_qr(i,s,r))/100+
                          { TAX3ST(i,s,r)+TAX3CG(i,s,r)+BAS3(i,s,r)}*t3_com(i,s)/100;
         (Change)(All,i,Com)(All,s,Sou)(All,r,Reg)            TAX3ST(i,s,r)=
                                    TAX3ST(i,s,r)*( p0(i,s)+x3_qr(i,s,r))/100+
                          { TAX3ST(i,s,r)+TAX3CG(i,s,r)+BAS3(i,s,r)}*t3_state(i,s,r)/100;
         (Change)(All,i,Com)(All,r,Reg)                       TAX4(i,r)=
                                    TAX4(i,r)*( p0(i,r)+x4r(i,r))/100+
                                    (TAX4(i,r)+BAS4(i,r))*t4_com(i,r)/100;
          (Change)(All,i,Com)TAXMCG(i)= TAXMCG(i)*[x_imp(i)+pmp(i)+x_rate]/100
                          + VIMPORT(i)*tm(i)/100;
                   (All,r,Reg) DOLE(r) =x_unemp(r)*punb;
                   (All,r,Reg) COM2STATPAY(r) =g56(r);
                   (All,r,Reg) COM2pers(r) = g5p(r);
                   (All,r,Reg) FEEFINESG(r) =t_sg_yr(r);
                   (All,r,Reg) STAT2pers(r) =g6p(r);
          (All,q,Occ)(All,j,Ind)(All,r,Reg)   WAGE(q,j,r) =          postw(q,j,r)*x_lab(q,j,r);
          (All,q,Occ)(All,j,Ind)(All,r,Reg)   INCTAX(q,j,r)=         paye(q,j,r)*x_lab(q,j,r);
          (All,q,Occ)(All,j,Ind)(All,r,Reg)   PAYROLL(q,j,r)=        p_roll(q,j,r)*x_lab(q,j,r);
          (All,j,Ind)(All,r,Reg)              KAPRENT(j,r)=          p_krnt(j,r)*k_rjst(j,r);
          (All,j,Ind)(All,r,Reg)              KAPTAX(j,r)=           p_kaptax(j,r)*k_rjst(j,r);
          (All,j,Ind)(All,r,Reg)              LNDTAX(j,r)=           pcom_tax(j,r)*k_rjst(j,r);
          (All,j,Ind)(All,r,Reg)              AGLND(j,r) =           p_land(j,r)*x_agland(j,r);
          (All,j,Ind)(All,r,Reg)              AGRITAX(j,r)=          p_landtx(j,r)*x_agland(j,r);
          (All,j,Ind)(All,r,Reg)              ST1TAX(j,r) =          spptax(j,r)*xsptax(j,r);
          (All,j,Ind)(All,r,Reg)              CO1TAX(j,r) =          cpptax(j,r)*xcptax(j,r);
          (All,j,Ind)(All,r,Reg)              OTHCOST(j,r) =         pcost(j,r)*xcost(j,r);
         (Change) (All,r,Reg) UMPE_1(r) =UMPE_1(r)*[lr_emp(r) - x_unemp(r)]/100;
         (Change) (All,r,Reg) UMPE_2(r) =UMPE_2(r)*[fun_r(r) -x_unemp(r)]/100;
          (change) (All,i,Com)(All,r,Reg)             EPSIL(i,r)= EPSIL(i,r)*
                   [x3lux(i,r)-x3_q(i,r)+ v3_r(r)-v3lux(r)]/100.0;
Update (All,i,COM)(All,j,IND)(All,r,REG) MAKE(i,j,r)= p0(i,r)*q1(i,j,r);
```

Model parameters that are not updated during a simulation include Armington and intra-domestic elasticities of substitution (prefixed with *ZIG*), and export demand elasticities. The expenditure demand elasticities that appear in the household demand equations are updated to ensure that the model is homothetic, as these are conditional parameters.

Some coefficients are calculated from other coefficients within the model using a ‘Formula’ statement, rather than being extracted from the database. Excerpt 4 of the code contains the formula statements. These include those prefixed with *VAL*, referring to the total value of a transaction, including the basic value, the margins value and the value of taxation. For example, for the three wine types, the basic consumer value (*BAS3* in the database) is calculated at the producer price. *MAR3* contains the four margin types associated with each sale, the largest of which is the ‘C22Hotels’ markup for on-premise consumption, calculated outside the model as the on-premise proportion of total consumption multiplied by the markup on the wholesale price. The *TAX3CG* matrix contains the value of Commonwealth tax imposed on each transaction, at present including the wholesale sales tax on wine. *VAL3* represents the total value of the transaction from the perspective of consumers.

Excerpt 4 also includes calculations using the expenditure elasticities of demand for each commodity and the Frisch parameter (which provides a measure of the proportion of expenditure to luxury expenditure). The linear expenditure system of demand used in the model is one of the least empirically challenging of specifications.

Regional aggregates are calculated towards the end of excerpt 4. For example, coefficients denoted *TAXnCGZ* and *TAXnSTZ* (n = type of sale) add up Commonwealth and state indirect taxes respectively by type of sale in each region. Subsequent formulae calculate GDP on the income and expenditure sides. The model includes some fiscal detail. Therefore, it is necessary to sum different types of Commonwealth and state government revenues and expenditure, in order to calculate national incomes and expenditures and public sector borrowing requirements. Total industry costs (*TOTCOST*) appears in equation E_p1tot, defining zero pure profits in production. The level of sales (*SALE*) appears subsequently in the market-clearing equations E_p0_B and E_p0_C.

Excerpt 4: coefficients calculated within the model

```
Formula
          (All,i,Com)(All,s,Sou)(All,j,Ind)(All,r,Reg) VAL1(i,s,j,r)=
 BAS1(i,s,j,r)+sum(u,MAR,MAR1(i,s,j,r,u))+TAX1ST(i,s,j,r)+TAX1CG(i,s,j,r);
          (All,i,Com)(All,s,Sou)(All,j,Ind)(All,r,Reg) VAL2(i,s,j,r)=
 BAS2(i,s,j,r)+sum(u,MAR,MAR2(i,s,j,r,u))+TAX2ST(i,s,j,r)+TAX2CG(i,s,j,r);
          (All,i,Com)(All,s,Sou)(All,r,Reg)            VAL3(i,s,r)=
 BAS3(i,s,r)  +sum(u,MAR,MAR3(i,s,r,u))+TAX3ST(i,s,r)+TAX3CG(i,s,r);

   (All,i,Com)(All,s,REG)                              VAL4(i,s)=
 BAS4(i,s)+sum(u,MAR,MAR4(i,s,u))+TAX4(i,s);
Zerodivide default 0.5;

Formula
   (All,i,Com)(All,r,Reg)                              SH4(i,r)=
 VAL4(i,r) / sum(t,REG,VAL4(i,t));
          (All,r,Reg)                                  VAL4NT(r)=
 sum(i,IMP, VAL4(i,r));
          (All,i,Com)(All,s,Sou)(All,r,Reg)            VAL5(i,s,r)=
BAS5(i,s,r)  +sum(u,MAR,MAR5(i,s,r,u));
   (All,i,Com)(All,s,Sou)(All,r,Reg)                   VAL6(i,s,r)=
 BAS6(i,s,r)  +sum(u,MAR,MAR6(i,s,r,u));
   (All,i,Com)                                         VAL6D(i)=
 sum(t,REG,sum(r,REG,VAL6(i,t,r)));
   (All,i,Com)                                         VAL5D(i)=
 sum(t,REG,sum(r,REG,VAL5(i,t,r)));
  (All,j,Ind)(All,r,Reg)                               VAL2sum(j,r)=
 sum(i,COM,sum(s,SOU,VAL2(i,s,j,r)));
 (All,j,Jset)(All,r,Reg)                               V2SG(j,r) = 0;
 (All,j,Jset)(All,r,Reg)                               V2CG(j,r) = 0;
 (All,j,Notj)                          V2SG(j,"SA")  =0.40*VAL2sum(j,"SA");
 (All,j,Notj)                          V2SG(j,"ROA") = 0.48*VAL2sum(j,"ROA");
 (All,j,Notj)                          V2CG(j,"SA") = 0.05*VAL2sum(j,"SA");
 (All,j,Notj)                          V2CG(j,"ROA")= 0.06*VAL2sum(j,"ROA");
    !purchase value V1,V2 and V3 calculations for two stage nests!
(All,i,Com)(All,j,Ind)All,r,Reg )VAL1T(i,"domestic",j,r)= sum(s,reg,VAL1(i,s,j,r));
(All,i,Com)(All,j,Ind)(All,r,Reg)VAL1T(i,"foreign",j,r)  = VAL1(i,"ROW",j,r);
(All,i,Com)(All,j,Ind)(All,r,Reg)VAL1O(i,j,r)= sum(aa,Twosou,VAL1T(i,aa,j,r));
(All,i,Com)(All,j,Ind)All,r,Reg )VAL2T(i,"domestic",j,r)= sum(s,reg,VAL2(i,s,j,r));
(All,i,Com)(All,j,Ind)(All,r,Reg)VAL2T(i,"foreign",j,r)= VAL2(i,"ROW",j,r);
(All,i,Com)(All,j,Ind)(All,r,Reg)VAL2O(i,j,r)=sum(aa,Twosou,VAL2T(i,aa,j,r));
(All,i,Com)(All,j,Ind)                                 SOU_SHR1(i,j)=
                    sum(r,REG,VAL1T(i,"domestic",j,r))/sum(x,REG,VAL1O(i,j,x));
(All,i,Com)(All,j,Ind)                                 SOU_SHR2(i,j)=
                    sum(r,REG,VAL2T(i,"domestic",j,r))/sum(x,REG,VAL2O(i,j,x));
```

```
(All,i,Com)(All,r,Reg)              VAL3T(i,"domestic",r)=sum(s,reg,VAL3(i,s,r));
(All,i,Com)(All,r,Reg)              VAL3T(i,"foreign",r)= VAL3(i,"ROW",r);
(All,i,Com)(All,r,Reg)              VAL3O(i,r)=sum(aa,Twosou,VAL3T(i,aa,r));
(All,i,Com)SOU_SHR3(i)=sum(r,REG,VAL3T(i,"domestic",r))/sum(x,REG,VAL3O(i,x));
(All,i,Com)SOU_SHR5(i)= VAL5D(i)/sum(s,SOU,sum(r,REG,VAL5(i,s,r)));
(All,i,Com)SOU_SHR6(i)= VAL6D(i)/sum(s,SOU,sum(r,REG,VAL6(i,s,r)));
 (All,i,Com)                        GAMMA(i)=1/ELAS(i);

Formula (All,i,Com)(All,r,Reg)      B3LUX(i,r) = -EPSIL(i,r)/FRISCH(r);
(All,i,Com)(All,r,Reg)              S3_BUD(i,r) =VAL3O(i,r)/Sum(k,COM,VAL3O(k,r));
Coefficient(All,i,Com)(All,r,Reg)S3LUX(i,r) # Marg. household budget shares #;
Formula    (All,i,Com)(All,r,Reg)S3LUX(i,r) = EPSIL(i,r)*S3_BUD(i,r);

 Formula         (All,q,Occ)(All,j,Ind)(All,r,Reg)LABOC(q,j,r)=
            WAGE(q,j,r) +INCTAX(q,j,r)+PAYROLL(q,j,r);
        (All,q,Occ)(All,r,Reg)              LAB_OC(q,r)=sum(j,IND, LABOC(q,j,r));
        (All,r,Reg)                         CAP_REG(r)=sum(j,IND,KAPRENT(j,r));
   (All,j,Ind)(All,r,Reg)                   LABOUR(j,r)=  sum(q,OCC,LABOC(q,j,r));
        (All,j,Ind)(All,r,Reg)              CAPITAL(j,r)=
                                    KAPRENT(j,r) + KAPTAX(j,r) + LNDTAX(j,r);
        (All,j,Ind)(All,r,Reg)              AGRILND(j,r)=AGLND(j,r)+AGRITAX(j,r);
        (All,j,Ind)(All,r,Reg)              PRIMARY("Lab",j,r)=LABOUR(j,r);
        (All,j,Ind)(All,r,Reg)              PRIMARY("Cap",j,r)=CAPITAL(j,r);
        (All,j,Ind)(All,r,Reg)              PRIMARY("Land",j,r)=AGRILND(j,r);
        (All,r,Reg)                         AGGLAB(r)=sum(j,IND,LABOUR(j,r));
        (All,r,Reg)                         AGGCAP(r)=sum(j,IND,CAPITAL(j,r));
        (All,r,Reg)                         AGGLAND(r)=sum(j,IND,AGRILND(j,r));
        (All,j,Ind)(All,r,Reg)              PRIMTOT(j,r)=sum(v,FAC,PRIMARY(v,j,r));
(All,m,Occ)(All,j,Ind)(All,r,Reg)WAGEINC(m,j,r)=WAGE(m,j,r) +INCTAX(m,j,r);
                                            C_TWIST_SRC = 1.0;
        (All,r,Reg)                         AGGOCT(r)=sum(j,IND,OTHCOST(j,r));

Formula
        (All,j,Ind)         ZIGOCC(j, "SA")=0.5;
        (All,j,Ind)         ZIGOCC(j, "ROA")=0.55;
Formula
         W_LINK   =1.0;
        CPI_oct    =1.0;
        LINK_LK    =1.0;
        h_ben   =1.0;
        P2LINK   =1.0;
 (All,r,Reg) h34r(r)   =1.0;
         CPI_TRN    =1.0;
Formula !allocating national tariff revenue to regions & summing M!
(All,i,Com)(All,r,Reg)                      IMPORT(i,r)=sum(j,IND,[BAS1(i,"ROW",j,r)+
BAS2(i,"ROW",j,r)])+BAS3(i,"ROW",r)+BAS6(i,"ROW",r)+BAS5(i,"ROW",r);
(All,i,Com)(All,r,Reg)  TAXMCG_r(i,r)=
                        TAXMCG(i)*IMPORT(i,r)/sum(k,REG,IMPORT(i,k));
(All,r,Reg)             TAXMCGR(r) = sum(i,COM, TAXMCG_r(i,r));
(All,i,Com)             VIMPORT(i)=sum(r,REG,IMPORT(i,r));
(All,i,Com)             T0(i) = TAXMCG(i)/VIMPORT(i);
(All,i,Com)(All,r,Reg)  IMP_CIF(i,r)=IMPORT(i,r)-TAXMCG_r(i,r);
               !add up indirect taxes!
(All,r,Reg)TAX1STZ(r)= sum(j,IND,sum(i,COM,sum(s,SOU,TAX1ST(i,s,j,r))));
(All,r,Reg)TAX1CGZ(r)= sum(j,IND,sum(i,COM,sum(s,SOU,TAX1CG(i,s,j,r))));
(All,r,Reg)TAX2CGZ(r)= sum(j,IND,sum(i,COM,sum(s,SOU,TAX2CG(i,s,j,r))));
(All,r,Reg)TAX2STZ(r)= sum(s,SOU,sum(i,COM,sum(j,IND,TAX2ST(i,s,j,r))));
(All,r,Reg)TAX3STZ(r)= sum(s,SOU,sum(i,COM,TAX3ST(i,s,r)));
(All,r,Reg)TAX3CGZ(r)= sum(i,COM,sum(s,SOU,TAX3CG(i,s,r)));
```

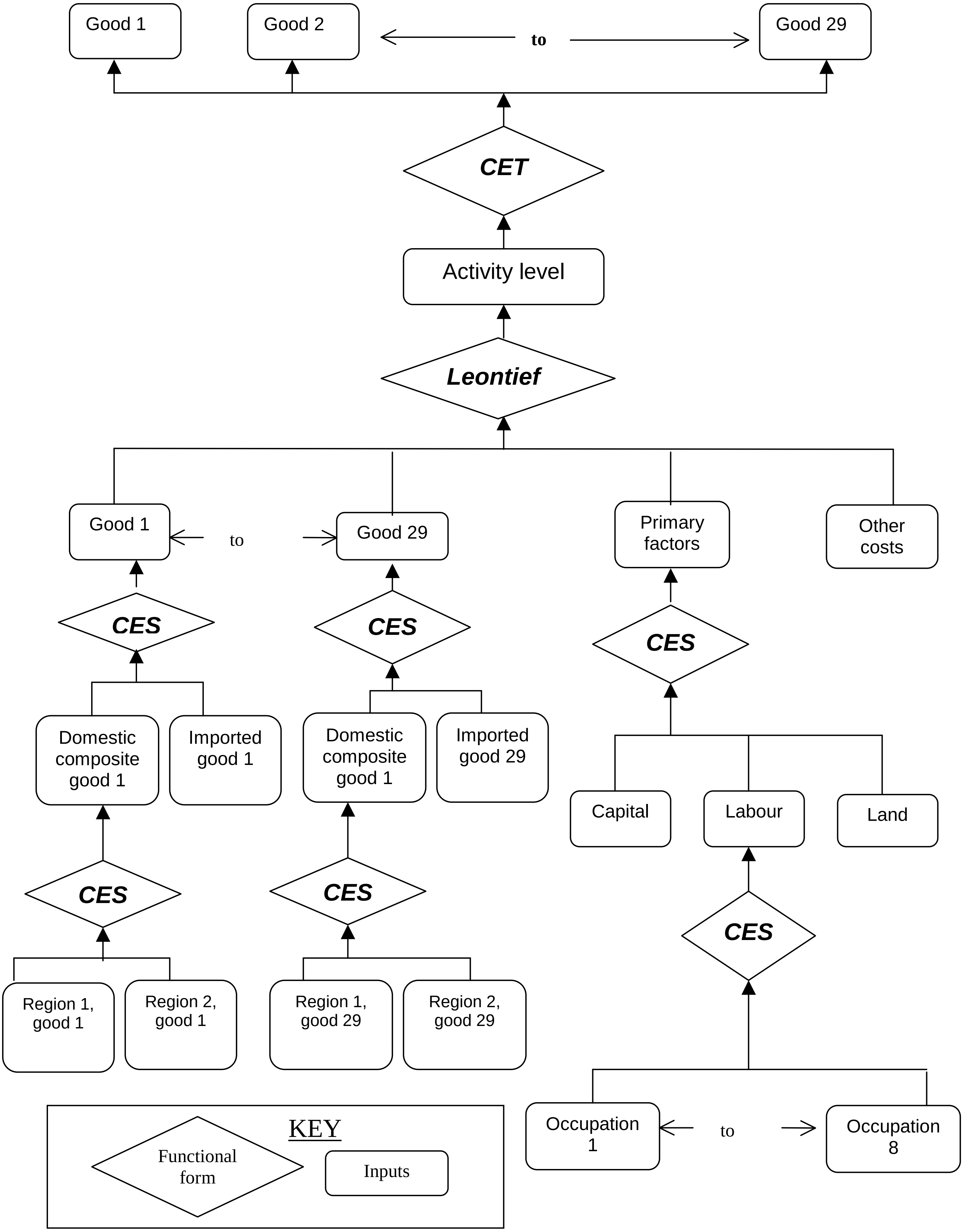
```
(All,r,Reg)TAX4CG(r) = sum(i,COM, TAX4(i,r));
(All,r,Reg)PRODTAXC(r) = sum(j,IND,CO1TAX(j,r));
(All,r,Reg)PRODTAXS(r) = sum(j,IND,ST1TAX(j,r));
Formula (All,r,Reg)INDI_REV(r) =
          TAX1STZ(r) +                TAX2STZ(r)+   TAX3STZ(r)
        + TAX1CGZ(r) +        TAX2CGZ(r)+   TAX3CGZ(r)
        + TAXMCGR(r) +        TAX4CG(r)              !trade taxes!
        + PRODTAXC(r)+        PRODTAXS(r);           !other revenue!
!adding up elements of GDP on income side!
Formula (All,r,Reg)GSPINC(r)
        =AGGLAB(r)+AGGCAP(r)+AGGLAND(r)+AGGOCT(r)+INDI_REV(r);
                !adding up elements of GDP on expenditure side!
Formula
(All,r,Reg)CON_r(r)=sum(i,COM,sum(s,SOU,VAL3(i,s,r)));
(All,r,Reg)INV_r(r)=sum(i,COM,sum(j,IND,sum(s,SOU,VAL2(i,s,j,r))));
(All,r,Reg)CGOV_r(r)=sum(s,SOU,sum(i,COM,VAL5(i,s,r)));
(All,r,Reg)SGOV_r(r)=sum(i,COM,sum(s,SOU,VAL6(i,s,r)));
(All,r,Reg)INVENT(r)= Sum{i,COM, Sum{s,Sou, BAS7(i,s,r) }};
Formula
(all,i,Com)(all,s,Reg)(all,r,Reg)INTER_FLO(i,s,r) = sum{j,IND, BAS1(i,s,j,r)}
                  + sum{j,IND, BAS2(i,s,j,r)} + BAS3(i,s,r)+ BAS5(i,s,r)+ BAS6(i,s,r);

(all,i,Com)(all,s,REG)INTER_EXP(i,s) =
  sum{r,Reg,INTER_FLO(i,s,r)} - INTER_FLO(i,s,s);
(all,i,Com)(all,r,Reg)INTER_IMP(i,r) =
  sum{s,Reg,INTER_FLO(i,s,r)} - INTER_FLO(i,r,r);

  (all,s,REG)INT_X(s) = Sum{i,Com,INTER_EXP(i,s)};
  (all,r,REG)INT_M(r) = Sum{i,Com,INTER_IMP(i,r)};
(All,r,Reg)EXP_r(r)=Sum{i,COM,{BAS4(i,r)+TAX4(i,r)+Sum{u,MAR,MAR4(i,r,u)}}};
(All,r,Reg)IMP_r(r)=Sum{i,COM,IMP_CIF(i,r)};
Formula (All,r,Reg)GDPEXP(r,"B2") = INV_r(r);
 (All,r,Reg)GDPEXP(r,"B3") = CON_r(r);
 (All,r,Reg)GDPEXP(r,"B4") = EXP_r(r);
 (All,r,Reg)GDPEXP(r,"B4I") = INT_X(r);
 (All,r,Reg)GDPEXP(r,"B5") = SGOV_r(r) + CGOV_r(r);
 (All,r,Reg)GDPEXP(r,"BS") = INVENT(r);
 (All,r,Reg)GDPEXP(r,"BM") = -IMP_r(r);
 (All,r,Reg)GDPEXP(r,"BMI") = - INT_M(r);
 (All,r,Reg)BASE_GSP(r) =  Sum(g,GDP,GDPEXP(r,g));
        BASE_GDP    =  Sum(r,REG,BASE_GSP(r));
 (All,r,Reg)BASE_GSP(r) = Sum(g,GDP,GDPEXP(r,g));
    BASE_GDP  = Sum(r,REG,BASE_GSP(r));
 (All,u,COM)(All,s,Reg)                     DIRSALE(u,s) =
 sum(j,IND,sum(r,REG,{BAS1(u,s,j,r)+BAS2(u,s,j,r)})) +
 sum(s,REG,{BAS3(u,s,r)+ BAS5(u,s,r)+BAS6(u,s,r)}) + BAS4(u,s) ;
(All,u,Mar)(All,r,Reg)                     MARGINS(u,r) =
 sum(i,COM,[sum(s,SOU,sum(j,IND,{MAR1(i,s,j,r,u)+
MAR2(i,s,j,r,u)})+MAR3(i,s,r,u)+MAR5(i,s,r,u) +MAR6(i,s,r,u))]
        +MAR4(i,r,u));
Formula (All,u,Nonmar)(All,r,Reg)          SALE(u,r) = DIRSALE(u,r);
(All,u,Mar)(All,r,Reg)SALE(u,r)=DIRSALE(u,r)+MARGINS(u,r);
(All,j,Ind)(All,r,Reg)                     TOTCOST(j,r) =
sum(i,COM,sum(t,SOU,VAL1(i,t,j,r)))+PRIMTOT(j,r)+ST1TAX(j,r)+
                                     CO1TAX(j,r)+OTHCOST(j,r);
(All,r,Reg)                 TAXPAYE(r) = sum(q,OCC,sum(j,IND,INCTAX(q,j,r)));
                            PRODTAXNAT = sum(j,IND,sum(r,REG,CO1TAX(j,r)));
(All,r,Reg)                 AGRITAXZ(r)= sum(j,IND,AGRITAX(j,r));
(All,r,Reg)                 KAPTAXZ(r) = sum(j,IND,KAPTAX(j,r));
```

```
(All,r,Reg)              VAL2CG(r)  = sum(i,IND,V2CG(i,r));
(All,r,Reg)              CGOVZ_r(r) =CGOV_r(r) + VAL2CG(r) !direct VAL5, VAL2!
        + DOLE(r)+COM2STATPAY(r)+COM2pers(r)!transfers to VAL3,VAL6!;
                         TZ_CGOV= sum(r,REG,
{TAX1CGZ(r)+TAX2CGZ(r)+TAX3CGZ(r)+TAX4CG(r)+TAXMCGR(r)})!commod'ity!
+PRODTAXNAT+sum(r,REG,{TAXPAYE(r)+KAPTAXZ(r)+AGRITAXZ(r)});!factor!
Formula
(All,r,Reg)              PAYROLLr(r)=sum(q,OCC,sum(j,IND,PAYROLL(q,j,r)));
(All,r,Reg)              LNDTAXr(r)= sum(j,Ind,LNDTAX(j,r));
(All,r,Reg)        SGOVZ_r(r)= SGOV_r(r)+sum(j,IND, V2SG(j,r))+ STAT2PERS(r) ;
(All,r,Reg)        TZ_SGOV(r)=TAX1STZ(r)+TAX2STZ(r)+TAX3STZ(r)     !commodity!
        +PAYROLLr(r)+LNDTAXres(r)+LNDTAXnr(r)+PRODTAXS(r)         !factor!
        +FEEFINESG(r)+COM2STATPAY(r);                             !transfers!
(All,j,Ind)(All,r,Reg)           MAKE_I(j,r)=sum(i,COM,MAKE(i,j,r));
(All,i,Com)(All,r,Reg)           MAKE_J(i,r)=sum(j,IND,MAKE(i,j,r));
Formula   !numbers for two stage nesting!
(All,s,Sou)        IS_DOM(s) = 1;
                   IS_DOM("ROW") = 0;
(All,s,Sou)        IS_IMP(s) = 0;
                   IS_IMP("ROW") = 1;
                   TINY = 0.000000000001;
```

A.5. Overview of the model's equations

Excerpts 5 to 17 of the TABLO code contain the equations of the model. Blocks of equations deal with production (excerpt 5), investment (excerpt 6), household consumption (excerpt 7), exports (excerpt 8), Commonwealth expenditure (excerpt 9) and state government expenditure (excerpt 10). Subsequent parts cover margins, prices, primary factor prices, market clearing equations and regional and national aggregates. This appendix outlines the equations in FEDSA-WINE without detailing the derivation of them. Horridge et al. (1998) provide derivations of the equations.

Figure A.2: Structure of production in FEDSA-WINE



A.5. Structure of production

Figure A.2 summarises the structure of production within the model. Separability assumptions keep the production specification of the model manageable. At the top of figure A.2, we assume input-output separability. Consider the production function of an industry, given as:

$$F(\text{inputs, outputs}) = 0 \qquad (A.1)$$

We write this as:

$$G(\text{inputs}) = X\_TOT = H(\text{outputs}) \qquad (A.2)$$

where X_TOT is an index of industry activity.

Excerpt 5 of the TABLO code includes equations describing the supply of commodities (the H function), shown at the top of figure A.2. Equation E_q1 uses a CET transformation function, so that any industry may produce more than one commodity. Within the database of the FEDSA-WINE, each industry is single product, so that this section of equations is not activated.

A.6. Demands for intermediate inputs

Further separability assumptions apply in a series of nests in the G function. Excerpt 5 also includes equations describing demand for intermediate inputs into production. This corresponds with the left side of figure A.2. The theory of the model assumes that producers' purchases from each source are imperfectly substitutable.

Equation E_x1_q includes two CES substitution 'nests'. In the first, changes in the domestic nest (*x1c,* solved in equation E_x1c) occur through substitution as a result of differences between the regional and domestic nested prices (at the bottom of figure A.2). In the second, changes in the domestic-international nest (*x1o*, solved in equation E_x1o) result from Armington substitution (Armington 1969; 1970). The final part of the equation allows a twist in preferences between domestic and imported goods through the variable *twist_src*. By making this variable endogenous, the modeller can shock the observed historical change in imports in historical simulations (chapter 3). Terms denoting changes in intermediate-input using technologies have been omitted from equation E_x1_q.

A.7. Demands for primary factors

The next block of equations in excerpt 5 deals with demands for primary factors. Starting at the bottom of the right hand side of figure A.2, the first problem is to choose a combination of labour types to minimise the total labour cost. This is solved in equation E_x_lab, in which different types of labour are substitutable according to a CES function linking occupation-specific labour costs, *plab*, to the composite labour cost.

Excerpt 5: production equations

```
!5: PRODUCTION COLUMN!
!5A: Outputs of commodities!
Equation E_q1  #supplies of commodities by industries#
  (All,i,Com)(All,j,Ind)(All,r,Reg)
q1(i,j,r) = zact(j,r) + SIGMA1OUT(j)*(p0(i,r) - p1tot(j,r));

Equation E_zact  #average price received by industries#
  (All,j,IND)(All,r,Reg)MAKE_I(j,r)*p1tot(j,r)=sum{i,COM,MAKE(i,j,r)*p0(i,r)};

Equation E_x_tot #total output of commodities#
  (All,i,Com)(All,r,Reg)MAKE_J(i,r)*x_tot(i,r)=sum{j,IND,MAKE(i,j,r)*q1(i,j,r)};

!5B: Intermediate inputs!
Equation E_x1_q  #demands by industries for intermediate inputs#
   (All,i,Com)(All,s,Sou)(All,j,Ind)(All,r,Reg)x1_q(i,s,j,r) =
IS_DOM(s)*(x1c(i,j,r)- ZIG1D(i)*(p1(i,s,j,r)-p1c(i,j,r)))        !domestic nest!
  + IS_IMP(s)*(x1o(i,j,r)- ZIG1I(i)*(p1(i,"ROW",j,r)-p1o(i,j,r))) !domestic-import nest!
- { IS_DOM(s) - SOU_SHR1(i,j) }*twist_src(i);                    !domestic-import twist!
```

```
Equation E_p1o  #price of domestic/foreign composite, V1#
  (All,i,Com)(All,j,Ind)(All,r,Reg)
[VAL1O(i,j,r)+TINY]*p1o(i,j,r) = Sum(s,SOU,VAL1(i,s,j,r)*p1(i,s,j,r));

Equation E_p1c  #price of domestic composite, V1, nest 2 #
  (All,i,Com)(All,j,Ind)(All,r,Reg)
[VAL1T(i,"domestic",j,r)+TINY]*p1c(i,j,r)= Sum(s,reg,VAL1(i,s,j,r)*p1(i,s,j,r));

Equation E_x1c  #demand for domestic composite, V1#
   (All,i,Com)(All,j,Ind)(All,r,Reg)
x1c(i,j,r) = x1o(i,j,r) - ZIG1I(i)*(p1c(i,j,r)-p1o(i,j,r));

Equation E_x1o  #demands for composite inputs, V1#
  (All,i,Com)(All,j,Ind)(All,r,Reg) x1o(i,j,r) -a_in(j,r) = zact(j,r);

Equation E_t1_com   # power of tax on sales to intermediate #
 (All,i,Com)(All,s,Sou)(All,j,Ind)(All,r,Reg)t1_com(i,s,j,r)=
  f0tax_s(i)+f1_com(i,s)+f1_ind(s,j,r);

Equation E_znat #national industry outputs, value-added weights#
(All,j,Ind)Sum(r,Reg,PRIMTOT(j,r))*znat(j)=Sum(r,Reg,PRIMTOT(j,r)*zact(j,r));
!5C: Primary factors!
Equation E_employ  # Industry demands for effective labour #
(All,j,Ind)(All,r,Reg)employ(j,r)- a_fac("Lab",j,r) =
 x1prim(j,r)- ZIGPRI(j,r)*[pprim("Lab",j,r) + a_fac("Lab",j,r) - p1prim(j,r)];

Equation E_k_rjst  #capital demands#
  (All,j,Ind)(All,r,Reg)k_rjst(j,r)- a_fac("Cap",j,r) =
x1prim(j,r)- ZIGPRI(j,r) *[pprim("Cap",j,r) + a_fac("Cap",j,r) - p1prim(j,r)];

Equation E_pprimC       #land demands#
  (All,j,Ind)(All,r,Reg)x_agland(j,r)- a_fac("Land",j,r) =
x1prim(j,r)- ZIGPRI(j,r) *[pprim("Land",j,r) + a_fac("Land",j,r) - p1prim(j,r)];

Equation E_p1prim  # Effective price term for factor demand equations #
(all,j,Ind)(All,r,Reg)[PRIMTOT(j,r)+TINY]*p1prim(j,r) =
 LABOUR(j,r) * [pprim("Lab",j,r) + a_fac("Lab",j,r)]
+ CAPITAL(j,r)* [pprim("Cap",j,r) + a_fac("Cap",j,r)]
+ AGRILND(j,r)* [pprim("Land",j,r)+ a_fac("Land",j,r)];

Equation E_x1prim  # Demands for primary factor composite #
(all,j,IND)(All,r,Reg)  x1prim(j,r) - [a_prim(j,r) + a_in(j,r)] = zact(j,r);

Equation E_x_lab       #occupation specific demands#
   (All,q,Occ)(All,j,Ind)(All,r,Reg)x_lab(q,j,r) =
employ(j,r) - ZIGOCC(j,r) *[plab(q,j,r) - pprim("Lab",j,r)];

Equation E_pprimA   #industry price for labour#
        (All,j,Ind)(All,r,Reg)[LABOUR(j,r)+TINY]*pprim("Lab",j,r) =
Sum(q,OCC,LABOC(q,j,r)*plab(q,j,r));

Equation E_xsptax  #SGOV production tax#
   (All,j,Ind)(All,r,Reg)xsptax(j,r)=zact(j,r);

Equation E_xcptax  #CGOV production tax#
   (All,j,Ind)(All,r,Reg)xcptax(j,r)=zact(j,r);

Equation E_xcost  #other costs#
  (All,j,Ind)(All,r,Reg)xcost(j,r) - a_in(j,r) - a_cost(j,r)=zact(j,r);
```

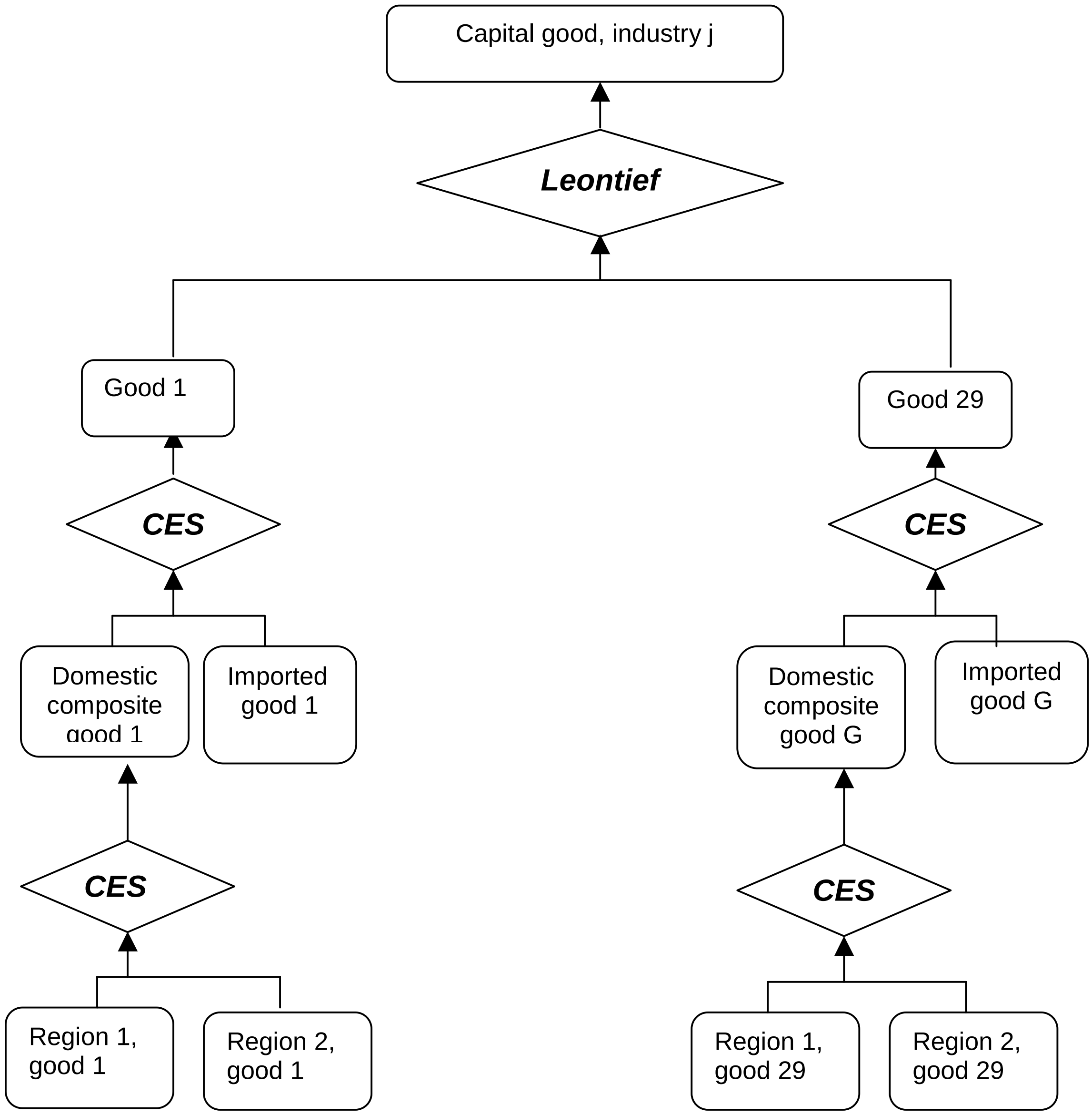
At the next level the primary factor costs are minimised for a given primary input requirement. Labour (a composite of occupations), capital and land (denoted by variables, *employ*, *k_rjst* and *x_agland*) have CES substitution possibilities. Note that since agricultural land is usually fixed in supply, *x_agland* is exogenous. This means that equation E_pprimC, with a similar functional form to E_employ and E_k_rjst, solves for the price of land (*pprim("Land",j,r)*) rather than quantities as in the other two equations. But if the modeller chooses the rate of return (*r_k*) to be endogenous instead of capital stocks (*k_rjst*), E_k_rjst solves for *r_k* indirectly through linkages to equation E_pprimB in excerpt 17.

The effective (i.e. nested) intermediate input and primary factor demands, plus other costs (including production taxes) are Leontief. This means that as the composite price of each input varies, the proportions of each composite input demanded remain unchanged, for a given technology.

A.8. Demands for investment inputs

The next section contains equations for investment demands (excerpt 6). Figure A.3 illustrates the structure of demand for investment. Unlike production, there are no direct primary inputs into investment. Rather, primary inputs are indirectly involved in capital creation through the intermediate inputs. For example, one of the important inputs into investment, construction (*C20Construct*), is relatively intensive in its use of labour. In determining the mix of intermediate inputs by source, investment demands follow the two stage nesting process (domestic-domestic and domestic composite-import) with CES substitution, as applies to production.

Figure A.3: Structure of investment demand



Excerpt 6: investment equations

```
Equation E_x2_q  #input demands, investment#
  (All,i,Com)(All,s,Sou)(All,j,Ind)(All,r,Reg)x2_q(i,s,j,r) =
 IS_DOM(s)*(x2c(i,j,r)- ZIG2D(i)*(p2(i,s,j,r)-p2c(i,j,r))) !domestic nest!
  + IS_IMP(s)*(x2o(i,j,r)- ZIG2I(i)*(p2(i,"ROW",j,r)-p2o(i,j,r)))!dom-imp nest!
-{ IS_DOM(s) -SOU_SHR2(i,j) }*twist_src(i);!dom-imp twist!

Equation E_p2o  #price of domestic/foreign composite, V2#
  (All,i,Com)(All,j,Ind)(All,r,Reg)
[TINY+VAL2O(i,j,r)]*p2o(i,j,r) = Sum(s,SOU,VAL2(i,s,j,r)*p2(i,s,j,r));

Equation E_p2c  #price of domestic composite, V2#
  (All,i,Com)(All,j,Ind)(All,r,Reg)
[TINY+VAL2T(i,"domestic",j,r)]*p2c(i,j,r) =Sum(s,reg,VAL2(i,s,j,r)*p2(i,s,j,r));

Equation E_x2c     #demand for domestic composite, V2#
  (All,i,Com)(All,j,Ind)(All,r,Reg)x2c(i,j,r) =
x2o(i,j,r) - ZIG2I(i)*(p2c(i,j,r)-p2o(i,j,r));

Equation E_x2o   #demands for composite inputs, V2#
  (All,i,Com)(All,j,Ind)(All,r,Reg)x2o(i,j,r) =  x2_jr(j,r)  ;

Equation E_x2ind  #private investment demands#
  (All,j,Ind)(All,r,Reg)[VAL2SUM(j,r)+TINY]*x2_jr(j,r)=
[VAL2SUM(j,r)-V2CG(j,r)-V2SG(j,r)]*x2ind(j,r)
  + V2CG(j,r)*x2_cg(j,r) + V2SG(j,r)* x2_sg(j,r);

Equation E_t2_com   # power of tax on sales to investment #
 (All,i,Com)(All,s,Sou)(All,j,Ind)(All,r,Reg)t2_com(i,s,j,r)=
  f0tax_s(i)+f2_com(i,s);
```

A.9. Household demands

As is the case for demand for intermediate inputs into production and investment, the nested household commodities are determined by two CES functions (figure A.4). Equation E_x3_q determines effective demand for household commodities.

The allocation of household expenditure between commodity composites (i) is derived from the Klein-Rubin utility function (omitting regions):

$$UTILITY \text{ per household} = \frac{1}{QHOUS} \prod_i \left(X3\_Q(i) - X3SUB(i)\right)^{S3LUX(i)} \quad \text{(A.3)}$$

S3LUX must sum to unity across all commodities. The following demand equations, in levels (block letters indicate the levels version of the percentage change variable in the code), arise from the utility function:

$$X3\_Q(i) = X3\_SUB(i) + S3LUX(i).V3LUXTOT/P3O(i) \qquad \text{(A.4)}$$

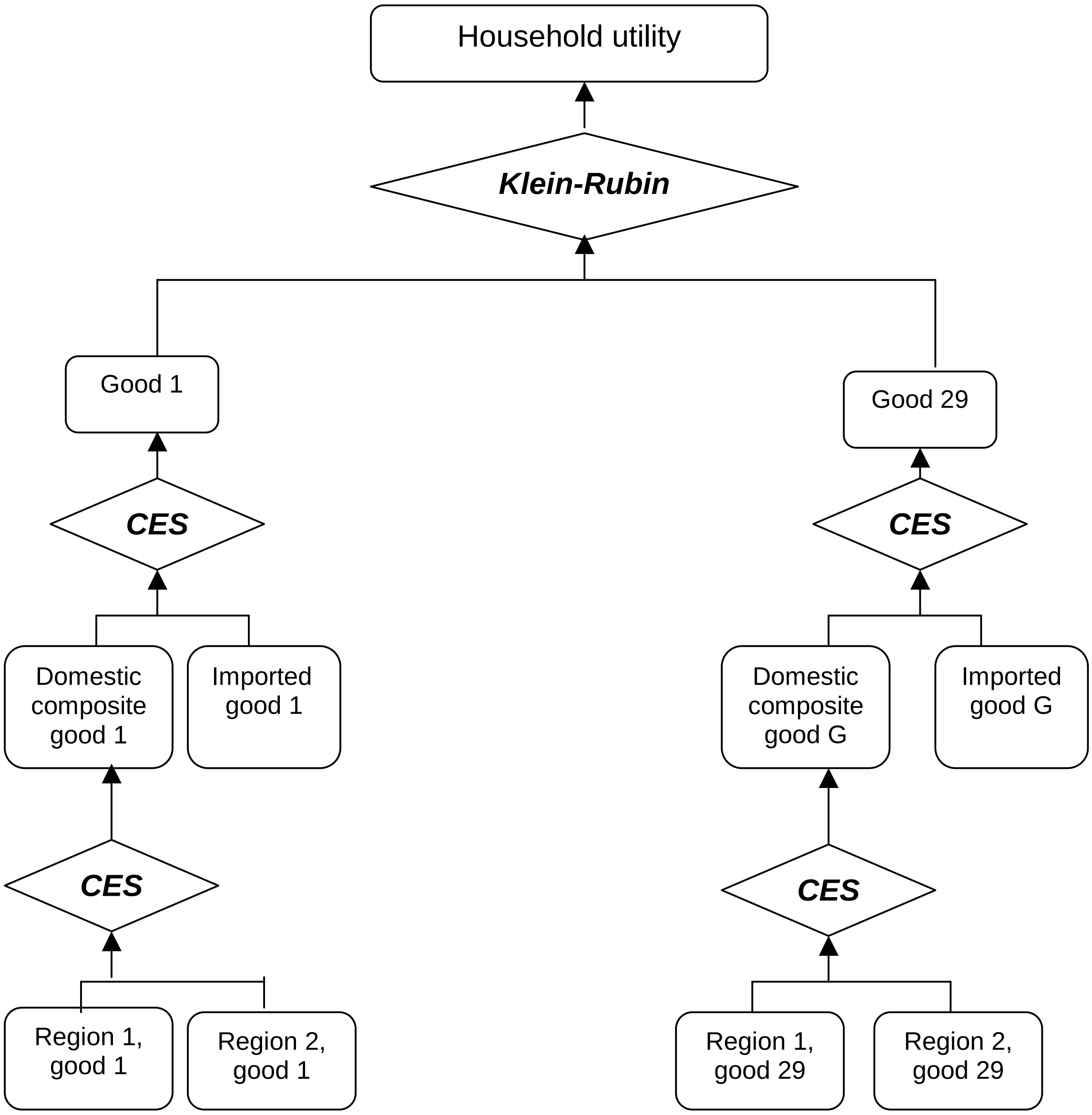
where:

$$V3LUXTOT = CON\_r - \Sigma X3\_SUB(i).P3O(i) \qquad \text{(A.5)}$$

The expenditure on each composite commodity is a linear combination of prices (*P3O*) and total nominal expenditure (*CON_r*), hence the term ‘linear expenditure system’. The form of the demand equations implies that household expenditure includes a ‘subsistence’ component (*X3_SUB*(*i*)), purchased independently of price. The remaining expenditure, *V3LUXTOT,* is the ‘luxury’ component. *S3LUX*(*i*) is the share of this remaining expenditure allocated to each commodity, and consequently is called the ‘marginal budget share’ of each commodity.

Equation E_x3sub indicates that percentage changes in subsistence demands equal the percentage changes in the number of households (*qhous*) plus the changes in individual household subsistence demands (*a3sub*). In equation E_x3lux, percentage changes in luxury expenditures on each commodity (*x3lux* + *p3o*) depend on percentage changes in marginal budget shares (*a3lux*) plus changes in total luxury expenditure (*v3lux*). And in E_x3_q, percentage changes in total household demands for each commodity are the expenditure-share weighted sum of changes in the luxury and subsistence components.

Figure A.4: Structure of household consumer demand



Excerpt 7: household column

```
Equation E_x3_qr   #demand for goods by source, V3#
  (All,i,Com)(All,s,Sou)(All,r,Reg)x3_qr(i,s,r) =
IS_DOM(s)*(x3c(i,r)-ZIG3D(i)*(p3r(i,s,r)-p3c(i,r))) !intradomestic!
 +IS_IMP(s)*(x3_q(i,r)-ZIG3I(i)*(p3r(i,"ROW",r)-p3o(i,r)))!import!
- { IS_DOM(s) - SOU_SHR3(i) }*twist_src(i);!dom-imp twister!

Equation E_x3sub  # Subsistence demand for composite commodities #
 (All,i,Com)(All,r,Reg) x3sub(i,r) = qhous(r) + a3sub(i,r);

Equation E_x3lux  # Luxury demand for composite commodities #
(All,i,Com)(All,r,Reg) x3lux(i,r) + p3o(i,r) = v3lux(r) + a3lux(i,r);

Equation E_x3_q  # Total household demand for composite commodities #
(All,i,Com)(All,r,Reg) x3_q(i,r)
   = B3LUX(i,r)*x3lux(i,r) + [1-B3LUX(i,r)]*x3sub(i,r);


Equation E_utility  # Change in utility disregarding taste change terms #
  (All,r,Reg)utility(r) + qhous(r) = sum{i,COM, S3LUX(i,r)*x3lux(i,r) };

Equation E_a3lux  # Default setting for luxury taste shifter #
(All,i,Com)(All,r,Reg)a3lux(i,r)= a3sub(i,r) -sum{k,COM, S3LUX(k,r)*a3sub(k,r)};

Equation E_a3sub  # Default setting for subsistence taste shifter #
(All,i,Com)(All,r,Reg)a3sub(i,r) = a3com(i,r)-sum{k,COM,S3_BUD(k,r)*a3com(k,r)};

Equation E_p3o   #price of domestic/foreign composite, V3#
   (All,i,Com)(All,r,Reg)
(TINY+VAL3O(i,r))*p3o(i,r) =Sum(s,SOU,VAL3(i,s,r)*p3r(i,s,r));

Equation E_p3c   #price of domestic composite, V3#
   (All,i,Com)(All,r,Reg)
(TINY+VAL3T(i,"domestic",r))*p3c(i,r)= Sum(s,reg,VAL3(i,s,r)*p3r(i,s,r));

Equation E_x3c   #demand for domestic composite, V3#
   (All,i,Com)(All,r,Reg)x3c(i,r) =
x3_q(i,r) - ZIG3I(i)*(p3c(i,r)-p3o(i,r));

Equation E_t3_com   # power of tax on sales to households #
 (All,i,Com)(All,s,Sou)t3_com(i,s)= f0tax_s(i) + f3_com(i,s);
```

Equation E_utility is the percentage-change form of the utility function shown in equation (A.3). Equations E_a3sub and E_a3lux provide default settings for the taste change variables, *a3sub* and *a3lux*.

A.10. Export demands

Separate export demands exist for traditional and non-traditional exports (excerpt 7). ‘Traditional’ exports, as defined by the set ‘Exp’ in excerpt 1 of the code, include primary products, some downstream manufactures from primary products, the three wine industries and, for GST simulations, tourism-related exports. Non-traditional exports generally only account for a small proportion of the output of the commodity so classified.

Excerpt 8: export column

```
Equation E_x4r   #export demands, traditional#
  (All,i,EXP)(All,r,Reg)x4r(i,r) =
-ELAS4(i) * [p4r(i,r) - fp4(i,r) - x_rate] + fx4(i,r) + f4_nat;

Equation E_x4r_ntagg    #export demands, non-trad aggregate#
  (All,r,Reg)x4r_ntagg(r) =
-ELAS4_NT*[ p4_ntagg(r) - fp4_ntagg(r)- x_rate] + fx4_ntagg(r) + f4_nat;

Equation E_x4r_A    #export demand functions, non-trad#
    (All,i,Imp)(All,r,Reg)x4r(i,r) = x4r_ntagg(r) + f4(i,r);

Equation E_x4  #export demands, national#
  (All,i,EXP) Sum{r,Reg,VAL4(i,r)}*x4(i) =Sum{r,Reg,VAL4(i,r)*x4r(i,r)};

Equation E_p4_ntagg   #export price, non-trad aggregate, foreign units #
    (All,r,Reg)VAL4NT(r)* p4_ntagg(r) = Sum(i,IMP,VAL4(i,r)*p4r(i,r));

Equation E_p4   #export price index, foreign units#
   (All,i,Com)p4(i) = Sum(r,REG,SH4(i,r)*p4r(i,r));

Equation E_t4_com   # power of tax on sales to export#
 (All,i,Com)(All,r,Reg)t4_com(i,r)= f0tax_s(i) + f4_com(i,r);
```

In equation E_x4, traditional exports face downward sloping demand curves with a constant commodity-specific export demand elasticity, *ELAS* (a positive number). The equation includes two demand shifters, *fp4* for price (vertical) shifts and *fx4* for quantity (horizontal) shifts. Non-traditional exports have an exogenous commodity composition due to a Leontief aggregation. The total quantity of non-traditional exports is related to the average non-traditional export price by a constant elasticity demand curve in equation E_x4r_ntagg.

A.11. Commonwealth government demands

An important motivation in developing the FEDERAL (Madden 1995) and Monash-MRF models (Naqvi and Peter 1995), which are multiregional 'bottom-up' models of the Australian economy, was to model the interaction between economic activity (disaggregated by industry, commodity and region) and fiscal policy changes. Consequently, these models include detailed fiscal modules.

Excerpt 9 of the code contains equations for Commonwealth government finances. Percentage changes in total Commonwealth expenditure are a value-weighted sum of percentage changes in the components of expenditure. These include direct Commonwealth spending (i.e. column 5 of the absorption matrix in figure A.1), Commonwealth capital creation, expenditure on unemployment benefits, transfers to the states and transfers to persons, as shown in equation E_b4.

Real direct Commonwealth expenditure, as defined in equation E_x5, is Leontief in commodity composition. The level of total direct expenditure is determined elsewhere in the model through one of a number of closure options, including keeping the total exogenous. Commonwealth transfers to states (equation E_t51) and persons (equation E_t52) are both linked to CPI. The shifter *f54r* in equation E_t51 may be endogenised to keep the state governments' PSBRs exogenous.

Equation E_b4 sums percentage changes in Commonwealth revenues as weighted percentage changes in indirect tax revenues, income taxes and production taxes. The indirect tax equations E_tax*n*_com (n = type of sale) and E_taxm_com add up percentage changes in indirect taxes for each type of sale, based on changes in commodity prices, quantities and power of the tax rates. Percentage changes in income tax revenues (equations E_b41r, E_b42r and E_b43r) are functions of revenue-weighted changes in factor quantities and unit tax rates. An equation defining the levels change in the Commonwealth PSBR, *cb2* (E_fpaye), completes the Commonwealth fiscal block of equations.

Excerpt 9: Commonwealth government finances

```
!9A: Expenditure!
Equation E_x5                    #Commonwealth demands by commodity#
(All,i,Com)(All,s,Sou)(All,r,Reg)x5(i,s,r) = f51(i,s)
+ f5nat  - { IS_DOM(s) - SOU_SHR5(i) }*twist_src(i);

Equation E_f_x5                  #C'wealth total demands#
   f_x5 = x3_nat + f_x52;

Equation E_cg_g                  # total Commonwealth G #
                 sum(r,REG,CGOVZ_r(r))*cg_g =
 sum(r,REG,{sum(i,COM,sum(s,SOU,VAL5(i,s,r)*[p5(i,s,r)+x5(i,s,r)]))+
                 sum(i,IND,V2CG(i,r)*[p2tot(i,r) + x2_cg(i,r)]) +
                 DOLE(r)*[punb + x_unemp(r)] +
                 COM2STATPAY(r)*g56(r) + COM2PERS(r)*g5p(r)});

Equation E_g56                   #C'wealth transfers to states#
                 (All,r,Reg)g56(r) = CPI_TRN*cpi + f56r(r);

Equation E_g5p                   # C'wealth transfers to persons #
                 (All,r,Reg)g5p(r) = CPI_TRN*cpi + f5p(r);

!9B: Receipts!
Equation E_cg_r                  # total Commonwealth receipts#
                 TZ_CGOV*cg_r =
sum(r,reg,{TAX1CGZ(r)*tax1_com(r) + TAX2CGZ(r)*tax2_com(r)
                 + TAX3CGZ(r)*tax3_com(r)
+ TAXMCGR(r)*taxm_com(r) + TAX4CG(r)*tax4_com
                 +  TAXPAYE(r)*t_paye(r)
                 + KAPTAXZ(r)*t_rnt(r)
                 + AGRITAXZ(r)*t_lnd(r)
                 + PRODTAXC(r)*tcg_pt(r)});

Equation E_tax1_com  #C'wealth govt receipts from producers' purchases#
  (All,r,Reg)TAX1CGZ(r)*tax1_com(r) =
Sum{s,SOU,Sum{i,COM,Sum{j,IND,
{BAS1(i,s,j,r)+TAX1CG(i,s,j,r)+TAX1ST(i,s,j,r)}*t1_com(i,s,j,r)
 + TAX1CG(i,s,j,r)*{x1_q(i,s,j,r)+p0(i,s)}}}};
```

```
Equation E_tax2_com  #C'wealth govt receipts from investors#
   (All,r,Reg)TAX2CGZ(r)*tax2_com(r) =
      Sum{s,SOU,Sum{i,COM,Sum{j,IND,
{BAS2(i,s,j,r)+TAX2CG(i,s,j,r)+TAX2ST(i,s,j,r)}*t2_com(i,s,j,r)
  +TAX2CG(i,s,j,r)*{x2_q(i,s,j,r)+p0(i,s)}}}};

Equation E_tax3_com   #C'wealth govt receipts from households#
   (All,r,Reg)TAX3CGZ(r)*tax3_com(r) =
Sum{s,SOU,Sum{i,COM,
[BAS3(i,s,r)+TAX3CG(i,s,r)+TAX3ST(i,s,r)]*t3_com(i,s,r)
  + TAX3CG(i,s,r)*[x3_qr(i,s,r)+p0(i,s)]}};

Equation E_tax4_com              #C'wealth export tax receipts#
                          (All,r,Reg)TAX4CG(r)* tax4_com(r)=
sum(i,COM,{BAS4(i,r)+TAX4(i,r)}*t4_com(i,r)
                           + TAX4(i,r)*{x4r(i,r)+p4r(i,r)});

 Equation E_t_paye                #PAYE receipts#
                          (All,r,Reg)TAXPAYE(r)*t_paye(r) =
sum(m,OCC,sum(j,IND,{INCTAX(m,j,r)*[paye(m,j,r) + x_lab(m,j,r)]}));

Equation E_t_rnt                  #rental tax receipts#
                          (All,r,Reg)KAPTAXZ(r)*t_rnt(r) =
sum(j,IND,(KAPTAX(j,r)*{p_kaptax(j,r) + k_rjst(j,r)}));

Equation E_t_lnd                  #agri. land tax receipts#
                          (All,r,Reg)AGRITAXZ(r)*t_lnd(r) =
sum(j,IND,AGRITAX(j,r)*{p_landtx(j,r) + x_agland(j,r)}) ;

Equation E_taxm_com  #tariff revenue of region r#
 (All,r,Reg)TAXMCGR(r)*taxm_com(r) =
 Sum{i,COM, TAXMCG_r(i,r)*[pmp(i) + xr_imp(i,r) +x_rate]+ IMPORT(i,r)*tm(i)};

Equation E_tcg_pt                 #prod tax revenue by region r#
                           (All,r,Reg)PRODTAXC(r)*tcg_pt(r) =
 sum(j,IND, CO1TAX(j,r)*[cpptax(j,r) +xcptax(j,r)]);

Equation E_fpaye                  # Commonwealth PSBR #
100*cb2 =sum(r,REG,CGOVZ_r(r))*cg_g - TZ_CGOV*cg_r ;
```

A.11. State government demands

Excerpt 10 of the code deals with the state government finance module. State demands, if endogenous, are Leontief (equation E_x6). Percentage changes in state expenditure are the weighted sum of percentage changes in public consumption, public investment and transfers to persons (equation E_sg_g). Remaining equations describe percentage changes in revenues collected from payroll taxes (E_t_prol), property taxes (E_t_comp), state production taxes (E_tsg_pt), indirect taxes (E_tax*n*_st) and fees and fines (E_t_sg_yr). The state PSBR is calculated in equation E_f56r. The variable f56r is kept endogenous and the PSBR exogenous in the GST scenarios discussed in chapter 4. This assumes that as state financial taxes are reduced under a GST, the Commonwealth disburses revenues to the states as announced in the Commonwealth government's GST package.

Excerpt 10: state government finances

```
!10A: Expenditure!
Equation E_x6            #State demands by commodity#
                    (All,i,Com) (All,s,Sou) (All,r,Reg)  x6(i,s,r)=
f6p(i,s,r) + f6gen(r)- { IS_DOM(s) - SOU_SHR6(i) }*twist_src(i);

Equation E_f_x6   #State demands link to x3#
                    f_x6 = x3_nat + f_x62;

Equation E_sg_g                  #total State govt. outlays#
                    (All,r,Reg)SGOVZ_r(r)*sg_g(r)=
sum(i,COM,sum(s,SOU,{VAL6(i,s,r)*[p6(i,s,r) + x6(i,s,r)]})) +
        sum(j,IND, V2SG(j,r)*[p2tot(j,r) + x2_sg(j,r)]) + {STAT2PERS(r)*g6p(r)};

Equation E_g6p                   #State transfers to persons #
                    (All,r,Reg)g6p(r) = CPI_TRN* cpi + f_transr(r);

!10B: Receipts!
Equation E_sg_r                  #total State govt. revenues#
                    (All,r,Reg)TZ_SGOV(r)*sg_r(r) =
PAYROLLr(r)*t_prol(r)
                    + LNDTAXr(r)*t_comp(r)
                    + PRODTAXS(r) *tsg_pt(r)       !1: primary factor tax revenues!
                    + TAX1STZ(r)*tax1_st(r)
                    + TAX2STZ(r)*tax2_st(r)
                    + TAX3STZ(r)*tax3_st(r)        !2: commodity tax revenues!
                    + FEEFINESG(r)*t_sg_yr(r)      !fines, etc. not linked to 1 or 2!
                    + COM2STATPAY(r)*rcg_sg(r);  !from Commonwealth!

Equation E_t_prol                #payroll tax revenues#
                    (All,r,Reg)PAYROLLr(r)*t_prol(r) =
sum(m,OCC,sum(j,IND,PAYROLL(m,j,r) * [p_roll(m,j,r) + x_lab(m,j,r)]));

Equation E_prop_tax  # property tax rate#
 (All,j,Ind)(All,r,Reg)prop_tax(j,r) = P2LINK*p2tot(j,r)+f_prop_tax(j,r);

Equation E_t_comp   #property tax receipts#
  (All,r,Reg)LNDTAXr(r)*t_comp(r) =
Sum(j,IND,{LNDTAX(j,r)*[prop_tax(j,r)+k_rjst(j,r)]});
```

```
Equation E_tax1_st  #State govt receipts from producers' purchases#
(All,r,Reg)TAX1STZ(r)*tax1_st(r)=
      Sum{s,SOU,Sum{i,COM,Sum{j,IND,
   [BAS1(i,s,j,r) + TAX1ST(i,s,j,r)+ TAX1CG(i,s,j,r)]*t1_state(i,s,r)
      + TAX1ST(i,s,j,r)*[x1_q(i,s,j,r)+p0(i,s)]}}};
Equation E_tax2_st  #State govt receipts from investors' purchases#
  (All,r,Reg)TAX2STZ(r)*tax2_st(r)=
      Sum{s,SOU,Sum{i,COM,Sum{j,IND,
   [BAS2(i,s,j,r) + TAX2ST(i,s,j,r)+ TAX2CG(i,s,j,r)]*t2_state(i,s,r)
      + TAX2ST(i,s,j,r)* [x2_q(i,s,j,r)+p0(i,s)]}}};

 Equation E_tax3_st  #State govt receipts from household purchases#
(All,r,Reg)TAX3STZ(r)*tax3_st(r)=
      Sum{i,com,Sum{s,SOU,
[BAS3(i,s,r)+TAX3ST(i,s,r)+TAX3CG(i,s,r)]*t3_state(i,s,r)
      + TAX3ST(i,s,r)*[x3_qr(i,s,r)+p0(i,s)]}};
Equation E_t_sg_yr                    #fines, fees#
                         (All,r,Reg)t_sg_yr(r) = h34r(r)*gsp_inc(r) + f_ytax(r);

Equation E_tsg_pt                     #State production taxes#
                         (All,r,Reg)[PRODTAXS(r)+TINY]*tsg_pt(r) =
 sum(j,IND,ST1TAX(j,r)*[spptax(j,r) + xsptax(j,r)]);

Equation E_spptax                     #State production taxes, ir#
                         (All,j,Ind)(All,r,Reg)spptax(j,r) = CPI_oct*p3_r(r) +fprodrj(j,r);

Equation E_f56r            # State PSBR#
                         (All,r,Reg)100*cb1r(r) = SGOVZ_r(r)*sg_g(r) - TZ_SGOV(r)*sg_r(r) ;
```

A.12. Demands for margins

The percentage change in margins associated with each transaction is set equal to the percentage change in the volume of each type of sale in excerpt 11. Technical change terms for margins usage have been omitted.

Excerpt 11: margins

```
Equation E_x_mar1
             (All,i,Com)(All,s,Sou)(All,j,Ind)(All,r,Reg)(All,u,Mar)
 x_mar1(i,s,j,r,u) = x1_q(i,s,j,r);

Equation E_x_mar2
             (All,i,Com)(All,s,Sou)(All,j,Ind)(All,r,Reg)(All,u,Mar)
x_mar2(i,s,j,r,u) = x2_q(i,s,j,r);

Equation E_x_mar3
             (All,i,Com)(All,s,Sou)(All,r,Reg)(All,u,Mar)  x_mar3(i,s,r,u) = x3_qr(i,s,r);

Equation E_x_mar4
             (All,i,Com)(All,r,Reg)(All,u,Mar) x_mar4(i,r,u) = x4r(i,r);
```

```
Equation E_x_mar5
         (All,i,com)(All,s,Sou)(All,r,Reg) (All,u,Mar) x_mar5(i,s,r,u) = x5(i,s,r);

Equation E_x_mar6
         (All,i,Com)(All,s,Sou)(All,r,Reg)(All,u,Mar) x_mar6(i,s,r,u) = x6(i,s,r);
```

A.13. Prices for each type of purchase

The first equation in excerpt 12, E_p1tot, sets the percentage change in output prices equal to the cost-share weighted sum of percentage changes in the components of production. This imposes the zero pure profits condition on production. The same conditions applies to capital creators in equation E_p2tot, while prices faced by importers depend on shifts in commodity import prices, tariff rates and the nominal exchange rate (E_p0_A). Next, equations define prices for each type of buyer: producers (E_p1), capital creators (E_p2), household consumers (E_p3r), exporters (E_p4r), the Commonwealth government (E_p5) and state governments (E_p6). Equation E_delx7 allows inventory levels to change.

Excerpt 12: commodity prices

```
Equation E_p1tot                        # Zero pure profits in production#
                (All,j,Ind)(All,r,Reg)[TOTCOST(j,r)+TINY]*{p1tot(j,r)- a_in(j,r)} =
sum(i,COM,sum(s,SOU,VAL1(i,s,j,r)*p1(i,s,j,r)))
                + PRIMTOT(j,r)*{p1prim(j,r)+a_prim(j,r)}              +
        ST1TAX(j,r)*spptax(j,r) + CO1TAX(j,r)*cpptax(j,r)
                + OTHCOST(j,r)*pcost(j,r);

Equation E_p1nat # National price #
 (All,j,Ind)Sum{r,Reg,TOTCOST(j,r)}*p1nat(j) =Sum{r,Reg,TOTCOST(j,r)*p1tot(j,r)};

Equation E_p2tot                #Price of capital formation#
 (All,j,Ind)(All,r,Reg)
[VAL2sum(j,r)+TINY]*p2tot(j,r) = sum(i,COM,sum(s,SOU,VAL2(i,s,j,r)*p2(i,s,j,r)));

Equation E_p0_A                 #Zero pure profits in importing#
                (All,i,Com)p0(i,"ROW")=pmp(i) + x_rate + tm(i);
```

```
Equation E_p1             #Producers' purchase prices#
                   (All,i,Com)(All,s,Sou)(All,j,Ind)(All,r,Reg)
[VAL1(i,s,j,r)+TINY]*p1(i,s,j,r)=
                   {BAS1(i,s,j,r) +TAX1ST(i,s,j,r)
                   +TAX1CG(i,s,j,r)}*[p0(i,s)+t1_state(i,s,r)+t1_com(i,s,j,r)]
                   +[sum(u,MAR,MAR1(i,s,j,r,u)* p0(u,r))];

Equation E_p2                 #Capital creator prices#
(All,i,Com)(All,s,Sou)(All,j,Ind)(All,r,Reg)[VAL2(i,s,j,r)+TINY]*p2(i,s,j,r)=
{BAS2(i,s,j,r) +TAX2ST(i,s,j,r)
        +TAX2CG(i,s,j,r)}*[p0(i,s)+t2_state(i,s,r)+t2_com(i,s,j,r)]
        +[sum(u,MAR,MAR2(i,s,j,r,u)* p0(u,r))];

Equation E_p3r            #Household prices#
                   (All,i,Com)(All,s,Sou)(All,r,Reg)[VAL3(i,s,r)+TINY]*p3r(i,s,r)=
{BAS3(i,s,r)+TAX3ST(i,s,r)+TAX3CG(i,s,r)}*
                   [p0(i,s)+t3_state(i,s,r) +t3_com(i,s)]
                   +[sum(u,MAR,MAR3(i,s,r,u)* p0(u,r))];

Equation E_p4r            #Zero pure profits in exporting#
                   (All,i,Com)(All,s,REG)[VAL4(i,s)+TINY]*[p4r(i,s) + x_rate] =
{BAS4(i,s)+ TAX4(i,s)}*[p0(i,s)+t4_com(i,s)]
                   + sum(u,MAR,MAR4(i,s,u)*p0(u,s)) ;

 Equation E_p5            #C'wealth govt purchase prices#
        (All,i,Com)(All,s,Sou)(All,r,Reg)[VAL5(i,s,r)+TINY]*p5(i,s,r) =
BAS5(i,s,r)*p0(i,s)+sum(u,MAR,MAR5(i,s,r,u)*p0(u,s));

Equation E_p6             #State govt purchase prices#
        (All,i,Com)(All,s,Sou)(All,r,Reg)(VAL6(i,s,r)+TINY)*p6(i,s,r) =
BAS6(i,s,r)*p0(i,s)+sum(u,MAR,MAR6(i,s,r,u)*p0(u,s));

Equation E_delx7 # possible rule for stocks #
 (All,i,Com)(All,s,Sou)(All,r,Reg) 100*LEVP0(i,s,r)*delx7(i,s,r)=
   BAS7(i,s,r)*x_tot(i,r)+fx7(i,s,r);
```

A.14. Primary factor prices

Excerpt 13 deals with primary factor prices. Equation E_plab calculates the percentage change in the price of labour as the value-weighted sum of the percentage changes in the unit value of take-home wages, the income tax rate on labour and payroll tax rates. Equation E_postw calculates the percentage change in wages as the sum of wage shifters of various dimensions, and includes a parameter (CPI_w) linking wages to CPI. Further equations calculate percentage changes in the unit values of wage income taxes (E_paye) and payroll taxes (E_p_roll). Equation E_pre_w calculates the percentage change in before-tax wages as the weighted sum of percentage changes in take-home wages and income tax rates. Finally, equation E_postw_r calculates a regional index of percentage changes in take-home wages.

Excerpt 13: primary factor prices

```
Equation E_plab                    #price of labour#
                    (All,m,Occ)(All,j,Ind)(All,r,Reg)
[LABOC(m,j,r)+TINY]*plab(m,j,r) =
                    WAGE(m,j,r)*postw(m,j,r) +
                    INCTAX(m,j,r)*paye(m,j,r) + PAYROLL(m,j,r)*p_roll(m,j,r);

Equation E_postw  #wage shifters#
 (All,m,Occ)(All,j,Ind)(All,r,Reg)postw(m,j,r) =
W_LINK*cpi +fpost + fpostr(r) + fpostq(m) + fpostqr(m,r) + fpostj(j)
  + fpostjr(j,r) + fpostqj(m,j) + fpostqjr(m,j,r);

Equation E_paye   #PAYE tax unit value#
 (All,m,Occ)(All,j,Ind)(All,r,Reg)paye(m,j,r) = W_LINK*pre_w(m,j,r) + fpaye;

Equation E_p_roll                  #payroll tax unit value#
                    (All,m,Occ)(All,j,Ind)(All,r,Reg)p_roll(m,j,r) =
W_LINK *pre_w(m,j,r) + fROLLr(r) +fROLLm(m,r) + fROLLh(j,r) + fROLLmh(m,j,r);

Equation E_pre_w                   #pre-tax wage occ*ind*reg#
          (All,m,Occ)(All,j,Ind)(All,r,Reg)[WAGEINC(m,j,r)+TINY]*pre_w(m,j,r) =
WAGE(m,j,r)*postw(m,j,r) + INCTAX(m,j,r)*paye(m,j,r);

Equation E_postw_r                 #regional take-home wage#
          (All,r,Reg)sum(m,OCC,sum(j,IND,WAGE(m,j,r)))*postw_r(r)=
sum(m,OCC,SUM{j,IND,WAGE(m,j,r)*postw(m,j,r)});

Equation E_p_krnt  #post tax capital price#
 (All,j,Ind)(All,r,Reg)
 [KAPRENT(j,r)+TINY]*p_krnt(j,r) =
          CAPITAL(j,r)*pprim("Cap",j,r)
          - KAPTAX(j,r)*p_kaptax(j,r)
          - LNDTAX(j,r)*prop_tax(j,r);

Equation E_p_kaptax  #rental tax rate#
 (All,j,Ind)(All,r,Reg) p_kaptax(j,r) = LINK_LK*pprim("Cap",j,r) + f_kaptax(j)+ fpaye;

Equation E_p_landtx                #agriland tax rate#
                    (All,j,Ind)(All,r,Reg)p_landtx(j,r) =
 CPI_LK*pprim("Land",j,r) + f_lndtax(j,r) + fcorp;

Equation E_p_land                  #agriland rental price#
                    (All,j,Agg)(All,r,Reg)[AGRILND(j,r)+TINY]*pprim("Land",j,r) =
AGLND(j,r)*p_land(j,r) + AGRITAX(j,r)*p_landtx(j,r);

Equation E_p_land_n
                    (All,j,NONAgg)(All,r,Reg)p_land(j,r) =0;
```

```
Equation E_pcost                  #price, other costs#
                  (All,j,Ind)(All,r,Reg) pcost(j,r) =
CPI_oct*p3_r(r) + fcost(j) + fcostr(j,r);

Equation E_spptax                 #State production tax #
                  (All,j,Ind)(All,r,Reg)spptax(j,r) = CPI_oct*p3_r(r) +fprodrj(j,r);

Equation E_cpptax                 #C'wealth production tax #
                  (All,j,Ind)(All,r,Reg)cpptax(j,r) = CPI_oct*p3_r(r) + fprodj(j);
```

A.15. Market-clearing equations

The market clearing equations E_p0_B and E_p0_C follow. Equation E_x_tot in excerpt 5 of the code calculates changes in the aggregate supply of commodities. Equation E_p0_B sets the percentage changes in supply and demand equal for margins, while equation E_p0_C does likewise for non-margins commodities.

Excerpt 14: market clearing equations

```
Equation E_p0_B                   #market clearing equation, margins#
                  (All,u,Mar)(All,s,Reg)(SALE(u,s)+TINY)*x_tot(u,s) =
 sum[r,REG,sum(j,IND,{BAS1(u,s,j,r)*x1_q(u,s,j,r)
                  +BAS2(u,s,j,r)*x2_q(u,s,j,r)})
                  +BAS3(u,s,r)*x3_qr(u,s,r)
                  +BAS5(u,s,r)*x5(u,s,r)
                  +BAS6(u,s,r)*x6(u,s,r)
                  +100*LEVP0(u,r,t)*delx7(u,r,t)]
                  + BAS4(u,s)*x4r(u,s)
+ sum(i,COM,[sum(s,SOU,sum(j,IND,{MAR1(i,s,j,r,u)*x_mar1(i,s,j,r,u)
                  +MAR2(i,s,j,r,u)*x_mar2(i,s,j,r,u)})
                  +MAR3(i,s,r,u)*x_mar3(i,s,r,u)
                  +MAR5(i,s,r,u)*x_mar5(i,s,r,u)
                  +MAR6(i,s,r,u)*x_mar6(i,s,r,u))]
                  +MAR4(i,r,u)*x_mar4(i,r,u));

Equation E_p0_C           #market clearing equation, non-margins#
                  (All,u,Nonmar)(All,r,Reg)(SALE(u,r)+TINY)*x_tot(u,r) =
 SUM[t,REG,sum(j,IND,{BAS1(u,r,j,t)*x1_q(u,r,j,t)
                  +BAS2(u,r,j,t)*x2_q(u,r,j,t)})
                  +BAS3(u,r,t)*x3_qr(u,r,t)
                  +BAS5(u,r,t)*x5(u,r,t)
                  +BAS6(u,r,t)*x6(u,r,t)
                  +100*LEVP0(u,r,t)*delx7(u,r,t)]]
                  +BAS4(u,r)*x4r(u,r);
```

A.16. Regional and national aggregates

Excerpt 15 calculates an array of regional and national aggregates. These include aggregates of labour and capital from industry demands. Equations E_punb and E_fun_r compute percentage changes in unemployment benefits per person and regional unemployment respectively. Aggregates on the income and expenditure sides of the economy are calculated in excerpts 15B and 15C respectively.

Excerpt 15: regional and national aggregates

```
!15A: quantities!

Equation E_lrm_emp  #demand equals supply for reg. skills#
 (All,m,Occ)(All,r,Reg)LAB_OC(m,r)*lrm_emp(m,r)=
Sum(j,IND,LABOC(m,j,r)*x_lab(m,j,r));

Equation E_x_imp  #national import totals#
   (All,i,Com)VIMPORT(i)* x_imp(i)= Sum[r,REG,IMPORT(i,r)*xr_imp(i,r)];

Equation E_imports   #foreign currency value of imports, c.i.f. weights#
  (All,r,REG)IMP_r(r)*imports(r) = Sum(i,COM,IMP_CIF(i,r)*{pmp(i)+xr_imp(i,r)});

Equation E_imp_nat   #foreign currency value of imports#
   Sum(r,Reg,IMP_r(r))*imp_nat = Sum(r,Reg,IMP_r(r)*imports(r));

Equation E_e_r   #foreign currency value of exports#
   (All,r,Reg)EXP_r(r)*e_r(r) = Sum(i,COM,VAL4(i,r)*{p4r(i,r)+x4r(i,r)});

Equation E_e   #foreign currency value of exports#
   Sum(r,Reg,EXP_r(r))*e=Sum(r,Reg,EXP_r(r)*e_r(r));

Equation E_delb  #national balance of int. trade#
    100*delb=Sum(r,Reg,{EXP_r(r) * e_r(r) - IMP_r(r)* imports(r)});

Equation E_lr_emp
 (All,r,Reg)AGGLAB(r)*lr_emp(r) =Sum(m,OCC,{LAB_OC(m,r)*lrm_emp(m,r)});

Equation E_l_emp
 Sum(r,REG,AGGLAB(r))*l_emp = Sum(r,Reg,{AGGLAB(r)*lr_emp(r)});

Equation E_k_rst
 (All,r,Reg)AGGCAP(r)*k_rst(r) = Sum(j,IND,{CAPITAL(j,r)*k_rjst(j,r)});

Equation E_kst
 Sum(r,REG,AGGCAP(r))*kst = Sum(r,Reg,{AGGCAP(r)*k_rst(r)});

Equation E_punb  #unemployment benefits/person#
   punb = h_ben*cpi + fun_b;

Equation E_fun_r   #regional unemployment#
 (All,r,Reg)x_unemp(r) = UMPE_1(r)*lr_emp(r) - UMPE_2(r)*fun_r(r);
```

```
!15B: income side aggregates!

Equation E_caprev  #rental income#
 (All,r,Reg)AGGCAP(r)*caprev(r)=
Sum(j,IND,{CAPITAL(j,r)*[pprim("Cap",j,r)+k_rjst(j,r)]});

Equation E_labrev  #labour income#
 (All,r,Reg)AGGLAB(r)*labrev(r) =
Sum(j,IND,{LABOUR(j,r)*[pprim("Lab",j,r)+employ(j,r)]});

 Equation E_landrev  #land income#
 (All,r,Reg)AGGLAND(r)*landrev(r)=
Sum(j,IND,{AGRILND(j,r) *[pprim("Land",j,r)+ x_agland(j,r)]});

Equation E_octrev  #other factor income#
 (All,r,Reg)AGGOCT(r)*octrev(r)=
Sum(j,ind,OTHCOST(j,r)* {pcost(j,r)+xcost(j,r)});

Equation E_itrev_r   #indirect tax revenue#
  (All,r,Reg)INDI_REV(r)*itrev_r(r) =
 TAX1STZ(r)*tax1_st(r) + TAX2STZ(r)*tax2_st(r) + TAX3STZ(r)*tax3_st(r)
 + TAX1CGZ(r)*tax1_com(r)+ TAX2CGZ(r)*tax2_com(r)+ TAX3CGZ(r)*tax3_com(r)
 + TAXMCGR(r)*taxm_com(r)+ TAX4CG(r)*tax4_com(r)
 + PRODTAXC(r)*tcg_pt(r)  + PRODTAXS(r)*tsg_pt(r);

Equation E_gsp_inc   #GSP income side#
 (All,r,Reg)GSPINC(r)*gsp_inc(r)=
 AGGLAB(r)*labrev(r)+ AGGCAP(r)*caprev(r) +AGGLAND(r)*landrev(r)
 +AGGOCT(r)*octrev(r)+ INDI_REV(r)*itrev_r(r);

Equation E_gdp_inc   #GSP income side#
 Sum(r,Reg,GSPINC(r))*gdp_inc = Sum(r,Reg,GSPINC(r)*gsp_inc(r));

!15C: expenditure side!
Equation E_realdev  #real devaluation#
 realdev = pimp_nat - gdp_def;

Equation E_p2_r   #regional price index of capital goods#
  (All,r,Reg)INV_r(r) *p2_r(r)  =Sum(j,IND,VAL2SUM(j,r)*p2tot(j,r));

Equation E_x2_r   #regional real investment#
 (All,r,Reg)INV_r(r)*x2_r(r)=Sum(j,IND,VAL2SUM(j,r)*x2_jr(j,r));

Equation E_v2_r   #regional nominal investment#
  (All,r,Reg) v2_r(r) = p2_r(r) + x2_r(r);

Equation E_p2_nat   #national price index of capital good#
  Sum(r,REG,INV_r(r))*p2_nat  = Sum(r,REG,INV_r(r)*p2_r(r));

Equation E_x2nat   #national index of real investment#
 Sum(r,REG,INV_r(r))*x2_nat  = Sum(r,REG,INV_r(r)*x2_r(r));

Equation E_v2_nat   # index,  nom.l investment demand#
  v2_nat = p2_nat + x2_nat;

Equation E_p3_r # regional CPI #
  (All,r,Reg)CON_r(r)* p3_r(r) = Sum(i,COM,VAL3O(i,r)*p3o(i,r));
```

```
Equation E_x3_r #regional real consumption #
  (All,r,Reg)CON_r(r)* x3_r(r) = Sum(i,COM,VAL3O(i,r)*x3_q(i,r));

Equation E_v3_r   #nominal regional consumption expenditure#
  (All,r,Reg) v3_r(r) = x3_r(r)+p3_r(r);

Equation E_v3lux   #consumption function#
  (All,r,Reg) x3_r(r) = f3_nat + f3_r(r) + gsp_real(r);

Equation E_x3_nat   #national real consumption from commodity accounts#
  Sum(r,REG,CON_r(r))*x3_nat = Sum(r,REG,CON_r(r)*x3_r(r));

Equation E_v3_nat   #nominal national consumption expenditure#
  Sum(r,REG,CON_r(r))*v3_nat = Sum(r,REG,CON_r(r)*v3_r(r));

Equation E_x_rate #CPI#
 cpi = v3_nat - x3_nat;

Equation E_p4_r   # $A price index of regional exports#
 (All,r,Reg)EXP_r(r)*p4_r(r) = Sum(i,COM,VAL4(i,r)*{p4r(i,r) +x_rate});

Equation E_x4_r   # index of real regional  exports#
 (All,r,Reg)EXP_r(r)*x4_r(r) = Sum(i,COM,VAL4(i,r)*x4r(i,r));

Equation E_v4_r   # nominal ($A) regional  exports#
 (All,r,Reg) v4_r(r) = p4_r(r)+ x4_r(r);

Equation E_p4_nat   #national export price index#
  Sum(r,REG,EXP_r(r))*p4_nat = Sum(r,REG,EXP_r(r)*p4_r(r));

Equation E_x4_nat   #national index of real exports#
  Sum(r,REG,EXP_r(r))*x4_nat = Sum(r,REG,EXP_r(r)*x4_r(r));

Equation E_v4_nat  # export index= e at const x_rate#
  v4_nat = p4_nat+ x4_nat;

Equation E_p5_r   #C'wealth govt's price index#
  (All,r,Reg) CGOV_r(r)*p5_r(r)= Sum(i,COM,Sum(s,SOU,VAL5(i,s,r)*p5(i,s,r)));

Equation E_x5_r   # C'wealth govt's real con index A1#
(All,r,Reg) CGOV_r(r)*x5_r(r) =  Sum(i,COM,Sum(s,SOU,VAL5(i,s,r)*x5(i,s,r)));

Equation E_p5_nat   #national price index of capital goods(all industries)#
  Sum(r,REG,CGOV_r(r))*p5_nat  = Sum(r,REG,CGOV_r(r)*p5_r(r));

Equation E_x5nat   #Real C’wealth spending#
  Sum(r,REG,CGOV_r(r))*x5_nat  = Sum(r,REG,CGOV_r(r)*x5_r(r));

Equation E_v5_nat   #Nominal C’wealth spending#
  v5_nat = p5_nat +x5_nat;

Equation E_v5_r #C'wealth govt's nominal consumption#
  (All,r,Reg) v5_r(r) = p5_r(r) +x5_r(r);

Equation E_p6_r   #state govt's price index#
 (All,r,Reg)SGOV_r(r)*p6_r(r) =
Sum(i,COM,Sum(s,SOU,VAL6(i,s,r)*p6(i,s,r)));
```

```
Equation E_x6_r   #index of state govt's real consumption#
(All,r,Reg)SGOV_r(r)*x6_r(r)=Sum(i,COM,Sum(s,SOU,VAL6(i,s,r)*x6(i,s,r)));

Equation E_v6_r   #state govt's nominal consumption#
  (All,r,Reg) v6_r(r) = p6_r(r) +x6_r(r);

Equation E_p6_nat   # agg. state govt's price index#
  Sum(r,REG,SGOV_r(r))*p6_nat= Sum(r,REG,SGOV_r(r)*p6_r(r));

Equation E_x6_nat   #agg. index of state govt's real consumption#
 Sum(r,REG,SGOV_r(r))*x6_nat = Sum(r,REG,SGOV_r(r)*x6_r(r));

Equation E_v6_nat   #agg. state govt's nominal consumption#
  v6_nat = p6_nat +x6_nat;

Equation E_x7_r    # Inventories volume index #
  (All,r,Reg)[TINY+INVENT(r)]*x7_r(r) =
   100*Sum{i,COM, Sum{s,Sou, LEVP0(i,s,r)*delx7(i,s,r) }};

Equation E_p7_r    # Inventories price index #
 (All,r,Reg)[TINY+INVENT(r)]*p7_r(r) =
Sum{i,COM, Sum{s,Sou, BAS7(i,s,r)*p0(i,s) }};

Equation E_v7_r    # Aggregate nominal value of inventories #
 (All,r,Reg)v7_r(r) = x7_r(r) + p7_r(r);

Equation E_ximp_r  #import vol. index, c.i.f. weights#
  (All,r,Reg)IMP_r(r)*ximp_r(r) =Sum(i,Com,IMP_CIF(i,r)*xr_imp(i,r));

Equation E_pm_r  #$A c.i.f. import prices#
 (All,r,Reg)IMP_r(r)* pm_r(r) =Sum(i,COM,IMP_CIF(i,r)* {pmp(i) +x_rate});

Equation E_vimp_r   #nominal value of reg imports#
 (All,r,Reg)vimp_r(r) = pm_r(r) +ximp_r(r);

Equation E_ximp_nat   # nat_real_imports#
 Sum(r,REG,IMP_r(r))*ximp_nat = Sum(r,REG,IMP_r(r)*ximp_r(r));

Equation E_pimp_nat   #nat. import price index#
 Sum(r,REG,IMP_r(r))*pimp_nat = Sum(r,REG,IMP_r(r)*pm_r(r));

Equation E_vimp_nat   # nom_ nat_imports#
 vimp_nat = ximp_nat + pimp_nat;

Equation E_tot_nat   #terms of trade#
 tot_nat =  p4_nat - pimp_nat;

 Equation E_twist_src
 # Allows import/domestic twists to be determined by agg. import change #
 (All,i,Com)twist_src(i) =
twist_src_bar + ftwist_src(i)+ C_TWIST_SRC*[Sum(r,REG,x_tot(i,r)) - gdp_real];
```

Being a bottom-up regional model, FEDSA-WINE requires equations to describe interstate trade flows. Note that the consumption function given by equation E_v3lux links aggregate household consumption at the state level to real GSP on the expenditure side. It is important to include interstate trade flows in the GSP calculation, so that the model calculates the trade balance component of expenditure-side GSP as net interstate plus net international trade. As an example, consider introducing a revenue-neutral volumetric tax on wine. This raises South Australia's interstate trade surplus, at the expense of the international trade surplus, because the state's share of national premium wine production is even higher than its share of total wine production. The new tax diverts some of South Australia's premium wine sales from international to interstate exports. If we do not include interstate trade in the calculation of GSP, this will, through the consumption function, inappropriately diminish aggregate consumption and utility within the state.

Excerpt 16: Interstate trade

```
!16: interstate trade!
Equation E_x_inter #Interstate flows#
(all,i,Com)(all,s,Reg)(all,r,Reg)
[INTER_FLO(i,s,r)+TINY]*x_inter(i,s,r) =
        sum{j,IND, BAS1(i,s,j,r)*x1_q(i,s,j,r)}
                  + sum{j,IND, BAS2(i,s,j,r)*x2_q(i,s,j,r)}
                  + BAS3(i,s,r)*x3_qr(i,s,r)
                  + BAS5(i,s,r)*x5(i,s,r)
      + BAS6(i,s,r)*x6(i,s,r);

Equation E_x_inter_x #Interstate exports#
(all,i,Com)(all,s,REG)[INTER_EXP(i,s)+TINY]*x_inter_x(i,s) =
sum{r,Reg,INTER_FLO(i,s,r)*x_inter(i,s,r)} - INTER_FLO(i,s,s)*x_inter(i,s,s);

Equation E_x_inter_m #Interstate imports#
(all,i,Com)(all,r,Reg)[INTER_IMP(i,r)+TINY]*x_inter_m(i,r) =
sum{s,Reg,INTER_FLO(i,s,r)*x_inter(i,s,r)} - INTER_FLO(i,r,r)*x_inter(i,r,r);

Equation E_p_inter # Price - interstate trade flows #
(All,i,Com)(all,s,Reg)(all,r,Reg){TINY + INTER_FLO(i,s,r)} * p_inter(i,s,r) =
     sum{j,IND, BAS1(i,s,j,r) * p0(i,s)}
   + sum{j,IND, BAS2(i,s,j,r) * p0(i,s)}
   + BAS3(i,s,r) * p0(i,s)
   + BAS5(i,s,r) * p0(i,s)
   + BAS6(i,s,r) * p0(i,s);

Equation E_p_x_is # Price index - interstate exports #
(all,i,Com)(all,s,Reg){TINY + INTER_EXP(i,s)} * p_x_is(i,s) =
sum{r,Reg,INTER_FLO(i,s,r)*p_inter(i,s,r)} - INTER_FLO(i,s,s)*p_inter(i,s,s);
```

```
Equation E_p_m_is # Price index - interstate imports #
(all,i,Com)(all,r,Reg){TINY + INTER_IMP(i,r)} * p_m_is(i,r) =
sum{s,Reg,INTER_FLO(i,s,r)*p_inter(i,s,r)} - INTER_FLO(i,r,r)*p_inter(i,r,r);

Equation E_x_int #Interstate exports, aggregate#
   (all,s,REG)INT_X(s)*x_int(s) = Sum{i,Com,INTER_EXP(i,s)*x_inter_x(i,s)};

Equation E_m_int #Interstate imports, aggregate#
   (all,s,REG)INT_M(s)*m_int(s) = Sum{i,Com,INTER_IMP(i,s)*x_inter_m(i,s)};

Equation E_px_int #Interstate exports price index#
   (all,s,REG)INT_X(s)*px_int(s) = Sum{i,Com,INTER_EXP(i,s)*p_x_is(i,s)};
Equation E_pm_int #Interstate imports price index#
   (all,s,REG)INT_M(s)*pm_int(s) = Sum{i,Com,INTER_IMP(i,s)*p_m_is(i,s)};

!15E: GDP equations!
Equation E_gdp_def   #GDP deflator#
 BASE_GDP* gdp_def = Sum(r,REG,BASE_GSP(r)* gsp_def(r));

Equation E_gsp_nom  #Nominal GSP#
  (All,r,Reg)gsp_nom(r) =gsp_real(r) + gsp_def(r);

Equation E_gsp_def  #GSP deflator#
  (All,r,Reg)BASE_GSP(r)* gsp_def(r) =
 CON_r(r)*p3_r(r) + INV_r(r)*p2_r(r)
  + SGOV_r(r)*p6_r(r) + CGOV_r(r)*p5_r(r)+INVENT(r)*p7_r(r)
  + EXP_r(r)*p4_r(r) + INT_X(r)*px_int(r)
  - IMP_r(r)*pm_r(r) - INT_M(r)*pm_int(r);

Equation E_gsp_real  #Real GSP#
  (All,r,Reg)     BASE_GSP(r)* gsp_real(r) =
 CON_r(r)*x3_r(r) + INV_r(r)*x2_r(r)
  + SGOV_r(r)*x6_r(r) + CGOV_r(r)*x5_r(r) +INVENT(r)*x7_r(r)
  + EXP_r(r)*x4_r(r)  + INT_X(r)*x_int(r)
  - IMP_r(r)*ximp_r(r)- INT_M(r)*m_int(r);

Equation E_gdp_nom   #GDP_nominal expenditure side#
      gdp_nom = gdp_real + gdp_def;

Equation E_gdp_real   #Real GDP calculation#
         BASE_GDP* gdp_real = Sum(r,Reg,BASE_GSP(r)* gsp_real(r));

Equation E_xr_imp  #Imports#
(All,i,Com)(All,r,Reg)(IMPORT(i,r)+TINY)* xr_imp(i,r) =
Sum(j,IND,[BAS1(i,"ROW",j,r)*x1_q(i,"ROW",j,r)
            +BAS2(i,"ROW",j,r) * x2_q(i,"ROW",j,r)])
            +BAS3(i,"ROW",r)*x3_qr(i,"ROW",r)
            +BAS5(i,"ROW",r)* x5(i,"ROW",r)
            +BAS6(i,"ROW",r)*x6(i,"ROW",r)
            +100*LEVP0(i,"ROW",r)*delx7(i,"ROW",r);
```

A.17. Decomposition variables to help explain results

Next, the model includes additional equations used to help explain simulations. ‘Fan decomposition’, named after Mr Fan Mingtai of the Beijing Institute of Quantitative and Technical Economics, explains the total change in commodity sales as the sum of three effects: the local market effect, the import share effect and the export effect. At a regional level, the local market is divided into own-state sales and interstate exports. The import share effect is divided into international and interstate imports. To recognise this detail, we include two different sets of decomposition equations: one from the national perspective, the other from the regional perspective. In the latter, the export and import share effects include interstate exports and imports respectively.

The following explains Fan decomposition in terms of a variable X that is the sum of two parts:

$$X = A + B \qquad \text{or} \qquad PX = PA + PB \tag{A.6}$$

For small percentage changes, we can write:

$$x = conta + contb \tag{A.7}$$

where $conta = (PA/PX)a$ and $contb = (PB/PX)b$, and *conta* and *contb* are the contributions of A and B to the percentage change in X. To avoid computational errors associated with large changes requiring multi-step solutions, we can specify both *conta* and *contb* as ordinary change variables. This leads to the small change equation:

$$X^0 q = Xx \tag{A.8}$$

where X^0 is the initial value of X, and q is the ordinary change variable updated in each step to be identical to x in the final solution.

The revised decomposition is:

$$q = conta + contb \tag{A.9}$$

where *conta* = (PA/PX^0)*a* and *contb* = (PB/PX^0)*b*.

We define *x0loc*, the percentage change in local sales from all sources including interstate. Equation E_fandecompA expresses this percentage, weighted by the value of local domestic sales, as the local market component of the percentage change in local production. In these equations INITSALES corresponds to the term PX^0 in equation (A.10): it is the initial value of sales, updated only by the change in price. Equation E_fandecompB corresponds to equation (A.9). And equation E_fandecompD corresponds to equation (A.8). Decomposition at the regional level is of interest for the wine industry in South Australia, as interstate exports may account for a large proportion of the change in output in a policy simulation.

Excerpt 17: Fan decomposition, regional

```
Set FAN # parts of Fan decomposition at regional level#
  (LocMarket, Export, Import, Total);
Variable
(All,i,Com)(all,r,Reg) x0loc(i,r)  #real percent change in LOCSALES (dom+imp)#;
(change)(All,i,Com)(All,r,Reg)(all,f,FAN)fandecomp(i,r,f) #Fan decomposition #;

Coefficient
 (All,i,Com)(All,r,Reg) LOCSALES(i,r)  # Total loc. sales = dom + imp i #;
 (All,i,Com)(All,r,Reg) INITSALES(i,r) #Initial vol. of SALES at final prices#;
Formula
 (All,i,Com)(All,r,Reg) LOCSALES(i,r) = SALE(i,r) + IMPORT(i,r)+ INTER_IMP(i,r)
                   -BAS4(i,r) - INTER_EXP(i,r);
 (initial) (All,i,Com)(All,r,Reg) INITSALES(i,r) = SALE(i,r);
Update
  (All,i,Com)(All,r,Reg) INITSALES(i,r) = p0(i,r);

Equation E_x0loc # %growth in local (state) market #
(All,i,Com)(All,r,Reg) LOCSALES(i,r)*x0loc(i,r) =
SALE(i,r)*x_tot(i,r)
+ IMPORT(i,r)*xr_imp(i,r)+ INTER_IMP(i,r)*x_inter_m(i,r)
- BAS4(i,r)*x4r(i,r) - INTER_EXP(i,r)*x_inter_x(i,r);

Equation E_fandecompA # growth in local (state) market effect #
(All,i,Com)(All,r,Reg) INITSALES(i,r)*fandecomp(i,r,"LocMarket") =
       [SALE(i,r)-BAS4(i,r)- INTER_EXP(i,r)]*x0loc(i,r);

Equation E_fandecompB # import (inc. interstate) leakage effect - via residual #
(All,i,Com)(All,r,Reg) fandecomp(i,r,"Total") =
fandecomp(i,r,"LocMarket") + fandecomp(i,r,"Import")
+fandecomp(i,r,"Export");
```

```
Equation E_fandecompC # export effect #
(All,i,Com)(All,r,Reg)INITSALES(i,r)*fandecomp(i,r,"Export")=
        BAS4(i,r)*x4r(i,r) + INTER_EXP(i,r)*x_inter_x(i,r);

Equation E_fandecompD # Fan total = x_tot #
(All,i,Com)(All,r,Reg)INITSALES(i,r)*fandecomp(i,r,"Total")=
      SALE(i,r)*x_tot(i,r);
```

Finally, equations E_x0locnat, E_fandenatA, E_fandenatB, E_fandenatC and E_fandenatD calculate the decomposition at the national level of aggregation. The local market contribution at the national level refers to the impact on industry output of changes in domestically-produced sales within Australia. The export effect describes the contribution of export growth to output, particularly useful because sometimes exports increase from a small base, with a very large percentage change that nevertheless remains small relative to output. And the import contribution, if positive, implies import replacement.

Excerpt 18: Fan decomposition, national

```
Variable !add up the Fan effects at the national level!
(All,i,Com)            x0locnat(i) # Real % change in NATSALES#;
(All,i,Com)(all,f,FAN) fandenat(i,f) #% growth in local market, national#;

Coefficient (All,i,Com)NATSALES(i) # Total nat. sales of dom + imp commodity i#;
        (All,i,Com)INITSALE_NAT(i)#Initial vol. of SALES at final prices#;
Update
  (All,i,Com)INITSALE_NAT(i) = p1nat(i)!assuming no multiproduct industries!;

Formula (All,i,Com)NATSALES(i)=Sum{r,Reg,[SALE(i,r)-BAS4(i,r)]} + VIMPORT(i);
(initial) (All,i,Com)INITSALE_NAT(i) = Sum{r,Reg,SALE(i,r)};
Equation E_x0locnat #% growth in national market #
(All,i,Com)NATSALES(i)*x0locnat(i) =
Sum{r,Reg,[SALE(i,r)*x_tot(i,r)-BAS4(i,r)*x4r(i,r)]} + VIMPORT(i)*x_imp(i);

Equation E_fandenatA # growth in national market effect #
(All,i,Com)INITSALE_NAT(i)*fandenat(i,"NatMarket") =
     Sum{r,Reg, [SALE(i,r)-BAS4(i,r)]}*x0locnat(i);

Equation E_fandenatB # export effect, national #
(All,i,Com)INITSALE_NAT(i)*fandenat(i,"Export")=
        Sum{r,Reg,BAS4(i,r)*x4r(i,r)};

Equation E_fandenatC # import leakage effect - via residual, national #
(All,i,Com) fandenat(i,"Total") =
fandenat(i,"NatMarket") + fandenat(i,"Import")+ fandenat(i,"Export");
```

```
Equation E_fandenatD # Fan total = x_tot, national #
(All,i,Com)INITSALE_NAT(i)*fandenat(i,"Total")=
    Sum{r,Reg,SALE(i,r)*x_tot(i,r)};
```

A.18. Linking rates-of-return on capital to investment

Excerpt 19 contains the equations dealing with investment and capital. These are based on the original DPSV ORANI equations, currently used in ORANI-G (Parmenter, Pearson and Horridge 1998). Equation E_x2_jrA relates the investment/capital ratio for endogenous investment industries to the net rate of return, relative to the economy-wide rate, r_k. This equation provides a rudimentary risk-related relationship, with relatively fast- (slow-) growing industries requiring premia (accepting discounts) on their rates of return.

Excerpt 19: static treatment of investment and capital

```
Equation E_pprimB # Definition of rates of return to capital #
(all,j,IND)(all,r,Reg) r_k(j,r) = 2.0*(pprim("Cap",j,r) - p2tot(j,r));

Equation E_x2_jrA # Investment rule #
(all,j,Jset)(all,r,Reg)
x2_jr(j,r) - k_rjst(j,r) = f_rate_r(j,r) + 0.33*[r_k(j,r) - omega];

Equation E_x2_jrB # Investment in exogenous industries #
(All,j,Notj)(All,r,Reg)x2_jr(j,r) = x2_r(r) + f_rate_r(j,r);
```

A.19. Calculating changing tax revenue and database checks

Given the emphasis in this study on taxation of the wine industry, I have included an equation to calculate the change in wine tax revenue in a simulation. Having the calculation within the model spares the modeller from a manual calculation with each new scenario. Finally, the model writes various calculations to an output file. These provide automatic checks on a number of aspects of the database.

Excerpt 20: database checks

```
!PART 18: wine taxes!
Coefficient (All,i,Wine)(all,r,Reg)TAX3Wine(i,r) #C'wealth revenue from wine#;
Formula (All,i,Wine)(all,r,Reg)TAX3Wine(i,r)=Sum{s,SOU,TAX3CG(i,s,r)};
Variable (all,r,Reg)tax3_wine(r) #C'wealth revenue from wine# ;

Equation E_tax3_wine   #C'wealth govt receipts from wine#
(all,r,Reg)Sum{w,Wine,TAX3Wine(w,r)}*tax3_wine(r) =
Sum{s,SOU,Sum{i,WINE,[BAS3(i,s,r)+TAX3CG(i,s,r)+TAX3ST(i,s,r)]*t3_com(i,s,r)
 + TAX3CG(i,s,r)*[x3_qr(i,s,r)+p0(i,s)]}};
!PART 19: database checks!
Coefficient (All,r,Reg)EPSTOT(r) # Average Engel elasticity: should = 1 #;
Formula
         (All,r,Reg)EPSTOT(r)   = Sum{i,COM, S3_BUD(i,r)*EPSIL(i,r)};
FILE (new) DATACHK #various data#;
WRITE TAX3Wine  to file DATACHK HEADER "T3WI" longname "wine tax revenues";
    GDPEXP    to file DATACHK HEADER "GDPE" longname "GDP expenditure side";
GSPINC    to file DATACHK HEADER "GDPI" longname "GDP income side";
SALE      to file DATACHK HEADER "SALE" longname "total dom. commodity sales";
TOTCOST   to file DATACHK HEADER "COST" longname "total industry costs";
VAL2SUM to file DATACHK HEADER "2SUM" longname "investment by industry";
VAL1_PUR to file DATACHK HEADER "1PUR" longname "inter.usage by comm.purch.pr.";
VAL2_PUR to file DATACHK HEADER "2PUR" longname "invst.usage by comm.purch.pr.";
VAL3 to file DATACHK HEADER "3PUR" longname "consumption, purchasers prices";
VAL4 to file DATACHK HEADER "4PUR" longname "exports, purchasers prices";
VAL5 to file DATACHK HEADER "5PUR" longname "CGOV, purchasers prices";
VAL6 to file DATACHK HEADER "6PUR" longname "SGOV, purchasers prices";
CAPITAL to file DATACHK HEADER "CAPL" longname "capital rentals";
LABOUR to file DATACHK HEADER "LABR" longname "labour costs";
AGRILND to file DATACHK HEADER "LAND" longname "land rentals";
IMBALANCE to file DATACHK HEADER "IMBA" longname "check sales-costs=0";
EPSTOT to file DATACHK HEADER "ETOT" longname "check weighted exp. elas sum =1";
```

Appendix B

List of variables in FEDSA-WINE in alphabetical order

Variable	Set elements	Description
a_cost(j,r)	j∈Ind r∈Reg	Other costs augmenting tech. change
a_fac(v,j,r)	v∈Fac j∈Ind r∈Reg	Factor augmenting tech change
a_in(j,r)	j∈Ind r∈Reg	All-input augmenting tech change
a_prim(j,r)	j∈Ind r∈Reg	All-factor augmenting tech change
a3com(i,r)	i∈Com r∈Reg	Taste change, h'hold, composite demands
a3lux(i,r)	i∈Com r∈Reg	Taste change, supernumerary demands
a3sub(i,r)	i∈Com r∈Reg	Taste change, subsistence demands
caprev(r)	r∈Reg	Returns to capital, regional
cb1r(r)	r∈Reg	PSBR of state governments
cb2		Commonwealth PSBR
cg_g		Commonwealth government outlays
cg_t		Commonwealth Govt Receipts
cpi		National CPI
cpptax(j,r)	j∈Ind r∈Reg	C'wealth production tax rate
delb		National balance of international trade
delx7(i,s,r)	i∈Com s∈Sou r∈Reg	Inventories demands
e		Foreign $ value of exports, national
e_r(r)	r∈Reg	Foreign $ value of exports, regional
employ(j,r)	j∈Ind r∈Reg	Labour demands by industry
f_kaptax(j)	j∈Ind	Capital tax shift
f_lndtax(j,r)	j∈Ind r∈Reg	Agri. land tax shift
f_prop_tax(j,r)	j∈Ind r∈Reg	State land tax rate shift
f_rate_r(j,r)	j∈Ind r∈Reg	Shifter, rate of return eq.
f_transr(r)	r∈Reg	State g to persons shift
f_x5(r)	r∈Reg	C'wealth shift
f_x52(r)	r∈Reg	C'wealth: no linkage to x3
f_x6(r)	r∈Reg	State shift
f_x62(r)	r∈Reg	State: no linkage to x3
f_ytax(r)	r∈Reg	Fees, fines shift
f0tax_s(i)	i∈Com	Power of tax shifter, all sales
f1_com(i)	i∈Com	Power of tax shifter, intermediate (i), C'wealth
f1_com_ij(i,j)	i∈Com j∈Ind	Power of tax shifter, intermediate (ij), C'wealth
f1_ind(j)	j∈Ind	Power of tax shifter, intermediate sales (j), C'wealth
f2_com(i)	i∈Com	Power of tax shifter, investment (is), C'wealth
f3(r)	r∈Reg	Consumption function shifter
f3_com(i)	i∈Com	Power of tax shifter, h'hold sales, C'wealth
f3_nat		Consumption function shifter: swap delb
f3_state(i,r)	i∈Com r∈Reg	Shift power of tax, h'hold sales, state
f4(i,r)	i∈Com r∈Reg	Export demand shifter
f4_com(i)	i∈Com	Power of export tax shifter
f4_nat		National price shift, exports
f51(i,s)	i∈Com s∈Sou	Shift in C'wealth demands
f56r(r)	r∈Reg	C'wealth transfers to states shift
Variable	**Set elements**	**Description**
f5p(r)	r∈Reg	C'wealth transfers to persons shift

f61(i,s,r)	i∈Com s∈Sou r∈Reg	Shift in State demands
fandecomp(i,r,f)	i∈Com r∈Reg f∈FAN	Fan decomposition
fandenat(i,f)	i∈Com f∈FAN	Fan decomposition, national
fcost(j)	j∈Ind	Shift in other costs
fp4(i)	i∈Exp	Price shift, traditional exports
fp4_ntagg(r)	r∈Reg	Price shift, non-traditional exports
fpaye		Income tax shifter
fpost		National wage shifter
fpostj(j)	j∈Ind	Industry wage shifter
fpostjr(j,r)	j∈Ind r∈Reg	Ind*reg shifter
fpostq(q)	q∈Occ	Occupation wage shifter
fpostqj(q,j)	q∈Occ j∈Ind	Occ*ind shifter
fpostqjr(q,j,r)	q∈Occ j∈Ind r∈Reg	Occ*ind*reg shifter
fpostqr(q,r)	q∈Occ r∈Reg	Occ*reg shifter
fpostr(r)	r∈Reg	Regional shifter
fprodj(j)	j∈Ind	C'wealth prod'n tax shift
fprodrj(j,r)	j∈Ind r∈Reg	State prod'n tax shift
frollh(j,r)	j∈Ind r∈Reg	Payroll shift by industry
frollm(q,r)	q∈Occ r∈Reg	Payroll shift by occupation
frollmh(q,j,r)	q∈Occ j∈Ind r∈Reg	Payroll shift:occ*ind
frollr(r)	r∈Reg	Payroll regional shifter
ftwist_src(i)	i∈Com	Commodity twist shift domestic-import
fun_b		Unemployment benefits shift
fun_r(r)	r∈Reg	Regional labour force
fx4(i)	i∈Exp	Q shift, tradiational exports
fx4_ntagg(r)	r∈Reg	Q shift, non-traditional exports
fx7(i,s,r)	i∈Com s∈Sou r∈Reg	Inventory shifter
g56(r)	r∈Reg	Commonwealth to state govt. transfer
g5p(r)	r∈Reg	C'wealth to persons
g6p(r)	r∈Reg	State transfers to persons
gdp_def		GDP deflator
gdp_inc		GDP income side
gdp_nom		Nominal GDP, expenditure side
gdp_real		Real GDP
gsp_def(r)	r∈Reg	GSP deflator
gsp_inc(r)	r∈Reg	GSP income side
gsp_nom(r)	r∈Reg	Nominal GSP
gsp_real(r)	r∈Reg	Real GSP
imp_nat		Foreign $ value of imports, national
imports(r)	r∈Reg	Foreign $ value of imports
itrev_r(r)	r∈Reg	Indirect tax revenue
k_rjst(j,r)	j∈Ind r∈Reg	Industry capital stocks
k_rst(r)	r∈Reg	Regional capital stock
kst		Economy-wide capital stock
l_emp		Aggregate national employment
labrev(r)	r∈Reg	Returns to labour
landrev(r)	r∈Reg	Returns to agricultural land
lr_emp(r)	r∈Reg	Aggregate regional employment
lrm_emp(q,r)	q∈Occ r∈Reg	Aggregate demands by occupation

Variable	**Set elements**	**Description**
m_int(r)	r∈Reg	Interstate imports, aggregate
octrev(r)	r∈Reg	Returns to other factors
omega		Average rate of return
p_inter(i,s,r)	i∈Com s∈Reg r∈Reg	Interstate flows price
p_x_is(i,r)	i∈Com r∈Reg	Interstate price - exports

px_int(s)	s∈Reg	Interstate exports price index
pm_int(r)	r∈Reg	Interstate imports price index
p_kaptax(j,r)	j∈Ind r∈Reg	C'wealth tax rate, capital
p_krnt(j,r)	j∈Ind r∈Reg	Post- tax capital rental
p_land(j,r)	j∈Ind r∈Reg	After-tax agri. land rental
p_landtx(j,r)	j∈Ind r∈Reg	C'wealth tax rate on agri. land
p_roll(q,j,r)	q∈Occ j∈Ind r∈Reg	Payroll tax per labour unit
p0(i,s)	i∈Com s∈Sou	Basic price
p1(i,s,j,r)	i∈Com s∈Sou j∈Ind r∈Reg	Purchasers' price, intermediate
p1c(i,j,r)	i∈Com j∈Ind r∈Reg	Dom.-imp. composite, intermediate
p1nat(j)	j∈Ind	Average input/output price, national
p1o(i,j,r)	i∈Com j∈Ind r∈Reg	Dom. composite, intermediate
p1prim(j,r)	j∈Ind r∈Reg	Effective primary factor price
p1tot(j,r)	j∈Ind r∈Reg	Average input/output price
p2(i,s,j,r)	i∈Com s∈Sou j∈Ind r∈Reg	Purchasers' price, investment
p2_nat		Aggregate investment price index
p2_r(r)	r∈Reg	Regional investment price index
p2c(i,j,r)	i∈Com j∈Ind r∈Reg	Dom.-imp. composite, investment
p2o(i,j,r)	i∈Com j∈Ind r∈Reg	Domestic composite, investment
p2tot(j,r)	j∈Ind r∈Reg	Capital creation unit cost
p3(i)	i∈Com	Household composite national price
p3_r(r)	r∈Reg	Regional CPI
p3c(i,r)	i∈Com r∈Reg	Household domestic composite
p3o(i,r)	i∈Com r∈Reg	Household composite price
p3r(i,s,r)	i∈Com s∈Sou r∈Reg	Purchasers' price, households
p4(i)	i∈Com	Export price: foreign currency, national
p4_nat		Exports price index, national
p4_ntagg(r)	r∈Reg	Non-trad exports, foreign units
p4_r(r)	r∈Reg	Exports price index, regional
p4r(i,r)	i∈Com r∈Reg	Export price: foreign currency units
p5(i,s,r)	i∈Com s∈Sou r∈Reg	Purchasers' price, C'wealth govt.
p5_nat		C'wealth govt. price index, national
p5_r(r)	r∈Reg	C'wealth govt. price index
p6(i,s,r)	i∈Com s∈Sou r∈Reg	Purchasers' price, state govt.
p6_nat		State govt. price index, national
p6_r(r)	r∈Reg	State govt. price index
p7_r(r)	r∈Reg	Inventories price index
paye(q,j,r)	q∈Occ j∈Ind r∈Reg	PAYE tax per labour unit
pcost(j,r)	j∈Ind r∈Reg	Price, other costs
pimp_nat		National price index of imports
plab(q,j,r)	q∈Occ j∈Ind r∈Reg	Labour costs
plab_reg(r)	r∈Reg	Regional index of labour costs
pm_r(r)	r∈Reg	Regional price index, imports
pmp(i)	i∈Com	Foreign $ c.i.f. price
postw(q,j,r)	q∈Occ j∈Ind r∈Reg	Post-tax wage

Variable	**Set elements**	**Description**
postw_r(r)	r∈Reg	Regional post-tax wage
pprim(v,j,r)	v∈Fac j∈Ind r∈Reg	Price of primary factors
pre_w(q,j,r)	q∈Occ j∈Ind r∈Reg	Before tax wage
prop_tax(j,r)	j∈Ind r∈Reg	Property tax rate
punb		Unemployment benefits
q1(i,j,r)	I∈Com j∈Ind r∈Reg	Multiproduct industry supply
qhous(r)		Number of households
r_k(j,r)	j∈Ind r∈Reg	Rate of return (RoR) on capital

realdev		Real devaluation
sg_g(r)	:eg	State government outlays
sg_t(r)	:eg	State govt. receipts
spptax(j,r)	ıd r∈Reg	State production tax rate
t_comp(r)	:eg	Commonwealth land tax receipts
t_lnd(r)	:eg	Agri. land tax receipts
t_paye(r)	:eg	PAYE receipts
t_prol(r)	:eg	State payroll receipts
t_rnt(r)	:eg	Rental tax receipts
t_sg_yr(r)	:eg	State income-reducing tax
t1_com(i,s,j,r)	:om s∈Sou j∈Ind r∈Reg	Power of tax on intermediate, C'wealth
t1_state(i,s,r)	:om s∈Sou r∈Reg	Power of tax on intermediate, state
t2_com(i,s,j,r)	:om s∈Sou j∈Ind r∈Reg	Power of tax on investment, C'wealth
t2_state(i,s,r)	:om s∈Sou r∈Reg	Power of tax on investment, state
t3_com(i,s,r)	:om s∈Sou r∈Reg	Power of tax, h'hold sales, C'wealth
t3_state(i,s,r)	:om s∈Sou r∈Reg	Power of tax, h'hold sales, state
t4_com(i,r)	:om r∈Reg	Power of export tax
tax1_com(r)	:eg	C'wealth intermediate tax, region total
tax1_st(r)	:eg	State intermediate tax, region total
tax2_com(r)	:eg	C'wealth invest. tax rate, region total
tax2_st(r)	:eg	State investment tax, region total
tax3_com(r)	:eg	C'wealth h'hold tax, region total
tax3_st(r)	:eg	State h'hold tax, region total
tax4_com(r)	:eg	Export tax revenue, region total
taxm_com(r)	:eg	Import tariff revenue, region total
tcg_pt(r)	:eg	Commonwealth production tax receipts
tm(i)	:om	Power of tariff rate
tot_nat		Terms of trade
tsg_pt(r)	:eg	State production tax receipts
twistlk(j,r)	ıd r∈Reg	Labour-capital twist
twist_src(i)	:om	Commodity twist shift domestic-import
twist_src_bar		National twist shift, domestic-import
utility(r)	:eg	Utility per household
v2_nat		Aggregate nominal investment
v2_r(r)	:eg	Aggregate nominal investment, regional
v3_nat		Nominal household consumption
v3_r(r)	:eg	Real household consumption, regional
v3lux(r)	:eg	Total nominal supernumerary h'hold expenditure
v4_nat		$A border value of exports
v4_r(r)	:eg	$A border value of exports, regional
v5_nat		Aggregate nominal C'wealth govt demands
v5_r(r)	:eg	Aggregate nominal C'wealth govt demands, reg.

Variable	**Set elements**	**Description**
v6_nat		Aggregate nominal. state govt demands
v6_r(r)	r∈Reg	Aggregate nominal state govt demands, reg.
v7_r(r)	r∈Reg	Aggregate nominal inventories
vimp_nat		Nominal $A value of nat. imports
vimp_r(r)	r∈Reg	Nominal value imports in $A
x_agland(j,r)	j∈Ind r∈Reg	Industry demand for agri. land
x_imp(i)	i∈Com	International imports
x_lab(q,j,r)	q∈Occ j∈Ind r∈Reg	Labour demands by occupation
x_mar1(i,s,j,r,u)	i∈Com s∈Sou j∈Ind r∈Reg u∈Mar	Margins on intermediate sales to production
x_inter(i,s,r)	i∈Com s∈Reg r∈Reg	Interstate trade
x_inter_x(i,s)	i∈Com s∈Reg	Interstate exports

x_inter_m(i,r)	i∈Com r∈Reg	Interstate imports
x_int(s)	s∈Reg	Interstate exports, aggregate
x_mar2(i,s,j,r,u)	i∈Com s∈Sou j∈Ind r∈Reg u∈Mar	Margins on intermediate sales to investment
x_mar3(i,s,r,u)	i∈Com s∈Sou r∈Reg u∈Mar	Margins on sales to households
x_mar4(i,r,u)	i∈Com r∈Reg u∈Mar	Margins on international exports
x_mar5(i,s,r,u)	i∈Com s∈Sou r∈Reg u∈Mar	Margins on sales to C'wealth govt.
x_mar6(i,s,r,u)	i∈Com s∈Sou r∈Reg u∈Mar	Margins on sales to state govts.
x_rate		Exchange rate ($Aus/$for)
x_tot(i,r)	i∈Com r∈Reg	Total domestic supplies
x_unemp(r)	r∈Reg	Unemployment by reg
x0loc(i,r)	i∈Com r∈Reg	Real percent change in LOCSALES (dom+imp)
x0locnat(i)	i∈Com	Real percent change in NATSALES (dom+imp)
x1_q(i,s,j,r)	i∈Com s∈Sou j∈Ind r∈Reg	Intermediate demands, production
x1c(i,j,r)	i∈Com j∈Ind r∈Reg	Intermediate demands, dom.nest
x1o(i,j,r)	i∈Com j∈Ind r∈Reg	Intermediate demands, dom-imp. nest
x1prim(j,r)	j∈Ind r∈Reg	Effective primary demand
x2_cg(j,r)	j∈Ind r∈Reg	C'wealth govt investment
x2_jr(j,r)	j∈Ind r∈Reg	Total industry investment
x2_nat		Aggregate real investment
x2_q(i,s,j,r)	i∈Com s∈Sou j∈Ind r∈Reg	Intermediate demands, investment
x2_r(r)	r∈Reg	Aggregate real investment, regional
x2_sg(j,r)	j∈Ind r∈Reg	State gov investment
x2c(i,j,r)	i∈Com j∈Ind r∈Reg	Intermediate demands, invest., dom. nest
x2ind(j,r)	j∈Ind r∈Reg	Private industry investment
x2o(i,j,r)	i∈Com j∈Ind r∈Reg	Intermediate demands, invest., dom.-imp.
x3_nat		Real household consumption
x3_q(i,r)	i∈Com r∈Reg	Household composite demands, dom.-imp.
x3_qr(i,s,r)	i∈Com s∈Sou r∈Reg	Household demands by source
x3_r(r)	r∈Reg	Real household consumption, regional
x3c(i,r)	i∈Com r∈Reg	Household domestic composite demands
x3lux(i,r)	i∈Com r∈Reg	Household - supernumerary demands
x3sub(i,r)	i∈Com r∈Reg	Household - subsistence demands
x4(i)	i∈Exp	International exports
x4_nat		Export volume index
x4_r(r)	r∈Reg	Export volume index, regional
x4r(i,r)	i∈Com r∈Reg	International exports by region
x4r_ntagg(r)	r∈Reg	Non-traditional exports, region total

Variable	**Set elements**	**Description**
x5(i,s,r)	i∈Com s∈Sou r∈Reg	C'wealth govt demands
x5_nat		Aggregate real C'wealth govt demands
x5_r(r)	r∈Reg	Aggregate real C'wealth govt demands, reg.
x6(i,s,r)	i∈Com s∈Sou r∈Reg	State govt demands
x6_nat		Aggregate real state govt demands
x6_r(r)	r∈Reg	Aggregate real state govt demands, reg.
x7_r(r)	r∈Reg	Aggregate real inventories
xcost(j,r)	j∈Ind r∈Reg	Other costs
ximp_nat		Quantity index of imports, national
ximp_r(r)	r∈Reg	Quantity index of imports, regional
xr_imp(i,r)	i∈Com r∈Reg	International imports by region
zact(j,r)	j∈Ind r∈Reg	Industry output
znat(j)	j∈Ind	National industry output

Appendix C

List of coefficients in FEDSA-WINE in order of appearance

Coefficient	Set elements	Description
BAS1(i,s,j,r)	i∈Com s∈Sou j∈Ind r∈Reg	Intermed., basic
BAS2(i,s,j,r)	i∈Com s∈Sou j∈Ind r∈Reg	Intermed., invest
BAS3(i,s,r)	i∈Com s∈Sou r∈Reg	Household basic flows
BAS4(i,s)	i∈Com s∈Reg	Exports basic flows
BAS5(i,s,r)	i∈Com s∈Sou r∈Reg	Com. govt. basic flows
BAS6(i,s,r)	i∈Com s∈Sou r∈Reg	State govt. basic flows
BAS7(i,s,r)	i∈Com s∈Sou r∈Reg	Inventories basic flows
LEVP0(i,s,r)	i∈Com s∈Sou r∈Reg	Levels basic prices
MAR1(i,s,j,r,u)	i∈Com s∈Sou j∈Ind r∈Reg u∈Mar	Intermediate margins
MAR2(i,s,j,r,u)	i∈Com s∈Sou j∈Ind r∈Reg u∈Mar	Investment margins
MAR3(i,s,r,u)	i∈Com s∈Sou r∈Reg u∈Mar	Households margins
MAR4(i,s,u)	i∈Com s∈Reg u∈Mar	Export margins
MAR5(i,s,r,u)	i∈Com s∈Sou r∈Reg u∈Mar	C'wealth govt. margins
MAR6(i,s,r,u)	i∈Com s∈Sou r∈Reg u∈Mar	State govt. margins
TAX1CG(i,s,j,r)	i∈Com s∈Sou j∈Ind r∈Reg	Intermed. C'w tax
TAX1ST(i,s,j,r)	i∈Com s∈Sou j∈Ind r∈Reg	Interm. state tax
TAX2CG(i,s,j,r)	i∈Com s∈Sou j∈Ind r∈Reg	Invest C'w tax
TAX2ST(i,s,j,r)	i∈Com s∈Sou j∈Ind r∈Reg	Invest state tax
TAX3CG(i,s,r)	i∈Com s∈Sou r∈Reg	H'hold C'w tax
TAX3ST(i,s,r)	i∈Com s∈Sou r∈Reg	H'hold state tax
TAX4(i,s)	i∈Com s∈Reg	Export tax
TAXMCG(i)	i∈Com	Import tariff revenue
VIMPORT(i)	i∈Com	Basic value of imports
DOLE(r)	r∈Reg	Commonwealth payments to unemployed
COM2STATPAY(r)	r∈Reg	Commonwealth payments to states
COM2pers(r)	r∈Reg	Commonwealth payments to person
STAT2pers(r)	r∈Reg	State payments to persons
FEEFINESG(r)	r∈Reg	State fees, fines
WAGE(q,j,r)	q∈Occ j∈Ind r∈Reg	Post-tax wages
INCTAX(q,j,r)	q∈Occ j∈Ind r∈Reg	Income tax on wage
PAYROLL(q,j,r)	q∈Occ j∈Ind r∈Reg	Payroll tax
KAPRENT(j,r)	j∈Ind r∈Reg	Total returns to capital
KAPTAX(j,r)	j∈Ind r∈Reg	Income tax on capital
LNDTAX(j,r)	j∈Ind r∈Reg	Property/residential tax
AGLND(j,r)	j∈Ind r∈Reg	Returns to agri. land
AGRITAX(j,r)	j∈Ind r∈Reg	Tax on agri. land
ST1TAX(j,r)	j∈Ind r∈Reg	State prod'n taxes
CO1TAX(j,r)	j∈Ind r∈Reg	C'wealth production taxes
OTHCOST(j,r)	j∈Ind r∈Reg	Returns to working capital
ZIG1D(i)	i∈Com	CES intermediate intra-domestic
ZIG1I(i)	i∈Com	CES intermediate international
ZIG2D(i)	i∈Com	CES invest intra-domestic

Variable	Set elements	Description
ZIG2I(i)	i∈Com	CES invest international

ZIG3D(i)	i∈Com	CES households intra-domestic
ZIG3I(i)	i∈Com	CES households international
ZIGPRI(j,r)	j∈Ind r∈Reg	Primary factor CES
ELAS4(i)	i∈Com	Export demand elasticities
ELAS4_NT		Non-trad exp demand elas
SIGMA1OUT(i)	i∈Ind	CET transformation
ZIG4(i)	i∈Com	Export regional elasticity of substitution
UMPE_1(r)	r∈Reg	Employed/unemployed ratio
UMPE_2(r)	r∈Reg	Labour/unemployed ratio
FRISCH(r)	r∈Reg	Frisch parameter
VAL1(i,s,j,r)	i∈Com s∈Sou j∈Ind r∈Reg	Prod'n, purch. value
VAL1T(i,aa,j,r)	i∈Com aa∈Twosou j∈Ind r∈Reg	Dom-imp VAL1
VAL1O(i,j,r)	i∈Com j∈Ind r∈Reg	All-source nest, VAL1
VAL1_PUR(i,r)	i∈Com r∈Reg	Value, commodity intermediates
VAL2(i,s,j,r)	i∈Com s∈Sou j∈Ind r∈Reg	Invest, purch. value
VAL2T(i,aa,j,r)	i∈Com aa∈Twosou j∈Ind r∈Reg	Dom-imp VAL2
VAL2O(i,j,r)	i∈Com j∈Ind r∈Reg	All-source nest, VAL2
VAL2_PUR(i,r)	i∈Com r∈Reg	Value, commodity intermediates
VAL2SUM(j,r)	j∈Ind r∈Reg	Investment, buyer prices, industry
V2CG(j,r)	j∈Ind r∈Reg	C'wealth govt. investment
V2SG(j,r)	j∈Ind r∈Reg	State govt. investment
VAL3(i,s,r)	i∈Com s∈Sou r∈Reg	H'hold consumption, purch. value
VAL3T(i,aa,r)	i∈Com aa∈Twosou r∈Reg	Dom.-imp. nest, VAL3
VAL3O(i,r)	i∈Com r∈Reg	All-source nest, VAL3
VAL4(i,r)	i∈Com r∈Reg	Export purchase value
VAL4NT(r)	r∈Reg	Non-traditional export purchase value
VAL5(i,s,r)	i∈Com s∈Sou r∈Reg	C'wealth govt. purch. value
VAL5D(i)	i∈Com	C'wealth govt. purch. value, dom. sources
VAL6(i,s,r)	i∈Com s∈Sou r∈Reg	State govt. purch. value
VAL6D(i)	i∈Com	State govt. purch. value, dom. nest
SOU_SHR1(i,j)	i∈Com j∈Ind	Dom/tot ratio from VAL1
SOU_SHR2(i,j)	i∈Com j∈Ind	Dom/tot ratio from VAL2
SOU_SHR3(i)	i∈Com	Dom/tot ratio from VAL3
SH4(i,r)	i∈Com r∈Reg	Commodity share of total regional exports
SOU_SHR5(i)	i∈Com	Dom/tot V5
SOU_SHR6(i)	i∈Com	Dom/tot V6
EPSIL(i,r)	i∈Com r∈Reg	H'hold expenditure elasticities
B3LUX(i,r)	i∈Com r∈Reg	Ratio, (supernumerary expenditure/total expenditure), by commodity
S3_BUD(i,r)	i∈Com r∈Reg	Commodity budget share
S3LUX(i,r)	i∈Com r∈Reg	Marginal household budget shares
LABOC(q,j,r)	q∈Occ j∈Ind r∈Reg	Occ'n labour cost
LABOUR(j,r)	j∈Ind r∈Reg	Labour cost, industry
CAPITAL(j,r)	j∈Ind r∈Reg	Capital cost, industry
AGRILND(j,r)	j∈Ind r∈Reg	Agri. land cost, industry
ZIGOCC(j,r)	j∈Ind r∈Reg	Occ substit'n
PRIMTOT(j,r)	j∈Ind r∈Reg	Total primary
PRIMARY(v,j,r)	v∈Fac j∈Ind r∈Reg	Total primary returns
AGGLAB(r)	r∈Reg	Regional returns to labour

Variable	**Set elements**	**Description**
AGGLAND(r)	r∈Reg	Regional returns to agri. land
AGGCAP(r)	r∈Reg	Regional returns to capital
AGGOCT(r)	r∈Reg	Regional returns to other costs
LAB_OC(m,r)	m∈Occ r∈Reg	Occupation share

WAGEINC(m,j,r)	m∈Occ j∈Ind r∈Reg	Pre-PAYE labour less payroll
C_TWIST_SRC		Sens. of imp/dom twists to x_tot/GDP
W_LINK		Wage link
CPI_oct		Prod'n tax CPI link
LINK_LK		K, lnd tax to K, lnd price
H_BEN		Unemployment benefits
P2LINK		Property tax
h34r(r)	r∈Reg	Link fees, fine to income
CPI_TRN		Govt transfers link to CPI
TAX1STZ(r)	r∈Reg	Regional indirect state taxes, intermediate
TAX1CGZ(r)	r∈Reg	Regional indirect C'wealth taxes, intermediate
TAX2STZ(r)	r∈Reg	Regional indirect state taxes, invest
TAX2CGZ(r)	r∈Reg	Regional indirect C'wealth taxes, invest
TAX3STZ(r)	r∈Reg	Regional indirect state taxes, households
TAX3CGZ(r)	r∈Reg	Regional indirect C'wealth taxes, households
TAX4CG(r)	r∈Reg	Regional export taxes
TAXMCGR(r)	r∈Reg	Regional allocation of tariff revenue
TAXMCG_r(i,r)	i∈Com r∈Reg	Allocation of tariffs, Com*Reg
PRODTAXC(r)	r∈Reg	Production tax, C'wealth
PRODTAXS(r)	r∈Reg	Production tax, state
IMP_CIF(i,r)	i∈Com r∈Reg	Tariff reduced import value
IMPORT(i,r)	i∈Com r∈Reg	Regional basic import value
INDI_REV(r)	r∈Reg	Total indirect tax revenue in region r
GSPINC(r)	r∈Reg	GDP income side
CON_r(r)	r∈Reg	Household C
INV_r(r)	r∈Reg	Investment I
CGOV_r(r)	r∈Reg	Govt. exp, G(C'wealth)
SGOV_r(r)	r∈Reg	Govt exp, G(state)
EXP_r(r)	r∈Reg	Export X
IMP_r(r)	r∈Reg	Import M
INVENT(r)	r∈Reg	Change in inventories
BASE_GDP		GDP nominal, national (expenditure)
BASE_GSP(r)	r∈Reg	GSP nominal, regional (expenditure)
GDPEXP(r,g)	r∈Reg g∈GDP	GDP expenditure components
INTER_FLO(i,s,r)	i∈Com s∈Reg r∈Reg	Interstate flows
INTER_EXP(i,s)	i∈Com s ∈Reg	Interstate exports
INTER_IMP(i,r)	i∈Com s∈Sou j∈Ind r∈Reg	Interstate imports
INT_X(s)	s∈Reg	Aggregate interstate exports
INT_M(r)	r∈Reg	Aggregate interstate imports
SALE(i,s)	i∈Com s∈Reg	Total sales
DIRSALE(i,s)	i∈Com s∈Reg	Direct sales without margins
MARGINS(u,s)	u∈Com s∈Reg	Margin activity
TOTCOST(j,r)	j∈Ind r∈Reg	Total industry cost
TAXPAYE(r)	r∈Reg	P.A.Y.E. receipts
KAPTAXZ(r)	r∈Reg	Tax receipts on capital rentals
AGRITAXZ(r)	r∈Reg	Tax receipts on agri. land rentals

Variable	**Set elements**	**Description**
VAL2CG(r)	r∈Reg	C'wealth capital expenditure
CGOVZ_r(r)	r∈Reg	Aggregate C'wealth G
TZ_CGOV		Aggregate C'wealth T
PAYROLLr(r)	r∈Reg	State payroll revenues
LNDTAXr(r)	r∈Reg	State commercial + residential tax revenues
SGOVZ_r(r)	r∈Reg	Aggregate state govt. G
TZ_SGOV(r)	r∈Reg	Aggregate state govt. T

MAKE(i,j,r)	I∈Com j∈Ind r∈Reg	Supply of i by j
MAKE_I(j,r)	j∈Ind r∈Reg	All prod'n by industry j
MAKE_J(i,r)	I∈Com r∈Reg	Total commodity i production
PURE_PROFITS(i,r)	I∈Ind r∈Reg	COSTS-MAKE_C : should be zero
LOST_GOODS(c,r)	c∈Com r∈Reg	SALES-MAKE_I : should be zero
IS_DOM(s)	s∈Sou	Binary dummy 1
IS_IMP(s)	s∈Sou	Binary dummy 2
TINY		A very small number for invertibility
LOCSALES(i,r)	I∈Com r∈Reg	Total loc. (state) sales = dom + imp i
NATSALES(i)	I∈Com	Total loc. (national) sales = dom + imp i
INTER_EXP(i,s)	I∈Com s∈Reg	Interstate exports
INTER_IMP(i,r)	I∈Com r∈Reg	Interstate imports
INITSALES(i,r)	I∈Com r∈Reg	Initial vol. of SALES at final prices
TAX3Wine(i)	I∈Wine	C'wealth revenue from wine
EPSTOT(r)	r∈Reg	Average Engel elasticity: should = 1

Appendix D

Condensing and closing the model

FEDSA-WINE, as detailed in appendices A to C, has too many equations and variables to generate a solution efficiently. The usual practice with CGE models in GEMPACK is to condense the model prior to generating the fortran code from the TABLO code. This entails omitting some variables that are exogenous and unshocked. The variables to be shocked depend on the simulations being undertaken. Therefore, appropriate variable omission may be specific to the scenarios being examined. In addition, some endogenous variables can be substituted out using specific equations, resulting in fewer but more complex equations. The name of the particular variable that could be substituted out is suggested by each equation name.

The stored input file to condense FEDSA-WINE prior to generation of the fortran code is *fedstat1.sti* on the accompanying diskette. The file starts by listing exogenous variables to be omitted. Commands for substituting out variables follow. For example, the variable x1_q is substituted out using the equation E_x1_q. The TABMATE program of GEMPACK software allows to user to generate both a valid closure and a revised stored input with endogenous variables of little interest substituted out. In addition, the modeller can still report variables substituted out if they are backsolved. This means that at each step of a multi-step simulation, the value of a backsolved variable is calculated by substituting into the equation known variables still in the condensed system. This reduces the memory requirements of a simulation while still allowing an endogenous variable to be reported.

Table D.1 tallies the variables and equations in the condensed version of FEDSA-WINE. The fifth column contains the variables that are not matched to any equation name. They are candidates for exogeneity and would provide a balanced closure (i.e, the number of equations would match the number of endogenous variables). TABMATE, part of version 6.0 and above of the GEMPACK software, allows the modeller to generate a list of exogenous variables automatically.

Three different closures have been used in chapters 3 and 4. In the GST scenarios in chapter 4, the italicised variables in the fifth column of table D.1 are endogenous. The variable *omega* has been swapped with national real investment *x2_nat*. The balance of trade *delb* become exogenous by swapping with *f3_nat*. Finally, real government spending becomes exogenous by swapping *x5_r* and *x6_r* with *f_x52* and *f_x62*. This closure ensures that all variations in real GDP result in increases in real consumption. Other components of real domestic absorption remain unchanged relative to the base case. Capital in excess of that of the base case is necessarily funded from overseas, as real domestic investment is exogenous. Foreigners are paid rentals on additional capital through an exogenously imposed balance of trade surplus.

Table D.1: Tally of variables and equations in FEDSA-WINE

1 Dimension	2 Variable Count	3 Equation Count	4 Exogenous Count	5 Unexplained Variables
MACRO	41	33	8	cb2 cpi fun_b *omega f3_nat* l_emp f4_nat twist_src_bar
REG	74	63	11	f3 f5p cb1r *f_x52 f_x62* qhous fpostr frollr x_unemp f4p_ntagg fx4_ntagg
COM	12	5	7	tm pmp f1_com f2_com f3_com f4_com ftwist_src
EXP*REG	2	1	1	fx4 fp4
COM∗REG	17	14	3	f4 a3_com f3_state
COM∗SOU*REG	7	4	3	fx7 t1_state t2_state
IND*REG	16	10	6	r_k a_in x2_cg x2_sg a_prim x_agland
FAC*IND*REG	2	1	1	a_fac
COM∗ IND	1	0	1	f1_com_ij
IND	2	1	1	f1_ind
OCC*REG	1	1	0	
COM*FAN	1	1	0	
COM*REG*FAN	1	1	0	
TOTAL	177	135	42	

In the historical simulation in chapter 3, observed changes in the expenditure components of GDP are imposed exogenously on the model. In addition, closure swaps allow us to impose available price and quantity data on winegrape and wine production, consumption and exports. Table D.2 lists the *HD'* (i.e., exogenous in the historical run, endogenous in the decomposition run) and matching *H'D* variables (i.e., endogenous in the historical run, exogenous in the decomposition run), as in chapter 3 simulations for the period 1987 to 1996. The two sets, *HD'* and *H'D*, were slightly smaller for the 1996 to 1999 simulations as less historical data were available.

Table D.2: Chapter 3 variables in closure swaps

Variables in the HD' set[a,b]	Corresponding H'D variables[c]
x2_nat	omega
x3_r	f3
x5_r	f_x52
x6_r	f_x62
e	f4_nat
imp_nat	twist_src_bar
fpost	l_emp
lr_emp	fpostr
x_imp (wine)	ftwist_src (wine)
e	f4_nat
x3_q (alcohol)	a3com (alcohol)
x4r (EXP)	fx4 (EXP)
p4r (wine)	f4_com (wine)
p1nat (winegrapes)	f1_ind 1-3 (winegrapes)
employ (all wine)	twistlk (all wine)

a (wine) = three wine commodities; (alcohol) = beer, spirits and three wine commodities; (EXP) = endogenous export commodities; (all wine) = three winegrape + three wine industries; (winegrapes)= three winegrape industries.
b Exogenous in the historical simulation, endogenous in the decomposition simulation.
c Endogenous in the historical simulation, exogenous in the decomposition simulation.

Appendix E

FEDSA-WINE's database and parameters

The model's database was initially updated to 1996 using the dynamic MONASH95 model (Dixon, Parmenter and Rimmer 1998). The national database was then split into the two regions, South Australia and the rest of Australia, using a TABLO-generated program. Regional disaggregation required the use of various ABS sources including national accounts, manufacturing census, trade and tax data. The tax base has been compiled using ABS catalogue no. 5506.0 and Treasury budget papers.[1] In addition, FEDSA-WINE has been modified slightly to facilitate projections to different database years, using observed or forecast macroeconomic plus industry-level data. No accumulation equations are included in FEDSA-WINE, as might apply to capital stocks, foreign debt or, in the context of this study, wine stocks. The latter were calculated outside the model as presented in various tables in chapters 3 and 5.

PISA (1997) and the Australian Wine and Brandy Corporation provided grape price data used in this study. At present, detailed price data by variety are available only for South Australia. ABS (1999 and previous issues) contains additional wine data relating to domestic consumption, exports, international trade and regional detail. In this study, I define premium white winegrape varieties to include Chardonnay, Riesling, Sauvignon Blanc, Semillon and Chenin Blanc (but not Colombard).

[1] Melissa Bright undertook much of the work on the taxation part of the database while at the South Australian Centre for Economic Studies.

Premium red winegrape varieties are defined to include Cabernet Sauvignon, Cabernet Franc, Pinot Noir and Ruby Cabernet in all regions. In regions of South Australia other than the Riverland, all Shiraz production is included. Riverland Shiraz was split half and half between the premium and non-premium categories. This was necessary, given the wide dispersion of Shiraz prices, from $220 to $1,275 per tonne in the Riverland, which was near both the high and low prices for all grape varieties produced in the region in 1996. Premium wine is distinguished from non-premium by its container: premium is defined to include only wines sold in bottles of no more than one litre. Since their volumes are relatively small and stable over time, for simplicity I have put all fortified and sparkling wines in the non-premium category. These decisions are an attempt to match wine grapes with wine in the respective categories. The premium category contains a large proportion of lower-priced commercial wines. Much more expensive ultra-premium (as distinct from super-premium) wines account for only a small proportion of premium production and consumption.

Many of the findings of this study arise from distinguishing between three categories of wine. The only econometric study of the Australian industry to include disaggregated wine types, and based on relatively recent data, estimates that premium red wine has an income elasticity of 2.45, premium white wine 1.38 and non-premium 0.35 (CIE 1995). In FEDSA-WINE, the expenditure elasticities imposed are 2.0 for premium red wine, 1.2 for premium white wine and 0.6 for non-premium wine. These parameters are slightly different from the CIE study because I believe the price data used in that study contain a disproportionate super-premium weighting in the premium wine categories.

Next, we consider parameters governing substitution by source. Winegrapes are tradable between regions. For example, Barossa wineries crushed almost 150 kt of winegrapes in 1998-99, yet the Barossa district produced only 67 kt of winegrapes in this period. The remaining districts in South Australia all produce more winegrapes than they crush. And the major irrigation districts of Murrumbidgee, Sunraysia, Kerang-Swan Hill and the Riverland are close enough together for grapes and must (i.e., newly pressed grape juice which does not appear as a separate entity in the database of FEDSA-WINE) to be transported from one district to the other within a day. Together, they produce almost two thirds of Australia's winegrapes. The intra-domestic substitution parameters for winegrapes sold as inputs into wine production are 9.6, reflecting limited differentiation by source in aggregate production. With further disaggregation, we might expect greater differentation by source and smaller parameters. At the retail end, the imposed intra-domestic elasticities (6.0) are smaller. This assumes the regional loyalties of Australian wine consumers are stronger than those of producers. In terms of volume, large corporate wineries, most of whom have a diverse regional base, account for a high proportion of Australian wine production. The Armington parameter (i.e, domestic-import substitution) for wine consumption is 3.0, implying more differentiation than for intra-domestic sources.

Chapter 4, section 2, contains a rationale for the choice of export demand elasticities for wine within the model. Through differentiation and a concentration of export sales in a few markets, the export demand elasticities chosen are smaller than one might infer from Australia's share of global wine trade.

Table E.1: FEDSA-WINE parameters

	Intra-domestic			International (Armington)				
	Production	Investment	Consumption	Production	Investment	Consumption	Export demand elasticity	1996 expenditure elasticity
White grapes	**9.6**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	-5.0*	1.00
Red grapes	**9.6**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	-5.0*	1.00
Non-premium grapes	**9.6**	**0.0**	**3.5**	**0.0**	**0.0**	**1.5**	-15.0	0.21
Soft drink	0.0	0.0	0.0	0.0	0.0	0.0	-5.0*	0.69
Beer	0.0	0.0	0.0	0.0	0.0	0.0	-5.0*	0.81
White wine	**9.6**	**9.6**	**6.0**	**4.8**	**4.8**	**3.0**	-8.0	1.20
Red wine	**9.6**	**9.6**	**6.0**	**4.8**	**4.8**	**3.0**	-8.0	2.00
Bulk wine	**9.6**	**9.6**	**6.0**	**4.8**	**4.8**	**3.0**	-4.0	0.60
Spirits	9.6	9.6	8.0	4.8	4.8	3.0	-5.0*	1.69
Agriculture etc., fishing	4.6	4.6	4.6	1.5	2.0	1.5	-11.6	0.50
Mining	5.0	5.0	6.0	1.7	1.9	2.0	-10.4	0.42
Processed minerals	2.7	2.7	2.8	0.9	0.8	0.9	-13.8	0.28
Food processing	4.1	4.1	3.5	1.4	1.1	1.2	-19.1	0.39
Cars	5.2	5.2	6.0	5.2	5.2	5.2	-5.0*	1.06
Textiles, early processing	4.5	4.5	4.5	1.5	1.1	1.5	-2.0	1.00
TCFs	7.5	7.5	7.5	2.5	2.2	2.5	-5.0*	0.50
Chemicals and fuel	6.0	6.0	6.0	2.0	2.0	2.0	-5.0*	1.01
Other manufacturing	3.9	3.9	4.2	1.3	0.9	1.4	-15.9	0.78
Utilities	0.0	0.0	0.0	0.0	0.0	0.0	-5.0*	1.01
Construction	0.0	0.0	0.0	0.0	0.0	0.0	-5.0*	1.00
Trade	0.0	0.0	0.0	0.0	0.0	0.0	-5.0*	1.13
Hotels	0.0	0.0	0.0	0.0	0.0	0.0	-3.0	0.75
Transport	4.2	4.2	4.5	1.4	2.0	1.5	-3.0	1.46
Communication	0.0	0.0	0.0	0.0	0.0	0.0	-5.0*	1.30
Insurance	0.0	0.0	0.0	0.0	0.0	0.0	-5.0*	1.62
Community services	0.0	0.0	0.0	0.0	0.0	0.0	-3.0	1.14
Public admin. & defence	0.0	0.0	0.0	0.0	0.0	0.0	-5.0*	1.26
Personal services	0.0	0.0	0.0	0.0	0.0	0.0	-5.0*	1.04
Ownership of dwellings	0.0	0.0	0.0	0.0	0.0	0.0	-5.0*	1.38

- Non–traditional exports change by the same proportion with an average export demand elasticity of –5.

Appendix F

Calculating revenue-neutral changes in the tax mix on alcohol consumption

The wine tax revenue (π_0) collected under the current wholesale sales tax (WST) arrangement is:

$$\pi_0 \quad = t^0 \sum_{i=1}^{6} p_i Q_i \tag{F.1}$$

where t^0 is the WST rate, p_i is the pre-tax wholesale price per litre of wine type i, and Q_i is the total number of litres of wine type i consumed (i.e., the six types are the three wine categories consumed both off- and on-premise).

By contrast, when a goods-and-services tax (GST) is introduced, consumers will pay a tax on the sale from licensed outlets. The amount of tax will vary for a given wine sale depending on whether consumption is off-premise or on-premise, as the latter outlets (restaurants, etc.) have much higher markups. In addition, consumers will be affected by any top-up wine tax or WET added at the wholesale level. If the WET and the marketing margins are both ad valorem, the wine tax revenue (π_1) under a GST is:

$$\pi_1 \quad = \sum_{i=1}^{6} [g(1+ m_i)(1+ t^1) + t^1]p_i Q_i \tag{F.2}$$

where g is the GST rate, m_i is the proportional sales margin for wine type i (where the *i's* are the three wine types each retailed in either on- and off-premise outlets), and t^1 is the top-up wine tax rate.

The revenue-neutral WET rate is found by setting the pre-GST wine tax revenue (π_0) in (F.1) equal to post-GST revenue (π_1) in (F.2) and solving for t^1:

$$t^1 = [t^0 - g(1+\sum_{i=1}^{6} \gamma_i m_i)] / [1+g(1+\sum_{i=1}^{6} \gamma_i m_i)] \quad \text{(F.3)}$$

where γ_i (= $p_i Q_i / \sum_{i=1}^{6} p_i Q_i$) is the pre-tax wholesale value-based share of wine type i in total wine sales.

Equations (F.3) shows that the revenue-neutral WET (t^1) depends on the GST rate (g), the pre-GST WST rate (t^0), the value-based consumption shares (γ_i), and the various markups (m_i).

Alternatively, the GST plus a volumetric wine tax would yield tax revenue of:

$$\pi_1 = \sum_{i=1}^{6} [vs_i + g(1+m_i)(p_i+vs_i)]Q_i \quad \text{(F.4)}$$

where v is the volumetric tax in dollars per litre of alcohol and s_i is the average volume of alcohol per litre of wine type i. The volumetric rate v with a known GST rate g that maintains revenue-neutrality after introducing the GST, given the pre-GST WST rate t_0, is found by setting π_0 in (B1) to π_1 in (F.4), in which case:

$$v = [t^0 - g(1+\sum_{i=1}^{6} \gamma_i m_i)] / \{\sum_{i=1}^{6} [1+g(1+m_i)] s_i \gamma_i / p_i\} \quad \text{(F.5)}$$

From (F.5), v is dependent not only on the same four variables as t^1 but also on the alcohol content (s_i) of each wine type. (F.3) and (F.5) are used to calculate the equivalent tax rates shown in table F.1.

Table F.1: The post-GST tax equivalents of possible tax packages[a]

	Wine tax in planned GST package	Revenue-neutral volumetric WET	Revenue-neutral ad valorem WET	Volumetric top-up tax applied at pre-GST beer rate	Volumetric top-up tax applied at pre-GST spirits rate
Pre-GST tax rate[b]	48.7% WST	$13.80/LoL	41% WST	$15.60/LoL + 37% WST	$35/LoL + 37% WST
'WET' top-up (%):					
Red premium	29.0	13.7	20.7	29.4	60.9
White premium	29.0	14.0	20.7	31.7	65.6
Non-premium	29.0	38.5	24.0	94.5	195.5
Wine, total	29.0	21.8	21.8	53.3	110.3
'WET' top-up ($/litre of alcohol)[c]					
Red premium	15.1	7.2	11.2	17.2	35.6
White premium	14.9	7.2	11.0	17.2	35.6
Non-premium	5.4	7.2	4.1	17.2	35.6
Wine, total	9.5	7.2	7.2	17.2	35.6

a The assumed shares of sales that are on-premise are 30% for premium wine, beer and spirits, and 10% for non-premium wine. The assumed retail margins are 150% for all alcoholic beverages for on-premise sales and 33% for premium wines, beer and spirits, and 25% for non-premium wine sold off-premise.

b Volumetric taxes are expressed in 1996 prices per litre of alcohol (LoL). Wine consumption shares are based on 2003 forecasts.

c Calculated by assuming the following alcohol content by volume: red premium 12.5%, white premium 11%, and non-premium 11%.

Appendix G

The Clements-Smith modification to demand

The Clements-Smith modification to the demand system in CGE models of the ORANI type provides a means of imposing conditional own-price and cross-price Slutsky parameters on a subset of commodities in a model in which demand is otherwise based on directly additive preferences. This appendix summarises the changes made to FEDSA-WINE without detailing the derivation (Clements and Smith 1983). Meagher et al. (1985) and CIE (1995) have modelled wine tax scenarios with this modification.

The utility function is divided into two, in this case, wine commodities (S_w) and non-wine commodities. A matrix of unconditional Slutsky parameters (π_{ij}) of n x n (where n is the number of commodities in the model) is constructed with the methodology. The matrix is partitioned into four, with π_{ij} =

$$\begin{array}{c|c|c} & j \in S_w & j \notin S_w \\ \hline i \in S_w & \pi_{ij}^{w} + \phi\theta_w (1 - \theta_w)[\theta'_i \theta_j] & -\phi[\theta_i \theta_j] \\ \hline i \notin S_w & -\phi[\theta_i \theta_j] & \phi[\theta_i (\delta_{ij} - \theta_j)] \end{array} \qquad (G.1)$$

where S_w is the set of wine commodities, π_{ij}^w the conditional (within wine) Slutsky coefficients, ϕ the income flexibility (the inverse of the Frisch parameter), θ_w the marginal budget share of wine as a group, θ'_i the conditional marginal budget share of wine type i, θ_i the unconditional marginal budget share of good i, and δ_{ij} the Kronecker delta.

The compensated price elasticities (η'_{ij}) are equal to π_{ij} divided by b_i, where b_i is the budget share of good i. The income elasticities equal θ_i divided by b_i. Finally, (G.2) calculates the uncompensated price elasticities (η_{ij}):

$$\eta_{ij} = \pi_{ij}/b_i - b_j\,\theta_i/b_i \qquad \text{(G.2)}$$

To include the Clements-Smith specification in FEDSA-WINE, the following equations in appendix A, excerpt 7 are removed: E_utility, E_a3lux, E_a3sub, E_x3sub and E_x3lux. In addition, we replace equation E_x3_q with a form of the equation including price and income elasticities (i.e, the original ORANI form of the equation). Marginal budget shares replace income elasticities within the parameters database. Otherwise, the only new parameters are a 3x3x2 matrix of conditional Slutsky parameters for the three wine types in each region (table G1). These are imposed rather than estimated parameters.

Table G1: Demand parameters in the modified demand system of FEDSA-WINE

	Conditional Slutsky coefficients (x 100)			Uncompensated price elasticities, 2003 database		
	π_{i1}^w	π_{i2}^w	π_{i3}^w	η_{i1}	η_{i2}	η_{i3}
Premium red	-0.21	0.14	0.07	-1.05	0.03	0.04
Premium white	0.14	-0.24	0.10	0.04	-0.94	0.23
Non-premium	0.07	0.10	-0.18	0.07	0.29	-0.73

Next, the TABLO code (i.e, excerpt 1) calculates the matrix of unconditional Slutsky parameters, as shown in (G.1). The calculation of the uncompensated price elasticity *ETA*, corresponding with (G.2), follows. Finally, the code includes a replacement for equation E_x3_q. If consumer tastes shift (i.e., *a3_com*), as in historical simulations, we would require additional equations to calculate a variable used to update the marginal budget shares. These are omitted, as this variant of the model has been used only in comparative static runs in chapter 4. Excerpt G.1 contains the TABLO code used to modify FEDSA-WINE to allow the three wine types to have specific substitutability with one another.

Excerpt 1: Parameters and coefficients in Clements-Smith module

```
Set NONWINE = COM - WINE;
Coefficient (all,i,COM)(all,r,REG) NORM_MARBUD(i,r);
(all,i,COM)(all,r,REG)Mar_budget(i,r);
(all,i,COM)(all,r,REG)EPSIL(i,r);
(all,i,COM)(all,k,COM)(all,r,REG)ETA(i,k,r) !Uncompensated price elasticities !;
(all,i,COM)(all,k,COM)(all,r,REG)SLUTSKY(i,k,r) !Conditional Slutsky parameters, wine !;
(All,r,Reg)ZMAR_BUD_WI(r) #Sum of wine marginal budget shares#;
(all,i,WINE)(all,r,REG)MAR_WI_STAR(i,r);
(All,i,Com)(All,r,Reg)     S3_BUD(i,r) #Commodity budget share#;

Read Mar_budget from file PARAMETERS header "MARB";
FORMULA
(All,i,Com)(All,r,Reg)S3_BUD(i,r)= VAL3O(i,r)/Sum(k,COM,VAL3O(k,r));
(all,i,COM)(all,r,REG)EPSIL(i,r) = Mar_budget(i,r)/S3_BUD(i,r);
 (All,i,Com)(All,r,Reg)     S3_BUD(i,r) =
  VAL3O(i,r)/Sum(k,COM,VAL3O(k,r));
 (all,i,COM)(all,r,REG)EPSIL(i,r)= Mar_budget(i,r)/S3_BUD(i,r);
 !Normalise marg budg shares to sum to one !
(all,i,COM)(all,r,REG)NORM_MARBUD(i,r) =
          Mar_budget(i,r)/Sum(j,COM,Mar_budget(j,r));
!this gives the unconditional marginal shares!
(All,r,Reg)ZMAR_BUD_WI(r)=Sum{i,WINE,NORM_MARBUD(i,r)} !sum of wine subset!;
(all,i,WINE)(all,r,REG)MAR_WI_STAR(i,r)=NORM_MARBUD(i,r)/ZMAR_BUD_WI(r);

COEFFICIENT (all,i,COM)(all,k,COM) DELTA(i,k) #Kronecker delta#;
(all,i,WINE)(all,k,WINE)(all,r,REG)SLUTSKY_WINE(i,k,r);
FORMULA (all,i,COM)(all,k,COM) DELTA(i,k) = 0;
FORMULA(all,i,COM)DELTA(i,i) = 1;
Read  SLUTSKY_WINE from file PARAMETERS header "SLWI";

FORMULA  (all,i,WINE)(all,k,WINE)(all,r,REG) !wine-wine quadrant!
SLUTSKY(i,k,r) = SLUTSKY_WINE(i,k,r)+ FRISCH(r)*ZMAR_BUD_WI(r)*
            [1-ZMAR_BUD_WI(r)]*MAR_WI_STAR(i,r)*MAR_WI_STAR(k,r);
```

```
FORMULA  (all,i,COM)(all,k,NONWINE)(all,r,REG) !wine non-wine quadrant!
SLUTSKY(i,k,r) = -FRISCH(r)*NORM_MARBUD(i,r)*NORM_MARBUD(k,r);

FORMULA  (all,i,NONWINE)(all,k,COM)(all,r,REG) !non-wine wine quadrant!
SLUTSKY(i,k,r) = -FRISCH(r)*NORM_MARBUD(i,r)*NORM_MARBUD(k,r);

FORMULA  (all,i,NONWINE)(all,k,NONWINE)(all,r,REG) ! non-wine non-wine quadrant!
SLUTSKY(i,k,r) =
FRISCH(r)*NORM_MARBUD(i,r)*{DELTA(i,k)-NORM_MARBUD(k,r)};

FORMULA  (all,i,COM)(all,k,COM)(all,r,REG)
ETA(i,k,r) = SLUTSKY(i,k,r)/S3_BUD(i,r) - S3_BUD(k,r)*EPSIL(i,r);

Equation E_x3_q
 (all,i,COM)(all,r,REG)
 x3_q(i,r) - qhous(r) = EPSIL(i,r)*[v3_r(r) - qhous(r)] +
 SUM(k,COM,ETA(i,k,r)*p3o(k,r)) +a3com(i,r);
```