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

A thesis submitted in fulfilment of the requirements for the degree of Doctorate of Philosophy.

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List of abbreviations and terms

ABS	Australian Bureau of Statistics
AWBC	Australian Wine and Brandy Corporation
AWEC	Australian Wine Export Council
AWF	Winemakers' Federation of Australia
CES	Constant elasticity of substitution
CGE	Computable general equilibrium
Commercial wine	Wine produced from vineyards in permanently irrigated, warm-climate regions. Overall, the category accounts for a high proportion of the total volume of exports.
CRESH	Constant ratios of elasticities of substitution, homothetic
GSP	Gross state product
GST	Goods-and-services tax
kt	Kilotonnes
Ml	Megalitre
Non-premium wine	Table wine produced almost exclusively from permanently irrigated, warm-climate grapes, including a combination of premium and multipurpose varieties. The category includes table wine sold domestically or exported in containers of more than two litres (excluding commercial wine exported in bulk, although this is also treated as non-premium in this study except in table 6.1). The category in this study also includes other relatively static segments of the market: wine for distillation, sparkling and fortified wines.
Premium wine	Wine produced from premium winegrapes and usually bottled in containers of less than two litres. The category includes a spectrum of qualities, including commercial, super-premium and ultra-premium wines.
SSA	Systematic sensitivity analysis (see chapter 4)
Super-premium wine	Wine produced from dry-land (i.e., not permanently irrigated) winegrapes, thereby excluding most inputs from the Murray and Murrumbidgee irrigated areas. Occasional wines from these latter regions defy the category by displaying exceptional quality.

Ultra-premium wine	These are rare wines, usually originating from low yielding vineyards. Retail prices typically exceed $50 per bottle.
WET	The 'wine equivalent tax' introduced as part of the GST package to replace the wholesale sales tax on wine. Throughout this study, 'WET' and 'top-up tax' are used interchangeably, as the WET is not revenue-neutral with respect to pre-GST wine taxes (as its name implies).
WST	Wholesale sales tax

Abstract

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.

Research Declaration

This thesis contains no material which has been previously submitted for the award of any other degree or diploma in any university or other tertiary institution, and, to the best of my knowledge and belief, contains no material previously published or written by another person, except where due reference has been made in the text.

I give consent to this copy of my thesis, when deposited in the university library, being available for loan and photocopying.

Glyn Wittwer

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Chapter 1

Introduction

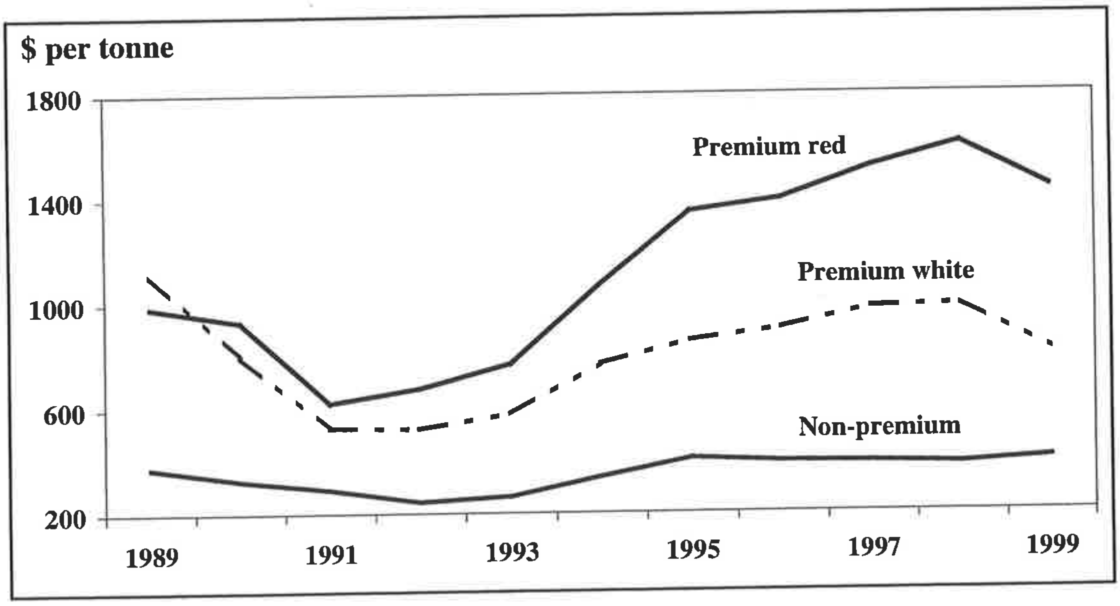
In this study, I use a computable general equilibrium model (CGE) of the Australian economy to account for the exceptional growth phase of the wine industry between 1987 and 1999, and to project the industry to 2003. The 2003 database is then used to analyse the impacts on the wine industry of the goods-and-services tax (GST) package introduced in Australia on 1 July 2000. The historical accounting exercise and forward projection of the model together provide a context for evaluating the impact that the GST may have on the rapidly growing wine industry.

The historical boom-bust cycle of the industry makes some commentators nervous about the future of the industry. Rapid vineyard plantings in the late 1990s have created fears that prices will eventually crash, resulting in losses for growers. The present study evaluates the extent to which such fears are justified, or whether signs of success are being misdiagnosed as an exaggerated response to rising winegrape prices in the 1990s.

1.1. Background

Australia's wine industry entered a sustained phase of prosperity in the late 1980s. This had an unlikely beginning. In 1986, the then Commonwealth government and the state government of South Australia responded to concerns of a grape oversupply by financing a vine-pull scheme. Within months, the scheme ceased as conditions in the industry improved — but not before a reduction in the area of vineyards of 9 per cent in South Australia and 6.5 per cent nationally (Osmond and Anderson 1998).

Figure 1.1: Price of winegrapes, South Australia, 1989 to 1999.



***Source*:** AWBC, unpublished data.

New plantings began in the late 1980s and, apart from a brief period in the early 1990s when industry growth stalled during the global recession, the industry has grown rapidly. Grape-growers and wineries profited hugely from growing demand for premium wines in the domestic and export markets during the 1990s.[1] Annual exports, which in the mid-1980s accounted for less than 5 per cent of Australian wine sales, reached $1 billion for the first time in July 1999, or nearly one third of sales. Indeed, wine is about to become the single largest export commodity in one state, South Australia, where it accounted for 13 per cent of merchandise exports in 1999 (ABS 1999). Winegrape prices, most notably for premium, in particular for premium red varieties, rose continuously between 1993 and 1998, before a small decline in 1999 (figure 1.1).

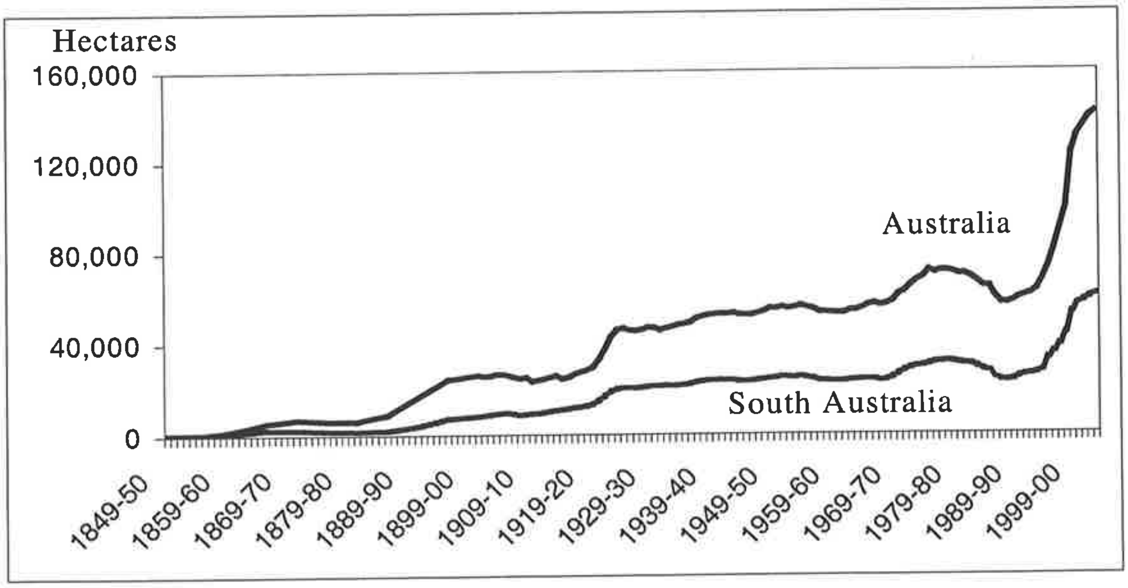
Existing growers and new investors have responded to increased profitability in the industry and accelerated depreciation provisions in tax legislation with unprecedented vineyard plantings. In the mid-1990s, land bearing premium winegrapes in Australia totalled less than 40,000 hectares. By 1999, the total area of premium winegrape vineyards that were bearing exceeded 70,000 hectares. In 1998 alone, producers planted over 10,000 hectares of premium vineyards, but this was followed by over 15,000 hectares in 1999. Consequently, premium winegrape production is increasing rapidly. The 2003 vintage of both premium and non-premium winegrapes is forecast to yield more than double the crop of 1996. Plantings data suggest that in the seven years to 2003, premium red winegrape production will increase by three-and-a-half-fold. With the rapidly growing supply of premium winegrapes at home, and similar trends abroad, it is not surprising that prices of premium winegrapes started to fall in the 1999 vintage.

[1] As an indicator of relative profitability, the All Ordinaries index increased by 30 per cent between August 1994 and January 1998. The share price of one major wine company (with substantial winegrape plantings), BRL Hardy, increased by 180 per cent in the same period (http://www.comsec.com.au).

Osmond and Anderson (1998) have carefully documented the historical pattern of booms and busts in the Australian wine industry. Figure 1.2 summarises the area planted to vines over the past 150 years. The first boom, in the 1850s, followed the gold rush. This boom was overwhelmingly domestic, with high duties and high transport hindering both inter-colonial and international trade. The second, from the 1880s, benefited from a relatively open British market and lower transport costs. Most international sales, accounting for one-sixth of production, were of generic, bulk red wine to Britain. The second boom ended with World War I. Soldier settlement after that war, combined with irrigation and land development subsidies, a wine export subsidy, and an imperial tariff preference in the British market for fortified wine, all contributed to the third boom, which started in the mid-1920s. By the mid-1930s, with the Depression driving down Australia's wine consumption, exports rose and peaked at one-quarter of production before World War II. During and following the war, the industry floundered. The export subsidy was removed and, after the war, Britain imposed a huge increase in the tariff on fortified wine. And with war-time grain rationing removed, Australians returned to beer consumption, thereby slowing growth in domestic wine consumption.

After a quarter-century of slow growth, a fourth wine boom started in the mid-1960s which was entirely domestic. Consumer tastes became more European, liquor licensing and trade practice laws changed and, with the industry being dominated increasingly by large corporate wineries, marketing improved and innovations accelerated. Among these, the plastic casks ('wine-in-a-box') attracted new consumers to the market, particularly for white wine. Per capita consumption of wine, which had languished at around 5 litres per year in the 1950s, rose to over 8 litres in the late 1960s. By the late 1970s, consumption approached 15 litres by capita. The peak occurred in 1986 (21.6 litres, WFA 1998), ironically at a time when red winegrape growers were experiencing severe financial difficulties. Concerns in the late-1970s and the 1980s over the histamine content of red wines may have dissuaded consumers from turning to reds. In the mid-1980s, exports of premium red wine were less than 5 million litres annually, and domestic premium red consumption amounted to only 5 per cent of the total volume of wine consumed in Australia. This provides a stark contrast with 1999, when premium red wine exports totalled almost 90 million litres and its share of domestic wine consumption had risen to almost 17 per cent — a more than trebling of domestic sales.

Figure 1.2: Area of vineyards, Australia, 1848-50 to 2002-03.



Source: Anderson (2000), Figure 1.

By the mid-1980s, segments of the industry struggled as domestic sales boomed. The Senate Standing Committee (1977) investigating the industry gave a hint concerning the nature of the problem: they surmised that technological change provided a way of making palatable wine with non-premium grapes. This stance was an anathema for much of the industry. Some labelling practices at the time were misleading. The cask wine that entered the market and was responsible for most of the growth in domestic sales typically was made from multipurpose grapes, notably sultanas, and labelled with an inappropriate varietal or regional name. One winemaker summarised the practice of the time as follows:

> Riesling is grown for its flavour — it is Australia's (perhaps the world's) greatest white wine grape. In Australia we defile the name 'riesling' by allowing it to be used on any white wine no matter what the grape material. To distinguish it from 'riesling', genuine Australian Riesling has to be labelled 'Rhine Riesling', implying German origin, thus making it unacceptable on export markets where such deception is illegal.
>
> (Wynn 1986, p. 10)

Fears for the premium wine industry, as mediocre wines flooded the market, gradually faded with a rise in exports in the early years of the present boom. In addition, the premium red segment started to benefit from an increasing domestic preference for wine, following the emergence of evidence of the health benefits of moderate red wine consumption (which ended the histamine scare).

Many of the fundamental strengths of the domestic industry had been established for decades, notably R&D investments in viticulture and winemaking, and training of winemakers. Marketing, however, was not a strength. Britain's most notable wine writer, Hugh Johnston, wrote in 1983 of the number of wineries, wines and 'styles' the Australian industry supported and the importance of wine to Australians. He noted, however, the weakness of Australian labelling practices in the following terms:

> Extraordinarily little of the buzz of Australian winemanship penetrates overseas — largely because her best wines are made in vast variety but small quantities, and partly, I believe, because lack of any kind of central direction make Australian labels a pathless jungle. .. Until Australia begins to develop an appellation system .. .. the only means of selection will be through the maker's name.
>
> (Johnson 1983, p. 462)

Johnson went on to describe the Australian industry as 'one of the world's most exciting wine countries in late, difficult and protracted adolescence.' Developing and adhering to a system of appellation has played only a small part in expanding Australia's exports since then, although this is beginning to change with the recent defining of geographical indications. A converse perspective is that strict appellation laws may have prevented Europeans from adapting to changing market conditions. Australia's relatively relaxed regulations may be closer to optimal. Indeed, in many markets Australia has led the New World producers in showing the Old World producers of Europe how to adapt rapidly to changing consumer demands.

1.2 Issues facing the wine industry

The chequered 150-year history of the Australian wine industry raises many issues concerning the industry that are worthy of economic analysis. One question, addressed by Osmond and Anderson (1998), is whether the industry can learn anything from the past. A second question is what explains industry growth, and whether the rapid supply response occurring at present is economically rational. A third might be to ask what impact the GST tax reform package, introduced in July 2000 will have on Australia's winegrape and wine industry. The present study deals mainly with the second and third questions.

In addressing the first question, Osmond and Anderson (1998) summarise key differences between the present boom and those of the past. The present boom is (especially export-) market-driven, whereas domestic demand drove other booms, notably the first and the fourth. Government assistance drove the inter-war boom. And none of the previous booms gave much attention to wine quality. By contrast, the current boom has developed an increasing emphasis on quality. For that reason, throughout the present study of the latest boom, there is a distinction made between premium red, premium white and non-premium wines.

Chapter 2 explains the motivation for using an economy-wide model, FEDSA-WINE, to analyse the latest wine industry and tax changes, despite wine accounting for only a small proportion of national production and consumption. Turning to the second question, will the growth in vineyard area shown in figure 1.2 mean that the industry is yet again heading into a period of depressed returns? This issue is discussed in chapters 3 and 5. In chapter 3, the FEDSA-WINE model is used to provide orders of magnitude of the contribution of different factors to wine industry growth in the 12 years to 1999. Variables estimated in this exercise are used within FEDSA-WINE to project wine production, consumption and exports to 2003. Chapter 5 analyses the impending growth phase in greater detail. Before that, account needs to be taken of the effect on the industry of the GST-related tax reform, the subject of chapter 4.

Historically, changes in taxes or subsidies on wine, together with domestic and foreign wine trade policies, have had marked impacts on production levels (Osmond and Anderson 1998). The question of relevance in the year 2000 is the extent to which changes in the domestic consumption tax on wine might affect producers in this relatively dynamic industry. Using the projected database for 2003 from the previous chapter, chapter 4 analyses the likely effects on the wine industry by 2003 of the tax package introduced on 1 July 2000.

Chapter 6 discusses areas for further research. Some of the discussion revolves around whether further data disaggregation is feasible, and the extent to which it might improve analysis. Other areas for further research include the supply response in the industry, water allocation issues, and modelling of the global wine market so as to get a better feel for future export demand.

Appendices A to E contain details of the FEDSA-WINE model developed as part of the present study (building on the FEDERAL model, Madden 1995). Appendix F derives the formula used to calculate a revenue-neutral switch from a WST-based wine tax to a GST plus top-up tax, for use in chapter 4. Finally, appendix G summarises a modification to the system of demand in FEDSA-WINE, based on Clements and Smith (1983).

Chapter 2

The CGE model, FEDSA-WINE

2.1 Motivation for using a CGE model to study the wine industry

The effects of changes in taxation have been prominent in quantitative studies of the Australian wine industry.[1] George (1974) and Tsolakis (1983) analysed the changes in wine taxation in a partial equilibrium framework. Others subsequently took advantage of the development of a general equilibrium model of the Australian economy, ORANI, to analyse wine taxation issues in an economy-wide setting (Dixon, Parmenter, Sutton and Vincent 1982). Clements and Smith (1983) outlined a modification to ORANI to include estimated own- and cross-price elasticities for beer, wine and spirits. Meagher, Parmenter, Rimmer and Clements (1985) used this modification, in a model variant called 'ORANI-WINE', to model the effects of imposing the beer rate of tax on wine consumption. The authors evaluated the effects of the tax impost on prices, wages and employment in a short-run environment. CIE (1995a) extended the Clements-Smith methodology by disaggregating wine into 'ultra-premium', 'premium' and

[1] Some analysts have studied the wine industry using hedonic price regressions. Prices of individual wines are explained by a combination of factors, including variety, sensory quality ratings (as adjudged at wine tastings), and individual and collective reputation indicators. The only Australian study the author is aware of is Ocskowski (1994).

'non-premium' categories to simulate the impact of introducing a partly volumetric tax to replace the then existing WST.[2]

The motivation for using a CGE model in the present study was even stronger than for earlier studies, namely to consider possible outcomes for the industry under economy-wide tax reforms of 1 July 2000 (hereafter the GST package).[3] Previous CGE studies of the wine industry have concentrated on the impact of just wine tax options on the industry (Meagher et al. 1985; CIE 1995b). The GST package affects all industries and households. But it is of particular interest to the wine industry for several reasons. First, wine, like other alcoholic beverages, had a wholesale sales tax (WST) imposed on it before the introduction of the GST in July 2000. Therefore, wine is one of the few commodities on which the relative consumption tax burden potentially could fall under the GST. Another reason why the GST is of interest to the industry is that wine faces two new taxes in place of the former WST. One is a so-called 'wine equalisation tax' (WET). The other is the GST on the service mark-up on on-premise wine consumption. In addition, a volumetric top-up tax or WET remains a theoretical policy option in place of the new ad valorem WET on top of the GST. Advocates of a switch to a volumetric WET argue it is a more direct instrument than an ad valorem tax for addressing any perceived negative externalities arising from wine consumption.

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[2] The definition of 'ultra-premium' as applied by CIE differs from that of the present study. In the CIE study, 'ultra-premium' refers to wine produced from dry-land winegrapes, whereas here, this is the 'super-premium' category. Definitions used in the present study appear under the heading 'List of abbreviations and terms'.

[3] A Commonwealth wholesale sales tax of 41 per cent applied to wine prior to the introduction of the GST. A top-up tax of 29 per cent is imposed on the pre-tax wholesale price of wine, in addition to the 10 per cent GST, under the new package. Chapter 4 contains further details on exemptions and rebates applying to cellar-door and other direct sales.

The wine industry, meanwhile, is gearing up to argue that there should be no WET at all, which is another option worth analysing.

Specifically, therefore, a CGE rather than partial equilibrium approach is necessary to capture the following:

- the change in the consumer price due to the direct change in wine taxation;
- the change in the costs of production for wine, mainly due to the elimination of wholesale sales taxes on intermediate inputs following the introduction of a GST;
- the change in wine consumption due to the expenditure effect (i.e., the change in real aggregate household consumption arising from the GST); and
- the impact of the GST package on wine exports, in an industry that is becoming increasingly export-oriented.

Of the above effects, only the direct change in the consumer price can be modelled in a partial equilibrium framework. The remaining effects require data, parameters and behavioural equations beyond those concerning only the wine industry. The direction of one effect could differ from that of others. Therefore, a CGE approach is needed to estimate the net effect of the GST package on wine producers and consumers. This study concentrates on long-run results in which national employment remains exogenous, unlike the wine tax study by Meagher et al. (1985). Moreover, both the grape and wine industries are disaggregated into three to distinguish between the rapidly growing premium red and other segments.

2.2 The TABLO code of the model

The FEDSA-WINE model used for CGE analysis in this study is based on the two-region FEDERAL model of the Australian economy developed by Madden (1995). FEDSA-WINE is in the ORANI family of general equilibrium models described in Dixon et al. (1982). I have revised the FEDERAL-SA version of that model extensively to streamline the TABLO code required to implement the model and to simplify the presentation of the model (see appendix A).[4] This is achieved by converting shares within equations to levels to reduce the number of calculations within the model. The extensive modifications for this study have been based on the theory of ORANI-G (Horridge, Parmenter and Pearson 1998) and a more recent multiregional model, the Monash multiregional forecasting model, or MMRF (Naqvi and Peter 1995).[5] Notably, CRESH substitution possibilities (i.e, constant ratios of elasticities of substitution, homothetic) applying to primary factor substitution and substitution by source have been replaced by CES equations. For substitution by source, this entails two-stage CES substitution, first between different domestic sources and then between a domestic composite and imports. FEDSA-WINE retains almost all the equations of the fiscal module of the FEDERAL model.

One reason for undertaking the laborious task of rewriting the model was to provide greater transparency. This is provided through the use of readily recognisable database coefficients instead of share terms, and the naming of each

[4] TABLO code resembles ordinary algebra. This makes it easier for the CGE modeller without programming skills to develop or modify a model.

[5] The home page www.monash.edu.au/policy/oranig.htm contains a summary of the ORANI-G family of models.

equation after the variable it solves for (as first appeared in Horridge, Parmenter and Pearson 1993). Another reason for revising the code of the original FEDERAL model was to implement tax shocks more simply. The old code required percentage shocks to the existing tax rate, so that eliminating a tax, for example, required a shock of –100 per cent. I chose to rewrite the entire model rather than make piecemeal changes (as I attempted earlier in the study, with considerable difficulty), notably in ascribing powers of taxes, to relevant parts of the code. In addition, following the MMRF model, database matrices were aggregated so that the sources for each type of purchase were in the same rather than separate matrices. For example, a four dimensional matrix (i.e., commodity x source x industry x region) contains the values of intermediate inputs into production (BAS1 as shown in appendix A). Previously, three matrices, one for each source, were needed for these data.

FEDSA-WINE includes a 'bottom-up' regional dimension and fiscal extension, and the TABLO code is more compact than that of either FEDERAL or MMRF (and only part of that is due to omitting accumulation equations as appear in MMRF).[6] Otherwise, the theory is virtually standard for models of the ORANI-type, including the original theory of investment, for example. Additions to the model include decomposition equations, based on the Fan method, as explained in appendix A. These have been extended from the national level, as included in ORANI-G (Horridge et al. 1998), to the regional level.

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[6] A 'bottom-up' regional disaggregation implies that activities in each region are solved in separate equations. In the 'top-down' approach, the model solves at the national level, and regional activities are calculated using exogenous shares. Wittwer (1999, section 4.23) discusses the relative merits of the respective approaches.

2.3 Constructing the disaggregated database

A first step in compiling the FEDSA-WINE database was to project the MONASH model to 1995-96 (Dixon, Parmenter and Rimmer 1998). This database was split into two regions and aggregated at the industry level. Various ABS sources including national accounts, manufacturing census, trade and tax data were used to check industry weights in the database with the regional disaggregation. The tax base was compiled using ABS catalogue no. 5506.0 and Treasury budget papers (see appendix E).

Some disaggregation of the existing grape and wine industries in the FEDSA-WINE database is necessary for several reasons. In Australia as in many wine-consuming countries since the mid-1980s, there has been little change in per capita wine consumption, but the quality of wine consumed has increased. This provides the motivation for disaggregating both the grape and wine industries into premium and non-premium segments. Another reason for disaggregation is that political pressure remains to introduce a volumetric rather than ad valorem WET on wine on top of the GST. If there were a revenue-neutral tax swap of this type, the price for domestic consumers of premium wines would fall while the price of non-premium wines would rise. This potentially may benefit premium producers at the expense of non-premium producers. In addition, consumers worldwide have shown an increasing preference for premium red wine over other wine types during the past 15 years, so the premium segment has been disaggregated into red and white components within the FEDSA-WINE database.

The CIE (1995a and 1995b) studies disaggregated wine into three types also: 'ultra-premium', 'premium' and 'non-premium' segments. They also disaggregated the grape industry into 17 regions. For present purposes, I considered less regional disaggregation necessary, so each segment is divided into just two regions, South Australia and the rest of Australia. This, I believe, is optimal, in terms of utilising available data and explaining the key differences between wine types.

The FEDSA-WINE model requires specific data on winegrape prices and quantity of consumption from which values can be inferred, by the three wine types (ABS 1999). Exports by wine type are also needed. The Australian Wine Export Council (AWEC) provides suitably disaggregated annual export volume data and export price data by type. The Australian Wine and Brandy Corporation (AWBC) provides winegrape price data. Prior to the 2000 vintage, the latter have been available only for South Australia. These data have been used to calculate appropriately weighted prices for all of Australia for the three winegrape types in the database. Unfortunately, disaggregated wholesale and retail price data for wine are not available. I have estimated the producer price by assuming that the grape input equals on average 25 per cent of the costs of wine production, with the proportion rising (falling) as grape prices rise (fall). Retail prices have been estimated from the wholesale price, adding on the WST (41 per cent prior to the introduction of the GST) and assumed retail markups of 33 per cent for premium wine and 25 per cent for non-premium wine (WFA, personal communication).

Within the separate regions of FEDSA-WINE, South Australia and the rest of Australia, I have estimated inter-regional sales. These turn out to be of interest when examining the regional outcomes discussed in chapter 4.

2.4 Model parameters

Appendix E contains further details on the parameters and database. In reference to chapter 4, the household demand specification is of the Stone-Geary type used in the ORANI-G model (Horridge et al. 1998), with the exception of one scenario. This is the introduction of a volumetric top-up tax on wine as part of the GST package, at the equivalent of the pre-GST tax on beer. It has been modelled by applying the Clements-Smith (1983) demand modification to the three wine types within the model, as summarised in appendix G.

Outside the grape and wine industries, the parameters files are value-weighted aggregates of the disaggregated MONASH database (Dixon, Parmenter and Rimmer 1998). Appendix E contains an explanation of the choice of Armington and intra-domestic elasticities of substitution within the grape and wine industries. Previous CGE and partial equilibrium studies of the wine industry have paid particular attention to the specification of demand and choice of demand parameters (Meagher et al. 1985; George 1974; CIE 1995a). Analysts frequently express concerns about the impact of parameter choice on comparative static outcomes within a CGE model. In chapter 4, I also consider the sensitivity of modelled outcomes of GST scenarios within a CGE framework to parameter choice. Systematic sensitivity analysis (SSA) is used to obtain estimated standard deviations for variables within the model arising from policy simulations. I also use SSA to depict the effects of policy uncertainty on the wine industry.

2.5 The regional dimension

South Australia accounts for approximately half the national value of wine industry production. Wine has been an outstanding performer in a state whose economy has otherwise grown slower than the national rate. This therefore provides an interesting case study for using a CGE model with two endogenous regions, South Australia and a composite of the rest of Australia, in preference to a single-region model. The pattern of sales of South Australian wine is quite different to that for wine from the rest of Australia. In South Australia, 42 per cent of the total volume of output was sold overseas in 1998-99, at an average price of $4.47 per litre. In the remaining regions, only 14 per cent of the volume of production was exported, but at a higher average price, $6.22 per litre (1999 dollars, ABS 1999). In addition, the proportion of premium wine in total production is higher in South Australia than nationally. The different production and sales patterns in the two regions mean that percentage changes in the respective regions are likely to differ in comparative static policy simulations. In addition, welfare changes in South Australia in policy simulations are likely to depend more on the outcome for the wine industry than in the rest of Australia, since the wine industry's weight in total economic activity is about 15 times that of the wine industry in the composite rest of Australia region.

2.6 Modelling a rapidly growing industry

The dramatic changes in the industry since the mid-1980s create a dilemma for the CGE modeller: what does one make of the comparative static results of policy simulations if the base case is changing rapidly over time? To help explain these changes, chapter 3 includes historical simulations covering the changes between 1987 and 1999. These simulations provide estimates of changes in key industry variables, namely domestic consumer tastes and export demand. In addition, the simulation captures the impacts on the wine industry of changes in the rest of the economy in this time, notably in aggregate real consumption, trade policies and population growth. I use the estimated changes in demand and supply derived from the historical simulation plus data on vineyard plantings as a basis for projecting the model into the future.

Updating the database to reflect projected industry and consumption weights for 2003 affects the composition of results in GST scenarios, as the respective contributions of changes in exports and local sales to projected industry output changes alter with different weights. How wine taxation policy rates among the factors affecting industry profitability and growth in the first decade of the millennium also warrants some discussion. For example, it might be easy to blame hikes in wine taxes associated with the GST package for any downturn in producer prices in the first few years of the millennium when in reality the supply response at home and abroad to the 1990s boom may explain most of the change.

Chapter 3

Accounting for growth in the wine industry, 1987 to 2003

3.1. Introduction

This chapter seeks to quantify the relative importance of the various factors that have contributed to the dramatic growth and change in the composition of output within the Australian wine industry between 1987 and 1999. In this time, Australian wine production increased by over 70 per cent. The composition of output also altered substantially, with premium output trebling (red more that white) while non-premium output changed little. The motivation for this chapter is to use available data and FEDSA-WINE to assess the relative contributions of various demand and supply factors to the rapid growth and structural changes in the wine industry since 1987, so as to be able to better project the industry into the future. Apart from the projection being useful in its own right, I wanted to update the database to analyse the impacts of the GST and associated wine tax changes on the wine industry, as presented in chapter 4, as of the early part of this decade rather than the middle of the past decade.

More specifically, the objective of the present chapter is to decompose the effect on output and prices of wine of changes between 1987 and 1999 in (1) export demand for wine, (2) domestic demand for wine, (3) wine taxes, (4) grape and wine industry productivity, (5) changes in the rest of the economy and (6) observed winegrape bearing area. Drawing on insights from the historical growth accounting exercise, plus additional industry-specific information, I project the model to 2003.

I wish to look beyond domestic demand issues, as in previous CGE studies focusing on the Australian wine industry, including Meagher, Parmenter, Rimmer and Clements (1985) and CIE (1995b), both of which analyse the impacts of increasing consumption taxes on wine. This study is based on the methodology of earlier CGE historical/decomposition simulation studies, Dixon, Malakellis, and Rimmer (1997), and Dixon, Menon and Rimmer (2000), both using the MONASH model.[1] This provides a means of linking the underlying theory of a CGE model with the available data. Since the emphasis here is focused just on the wine industry, I am able to develop a simpler approach, utilising less data in a less elaborate CGE model with less disaggregation of non-wine sectors than these earlier studies. But I allow for a degree of heterogeneity in the industry of focus, by dividing both winegrapes and wine into three segments: premium red, premium white and non-premium.

3.2 Methodology

FEDSA-WINE solves a system of equations of the following form:

$$F(X) = 0 \tag{3.1}$$

where

F is an m-vector of differentiable equations, and

X is an n-vector of variables for year t, $n > m$.

X includes variables for prices and quantities in year t, to which the database is updated from the base year during the simulation. The m equations follow the economic theory of CGE models, including supplies and demands reflecting utility- and profit-maximising behaviour, with supplies equalling demands, and perfectly competitive prices set equal to unit costs. Different closures or combinations of $n–m$ variables can be included in the exogenous set to solve the model. The method used for historical accounting involves running the model twice, doing first a historical simulation and then a decomposition simulation. To solve the model, I use a new version of GEMPACK software designed to decompose the shocks of large change simulations (Harrison, Horridge and Pearson 1999). The two runs require different combinations of exogenous variables. We can have four versions of X:

X(HD), X(H'D), X(HD') and *X(H'D')*

where

H is exogenous and H' endogenous in the historical closure and

D is exogenous and D' endogenous in the decomposition closure.

X(HD'), for example, refers to variables exogenous in the historical simulation and endogenous in the decomposition simulation. This set includes observable variables for which data on historical changes are available. For each of the three wine types, I select as exogenous the following variables: household consumption, export volumes, and f.o.b. export prices. I also include producer prices for

[1] Parmenter et al. (1994) is an earlier Australian CGE study of historical changes in the economy.

winegrapes and employment data for both winegrapes and wine.[2] Observable macroeconomic variables (e.g., aggregate consumption) are also part of the *X(HD')* set. This set thus includes variables that are normally endogenous in CGE simulations. To estimate unobservable variables, the observable variables are made exogenous in the historical simulation and shocked by the observed change. The unobservable variables have an economic interpretation. By making aggregate consumption exogenous, for example, we obtain an estimate of the change in the average propensity to consume between the two end points (1987 and 1999) of the historical simulation. In simulating, I divided the time period into two, from 1996 back to 1987, and from 1996 to 1999. But I report the 12 years from 1987 to 1999 as one time period for most variables. Table 3.1 summarises the categorization of key variables.

Table 3.1: Selected variables in the historical and decomposition closures

Components of *X(HD')*	**Corresponding components of *X(H'D)***
Wine consumption	Shifts in household preferences, wine
Producer prices, winegrapes	Markups on costs, winegrapes
Wine export volumes and f.o.b prices	Shifts in foreign demand and domestic supply functions, wine
Employment, winegrapes and wine	Capital/labour bias in technical change, winegrapes and wine
Aggregate consumption	Shift in average propensity to consume
Components of *X(HD)*	
Tax and tariff rates	
Population	
Winegrape bearing area	
Primary factor saving technical change	
Rates-of-return on capital	
Components of *X(H'D')*	
Producer prices, except winegrapes	
Consumer prices	
Demands for intermediate inputs and margins services	

[2] Aggregate employment data are available for both winegrapes and wine for 1987 and 1996. These have been disaggregated into premium red, premium white and non-premium segments on the basis of assumptions about differences in the labour requirement per unit of output.

I could include household consumer prices for wine in the *X(HD')* set if I had additional data. However, price data are not available for the three wine types, as ABS publishes only a single price index for wine, and other surveys tend not to have representative expenditure weights. Instead, wine prices are part of the *X(H'D')* set. This set also includes demands for intermediate inputs and margin services, and household consumption and prices for commodities other than wine. Other household demands for commodities are assumed in FEDSA-WINE to respond almost entirely to expenditure effects (induced by the imposed change in aggregate consumption) and price effects.[3] Such data are available but they would add little to our understanding of changes in the wine industry.

X(HD) includes observable changes in wine import tariff and consumer tax rates, c.i.f. import prices for wine, and population. CGE models generally are not used to explain these variables. This set also includes imposed primary factor productivity growth, as changes in capital stocks are not available to complete the picture of primary factor usage for winegrapes and wine.

To illustrate the use of the historical and decomposition simulations of the period 1987 to 1999 in this study, we consider a general function (i.e., not defining the functional form) for household demand within a CGE model:

$$x_i = (p_i, p_j, c, a_i, q) \qquad (3.2)$$

[3] A change in wine preferences change changes the expenditure shares of other goods slightly: hence other goods have a small offsetting uniform preference change.

In percentage change terms, x_i and p_i denote the domestic consumption quantity and price of household good i, p_j is the price of other goods ($i \neq j$), c is aggregate household consumption, a_i denote household preferences and q is population.[4] Some variables are observable and available, some are observable but unavailable and others are neither. For each of the three wine types in the database, x_i is observable and in the set *X(HD')*: it is exogenous in the historical run and endogenous in the decomposition run. Other observable variables include aggregate consumption, population growth and tax rates. The retail price p_i is unavailable. Variables with a large influence on p_i for wine include available winegrape prices (winegrapes account for about 25 per cent of such costs for wine) and tax shifters, the known changes of which help solve for p_i.[5] The unobservable residual a_i is in the set *X(H'D)*, and hence endogenous in the historical simulation: it provides an estimate of the taste change for each wine type.

In the decomposition simulation, x_i is now endogenous. We isolate the effect of the taste shifter a_i (estimated in the historical simulation) for the three wine types from the other shocks used to project the model between the end points. This provides an estimate of the contribution of domestic taste changes to the historical changes in the wine market. Similarly, the observable wine tax shocks in isolation provide an estimate of the historical impact of wine tax changes on the industry. And c, via the expenditure effect, and q, contribute to changes in wine consumption through general economic effects.

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[4] The relevant equations in FEDSA-WINE, as shown in appendix A, are E_x3_q, E_x3lux, E_a3lux and E_a3sub.

[5] As in historical simulations using the MONASH model, I exogenise producer prices for winegrapes by endogenising a phantom tax shifter. Unlike MONASH, FEDSA-WINE does not 'spread' the phantom taxes to rebalance the database. As winegrapes are a small part of the economy, the spurious fiscal effects arising from my method are minimal.

Table 3.2: Growth in the Australian grape and wine industries, 1987 to 1999

	1987	1996	mid-point % change '87-'96[a]	1999	mid-point % change '96-'99[a]
Population (total, millions)	16.3	18.3	11.6	19.0	3.8
Real aggregate consumption ($bn)[b]	220.7	303.9	31.7	340.1	11.2
Domestic consumption (Ml)[c]					
Premium red wine	22.4	38.5	52.9	62.5	47.8
Premium white wine	46.2	55.4	18.1	69.9	21.1
Non-premium wine	270.7	236.0	-13.7	240.7	2.3
Wine, total	**339.3**	**329.9**	-2.8	**372.6**	**12.2**
Production (Ml)[c]					
Premium red wine	64.9	168.7	88.9	270.5	46.4
Premium white wine	94.5	182.6	63.6	242.1	28.0
Non-premium wine	330.2	324.1	-1.9	339.6	4.7
Wine, total	**489.6**	**675.4**	31.9	**852.2**	23.1
Wine exports (Ml)[c]					
Premium red wine	4.6	47.2	164.5	87.8	60.2
Premium white wine	5.4	48.4	159.9	82.6	52.2
Non-premium wine	14.0	34.6	84.9	45.7	27.6
Wine, total	**24.0**	**130.2**	137.8	**215.5**	**49.3**
Winegrape prices ($/tonne)[b, d]					
Premium red grapes	653	1,394	72.4	1,437	3.1
Premium white grapes	874	899	2.8	813	-10.1
Non-premium grapes	290	392	29.9	402	2.6
C'wealth and state consumer taxes	19%	41%	..	41%	..
Wine stocks (Ml)[c]					
Premium red wine	155	264	52.0	580	52.7
Premium white wine	205	310	40.8	350	27.6
Non-premium wine	170	209	20.6	160	-12.0
Area of bearing winegrapes ('000 ha)[b]					
Premium red grapes	9.4	16.8	56.5	41.3	78.6
Premium white grapes	10.9	18.0	49.1	28.4	40.2
Non-premium grapes	14.9	15.2	2.0	14.8	-5.9

Sources and notes for table 3.2:

a Mid-point % change = $200(Z_f - Z_i)/(Z_f + Z_i)$ where Z_f and Z_i are the final and initial values of Z.
b All values are real, in 1995-96 dollars.
c ABS (1999).
d Author's estimates based on unpublished data from the Australian Wine and Brandy Corporation.

3.3. Results

The historical data

Table 3.2 shows data for the Australian wine industry for 1987 and 1999. At the macroeconomic level, income growth allowed Australia's aggregate real consumption of goods and services to rise 43 per cent (in mid-point terms[6]) over the 12 year period. But consumption of wine rose by less than 10 per cent, despite the income and aggregate expenditure growth. However, within the wine category, there has been a dramatic switch in consumption in Australia from non-premium to premium (especially red) wine. There has also been a boom in wine exports. Australia's exports of premium wine grew more than fifteen-fold between 1987 and 1999, with the share of production exported rising from less than 5 to more than 30 per cent. To accommodate a rapid increase in premium (especially export) demand, plantings of premium wine grapes trebled over that period, with an accompanying increase (albeit with a 3 to 5 year delay) in Australian premium wine production.

Export demand growth

The equation solving for the percentage change in export volume (x_i^4) in FEDSA-WINE is:

$$x_i^4 = \eta_i (p_i^4 - f_p^4) + f_x^4 \qquad (3.3)$$

[6] All changes are expressed in mid-point percentages, using the formula given in footnote a to table 3.2. Mid-points are used as some key indicators, notably exports, have experienced rapid growth from low base levels in 1987.

The percentage change in the export price in f.o.b. foreign currency terms is p_i^4.

The export demand elasticity (a negative number) is η_i, and f_p^4 and f_x^4 are price and quantity shifters to accommodate preference changes. The variables x_i^4 and p_i^4 are in the *X(HD')* set, f_x^4 is in the *X(H'D)* set and f_p^4 the *X(HD)* set.[7]

Table 3.3: Decomposition of wine industry changes, 1987 to 1999

	Export demand growth (1)	**Domestic consumer tastes** (2)	**Consumer tax changes** (3)	**Productivity growth** (4)	**Economic growth** (5)	**Winegrape area** (6)	**Total**
Premium red wine			mid-point % change				
Output	25.1	30.1	-4.6	11.3	26.2	34.5	122.6
Producer price	30.5	2.6	-0.7	-5.6	15.5	-11.2	31.2
Consumer price	17.1	1.5	9.3	-3.1	13.3	-6.5	31.5
Domestic consumption	-15.4	61.6	-7.9	2.8	46.9	6.5	94.5
Export volume	114.2	-18.5	2.1	28.4	-38.3	92.2	180.1
Premium white wine							
Output	31.7	0.4	-4.0	10.9	31.6	17.2	87.8
Producer price	4.6	-0.2	-0.5	-5.6	6.2	-7.0	-2.4
Consumer price	2.6	-0.1	10.4	-3.2	7.9	-4.1	13.6
Domestic consumption	-1.5	3.4	-6.3	2.0	40.8	2.6	41.0
Export volume	104.4	-2.1	1.3	27.6	-1.4	45.7	175.5
Non-premium wine							
Output	3.2	-32.7	-3.3	1.8	34.9	0.2	4.0
Producer price	2.8	-0.6	-0.2	-4.6	6.0	-0.5	2.9
Consumer price	1.8	-0.4	10.8	-3.0	6.7	-0.3	15.6
Domestic consumption	-0.6	-38.4	-3.6	1.0	30.5	0.1	-11.1
Export volume	82.4	2.3	0.3	15.1	4.4	1.7	106.2
Macroeconomic							
Real GSP – SA	1.19	0.22	-0.34	0.58	27.71	1.46	30.82
- ROA	-0.10	-0.02	0.05	-0.05	40.90	-0.11	40.68

Source: Author's FEDSA-WINE decomposition.

[7] The corresponding equation in appendix A is E_x4r.

Column 1 in table 3.3 shows the effect of the estimated value of f_x^4 and a markup shifter used to match export prices.[8] In the modelled decomposition of the observed period, export demand growth explains almost all the increase in producer prices for premium red wine (30.5 out of 31.2 per cent) and about one fifth of total output growth (25.1 out of 122.6 per cent). This implies that the wine supply response was not sufficient by the end of the period to dampen upward price pressures, even after adding the exogenous increase in winegrape area as shown in column 6 of table 3.3.

By contrast, for premium white wine, the output increase attributable to export demand growth was relatively larger and the price increases smaller than those for red wine. White winegrape prices were relatively high at the beginning of the period, indicating that demand for the premium white segment started at a high point. Note that the static CGE framework and use only of endpoint data do not explain the timing of the supply response, a point I discuss further in chapter 5.

A high proportion of Australian non-premium wine is sold domestically, with the rest exported, mostly to New Zealand. Though non-premium export demand grew in the historical period, exports remained a small proportion of total output. Export demand growth contributed only 3 per cent to non-premium output growth, despite an increase in export volume of 82 per cent (table 3.3).

[8] I also attribute a phantom tax shifter (endogenised in the historical simulation to fit the observed change in producer prices) and changes in rates-of-return on capital to this contribution. This helps obtain convergent decomposition solutions in dealing with extremely large proportional changes for exports.

Domestic consumer tastes

Column 2 of table 3.3 provides an estimate of changes in consumption attributable to changing preferences rather than price, income or population growth effects. In the period from 1987 to 1996, there was a taste swing against all alcoholic beverages except premium red wine. Between 1996 and 1999, there was also a preference change towards premium white wine consumption, with the net result that changing domestic consumer preferences explain almost none of the overall change in premium white wine production between 1987 and 1999. Increasing domestic preferences for premium red wine explain a significant part of the segment's output growth in the twelve-year period (30 per cent out of total growth of 123 per cent). By reducing excess supply, this effect had a negative impact on export growth (-19 per cent). Concerns during the 1970s and 1980s over the histamine content of red wines may have discouraged red wine drinkers, as reflected in low red wine consumption in 1987. Conversely, emerging evidence of the health benefits of moderate red wine consumption may explain much of the increase in demand for red wine since then. The main reason for the swing against white between 1987 and 1996 is that demand for white was already strong in 1987 at a time when interest in premium wines was growing, whereas the histamine scare had for a time stopped consumers from turning to red wine. The swing towards premium red wine between 1987 and 1996 redressed this, at the expense of premium white wine. The negative consumption and output contributions in column 2 of table 3.3 for non-premium wine reflect the growing preferences of consumers towards premium wine.

Increased consumer taxes and franchise fees

The Commonwealth Government introduced a 10 per cent wholesale sales tax on wine in August 1984, which had increased to 31 per cent by August 1993, before settling at 26 per cent in July 1995 after several adjustments. In addition, there were modest increases in State Government franchise fees on retail alcohol sales. The impact of increased taxes on domestic consumption had only a moderate effect on exports: 2 per cent for red, 1 per cent for white, and less than 1 per cent for non-premium exports (column 3 of table 3.3). This is because output is reduced by the increase in consumption taxes: with imperfect substitution between domestic and export sales, producers bear a small part of the burden of the tax. The rest is borne by domestic consumers, evident in declines in consumption of 8, 6 and 4 per cent for premium red, premium white and non-premium wines. For each, the increase in consumer price due to the ad valorem tax increase was around 10 per cent.

Productivity changes

Within the database for 1996, the shares of labour, capital and agricultural land in Australia's GDP are 0.59, 0.40 and 0.01. Between 1987 and 1999, the increases in labour, capital and land inputs were 24, 58 and 0 per cent (ABS 2000a). Real GDP rose 50 per cent in this period, implying total factor productivity (TFP) growth of about 14 per cent. In FEDSA-WINE, primary factor demands (x_i^p) are related to total output (z_i) for industry i in percentage change terms by:

$$x_i^p - a_i^p - a_i = z_i \tag{4}$$

where a_i^p and a_i are the all-primary factor and all-input technical change variables.[9] In the winegrape industry, changes in the bearing land area are known at a disaggregated level. For labour inputs, available data for both winegrapes and wine have been disaggregated by assuming that the premium segments are more labour-intensive than the non-premium segments. But changes in capital usage are unknown. These are estimated within the model, based on output growth, changes in the rate-of-return on capital (imposed to follow the direction of observed price changes) and imposed all-primary factor productivity (a_i^p) growth. I use the economy-wide TFP calculation to ascribe productivity shocks, adjusting for differences between broad industry groups.[10]

The growing emphasis on quality in all stages of production in grape-growing and wine-making implies that measures of productivity may understate the impact of new technologies on the industry. For example, a grape grower may raise the unit costs of production through practices that increase the quality and price of output, possibly without a productivity improvement — or even a decline — in quantitative terms. This emphasis on quality differs from an earlier understanding propounded by the Senate Standing Committee on Trade and Commerce (1977), which stresses that with technological improvements, winemakers could produce wine from inferior grapes. Now, much of the aim of the

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[9] The relevant equation in appendix A is E_x1prim.

[10] Consistent with the estimates of Dixon et al. (2000), who had capital stocks data available for other industries for the period 1987 to 1994, greater shocks are imposed on mining and agriculture than other industries. The estimates of Knopke, Strappazzon and Mullen (1995) of agricultural productivity growth also imply higher growth than the economy-wide average for Australia. This is similar to the finding for many countries (Martin and Mitra 1999).

industry is to maximise profits through raising the quality of grapes. Nonetheless, mechanical harvesting and pruning are being used increasingly, not only in non-premium production, but also in the commercial or lower end of the premium spectrum, with a significant impact on quantifiable productivity.[11] In particular, mechanisation and computerisation of irrigation have decreased the labour-intensity of winegrape production.

As for wineries, I can attribute much of the employment growth of 56 per cent between 1987 and 1996 (ABS 1999) to an increasing proportion of premium in total wine production. Premium wine production per litre of output is substantially more labour-intensive than non-premium production. Winemakers, for example, pay most attention to premium produce even in wineries where the volume of non-premium wine is substantially greater than the premium volume.

Column 4 of table 3.3 indicates an order of magnitude (based on the economy-wide estimate) rather than a more precise estimate of the impact of productivity growth on wine producers and consumers. Productivity growth contributes proportionally more to export growth (28 per cent for red) than growth in domestic consumption (3 per cent for red). This reflects the effect of supply shifts along the relatively elastic export demand curves compared with less elastic domestic demand. Such growth also more than compensates for increases in consumer taxes on premium wine in the historical period, from the producers' perspective. However, the small consumer price declines arising from the productivity effect fall well short of compensating consumers for rising taxes in

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[11] About 80 per cent of Australia's winegrape crop is harvested mechanically. Such technology, first used in the late 1960s, reduces costs by an estimated $1,500 per hectare (Industry Commission 1995, p. 45).

the period. The effect on premium wine output is proportionally larger than on non-premium wine. This is due to non-premium grapes being multipurpose. That is, increased productivity increases grape availability for use as table and dried grapes as well as increased inputs into non-premium wine production. In addition, the non-premium wine segment is less export oriented, so there is less scope for expansion through excess supply shifts along the relatively elastic export demand curve.

General economic growth and changes in other industries

In the historical simulation, the task is to fit observed data at the macroeconomic and at the industry level, beyond changes only in the wine industry. Macroeconomic data include the observed components of GDP. The 5th column of table 3.3 indicates the impact of changes in the economy not directly related to the wine industry. At the industry level, rates-of-return on capital in non-wine industries are adjusted to fit the aggregate change in capital stocks. The column also includes the impact of productivity growth in non-wine industries and the observable change in the real exchange rate. To summarise, this indicates what would have happened to the wine industry without any wine industry-specific changes in the historical period.

General economic growth increases domestic consumption of each wine type through the expenditure effect. The expenditure effect is output increasing and export reducing. It is surprising therefore that this column makes a positive contribution to exports for non-premium wine and has only a small negative effect on premium white exports. This appears to be due to rising apparent rates of return on capital in non-wine industries between 1987 and 1996. In isolation, this lowers the ratio of the rate of return in the wine industry to that in other industries, thereby inducing a capital inflow to wine and increasing its excess supply. The converse effect applied in the three years to 1999 when the apparent rate of return in other industries fell. For premium white and non-premium wines, the earlier period dominated the impact on exports.

Observed changes in the bearing area of winegrapes

Column 6 in table 3.3 shows the impact of changes in the winegrape bearing area between 1987 and 1999. As we expect, the outward supply shifts implied by increased bearing area for premium winegrapes raise output and the excess supply, while lowering producer and consumer prices. The price effect induces an increase in domestic consumption. This change in plantings comprises only part of the supply response of the winegrape segments, as they can still respond to changing prices via primary factor substitutability.

There are two reasons why I have presented the effects of changes in the bearing area in a separate column. First, part of the motivation for decomposition was to assist in projecting future industry outputs. Plantings in a given year plus the year's bearing area allow us to obtain a relatively accurate projection of the bearing area several years into the future. Second, explaining the decision to invest in a vineyard requires more than the standard theory embedded in a CGE model, be it static or dynamic. There is no theory within FEDSA-WINE for land usage to move endogenously between other agriculture and winegrapes in response to changes in relative rates of return to agricultural land. In addition, given the extremely high capital intensity of vineyard investments, there is an element of irreversibility in the decision to establish a vineyard. I discuss this issue further in chapter 5, section 3.

3.4. Regional impacts of wine industry growth

Despite its small size (wine accounts for less than 0.2 per cent of Australia's GDP), the rapid growth of the wine industry has made a significant impact on one state, South Australia. The state accounts for about half the national winegrape and wine industry, although the total economic activity of the state accounts for only 7 per cent of national GDP. By 1999 in South Australia, wine was about to become the largest single export, accounting for over 13 per cent of the state's merchandise exports. The CGE exercise provides us with an estimate of the contribution that growth in specific wine effects have made to growth in the economy of South Australia. This contribution has been disproportionate to the industry's overall size, given that it has grown rapidly in a state whose economic growth for decades has been much slower than that nationally.

Export demand growth, changes in consumer tastes, imposed productivity growth and the exogenous increase in wine area account for an increase of almost 3.5 per cent out of the state's mid-point real GSP increase of 30.8 per cent in the 12 years to 1999 (table 3.3). In other words, an industry that by 1999 earned about 2 per cent of the state's income had accounted for around 11 per cent of economic growth in the state in the preceding 12 years. The historical increase in wine taxes, on the other hand, decreased South Australia's real GSP in this time by 0.3 per cent.

The decomposed real GSP results provide a picture of competition for resources apparent only in a bottom-up rather than a top-down model of the economy. The wine industry considered in isolation in the historical simulation is a booming sector. This implies that the region where the boom is concentrated experiences income growth, which provides a boost to other sectors in that region through the income effect. The boom draws labour and capital to wine from other sectors, and in isolation induces a small real appreciation of the exchange rate, thereby detracting from the international competitiveness of exports other than wine. The interstate wine sectors also boom, but the resource movement effect has a larger impact on non-wine industries interstate than the income effect, so that the wine boom, viewed in isolation, is output decreasing for most interstate industries. Conversely, the historical hike in wine taxes moves resources in the other direction, thereby increasing the income of the rest of Australia at the expense of South Australia.

The wine boom was the one fragment of good economic news for South Australia in the 1990s. Column 5 of table 3.3 shows that real GSP arising from non-wine economic changes grew much more in the rest of Australia than in South Australia in the historical period. Growth in Australia's minerals sector, for example, made a significant contribution to national growth in this time and would have had a negative effect, in isolation, on South Australia's economy through the real exchange rate and resource movement effects.[12] This is because the state's minerals sectors as a proportion of GSP is much smaller than that in the rest of

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[12] The bail out of South Australia's State Bank in the 1990s also slowed economic growth in the region. Wittwer and Bright (1997) model the effects of an interstate mining boom on South Australia's economy.

Australia, so that negative indirect effects would have dominated the small direct effect of minerals growth in the state.

3.5. Updating the model to 2003

One can also use the FEDSA-WINE model to project the effects of the forecast increase in supply of winegrapes and wine into the future. This entails the use of macroeconomic projections plus the use of specific grape and wine industry forecasts. To capture the grape supply effect of known actual and intended plantings in the second half of the 1990s, 2003 has been chosen as the end of the projection period.

Table 3.4: Growth assumptions for projections, Australia, 1996 to 2003

Exogenous Variables	Actual 1996	Actual 1999	mid-point % change '96-'99	Projected for 2003	mid-point % change '99-'03
Population (total)	16.3	19.0	15.3	19.2	1.0
Real agg. consumption (billions, 1996 dollars)	220.7	340.1	42.6	383.3	11.9
Land bearing winegrapes (hectares)					
Red premium	9,400	41,300	125.8	63,100	41.8
White premium	10,900	28,400	89.1	32,500	13.5
Non-premium	14,900	14,800	-0.7	16,400	10.3
Total	**35,200**	**84,500**	82.4	**112,000**	**28.0**

Sources: ABS (1999); ABS (2000a).

The method used in this section for projecting the effects of increased grape and wine supply is to impose exogenous increases in land usage on the winegrape industries primary factor productivity growth on the winegrape and wine industries. These increases match the industry's projected increase in winegrape area, shown in table 3.4. In addition, I impose all-input productivity gains on the remaining industries in the model, and assume export demand growth and domestic taste changes continue, based approximately on the historical period 1987-99 (table 3.5).

Table 3.5: Changes to productivity, wine export demand and domestic wine preferences (% per annum, mid-point)

Primary factor productivity growth	1987 to 1999	1999 to 2003
Winegrapes	1.0	1.6
Wine	1.2	0.9
Export demand growth		
Red premium wine	*16.0*	12.3
White premium wine	*13.7*	10.0
Non-premium wine	*11.9*	8.3
Domestic taste change		
Red premium wine	*5.4*	4.5
White premium wine	*0.1*	2.4
Non-premium wine	*-3.2*	-2.6

Sources: Italicised numbers were estimated in the historical simulation.

The base case projection from 1999 to 2003

The base projection has domestic premium red wine consumption increasing from 63 Ml (megalitres) in 1999 to 91 Ml in 2003 (table 3.6). In the same period, premium white wine consumption increases from 70 Ml to 87 Ml, and non-premium wine consumption decreases from 241 Ml to 238 Ml. The effects of rising incomes and increased preferences for premium wine are reinforced by falls in consumer prices. Population growth and falling prices almost offset the projected taste swing against non-premium consumption.

Table 3.6: Projecting the Australian wine industry to 2003 under different assumptions

	1999[a]	Base 2003[b] (1)	mid-point % change '99-'03	2003[c] (2)	(2) – (1)
Wine consumption (Ml)					
Red premium wine	62.5	90.9	37.1	93.3	2.4
White premium wine	69.9	87.2	22.1	88.3	1.1
Non-premium wine	240.7	237.6	-1.3	238.3	0.7
Wine, total	**372.6**	**415.7**	**10.8**	**419.8**	**4.1**
Wine production (Ml)					
Red premium wine	270.5	576.1	72.2	536.9	-39.2
White premium wine	242.1	377.6	43.7	358.1	-19.5
Non-premium wine	339.6	355.1	4.5	347.1	-8.0
Wine, total	**852.2**	**1308.8**	**42.3**	**1242.1**	**-66.7**
Wine exports (Ml)					
Red premium wine	87.8	247.0	95.1	209.2	-37.8
White premium wine	82.6	145.5	55.1	126.3	-19.2
Non-premium wine	45.7	73.8	47.0	55.5	-18.3
Wine, total	**215.5**	**466.2**	**73.6**	**390.8**	**-75.4**
Wine imports (Ml)					
Red premium wine	4.2	8.1	63.2	6.7	-1.4
White premium wine	4.3	6.9	46.9	6	-0.9
Non-premium wine	15.8	11.3	-33.4	10.6	-0.7
Wine, total	**24.3**	**26.3**	**7.9**	**23.3**	**-3.0**
Winegrape prices ($/tonne)[d]					
Red premium grapes	1,437	1,263	-12.9	1,198	-65
White premium grapes	813	827	1.7	779	-48
Non-premium grapes	402	389	-3.3	388	-1
Wine export prices ($/litre)[d]					
Red premium wine	5.88	5.38	-6.2	5.17	-0.21
White premium wine	4.85	4.78	-1.5	4.62	-0.16
Non-premium wine	2.15	2.09	-2.9	2.06	-0.03
Wine stocks (Ml)					
Red premium wine	580	1,250	78.5	1,252	2
White premium wine	350	600	22.2	601	1
Non-premium wine	160	140	-13.3	131	-9

Sources and notes for table 3.6:

a From table 3.2.
b FEDSA-WINE projections.
c 2003 projections with no export demand shifts.
d 1996 Australian dollars.

Production of premium red wine is projected to double between 1999 and 2003, with slower yet still substantial growth in premium white wine production. Due to this increase, the export supply of premium wine is projected to escalate in this period. Premium red wine exports increase from 88 Ml in 1999 to 253 Ml in 2003, premium white wine exports from 83 Ml to 146 Ml, and non-premium exports from 46 Ml to 74 Ml.

No growth in export demand between 1999 and 2003

A key motivation for running a historical simulation is to obtain estimates of structural changes over time that we might otherwise overlook in forecasting. On the demand side, this means that expenditure effects arising from population and income growth forecasts are not the sole basis for forecasting demand. This chapter provides estimates of historical changes in domestic and foreign preferences that I use in the projecting FEDSA-WINE ahead to 2003. There could be debate as to whether demand for premium red wine will continue to grow, given that part of the taste swing in the historical period was attributable to a realigning of consumer tastes after the histamine scare. But domestic consumption is accounting for a decreasing proportion of red wine sales. Export demand growth is more important in shaping Australia's wine industry. In an alternative scenario, I assume (perhaps quite unrealistically) that export demand growth between 1999 and 2003 is zero, instead of as shown in table 3.5.

In setting export demand growth to zero, I could choose to keep capital in the winegrape and wine industries endogenous, so that smaller-than-otherwise growth in export demand induces a smaller movement of labour and capital into these industries. An alternative assumption might be to set capital stocks exogenously at the levels of the base 2003 simulation. The latter would imply a lack of response by the industry to a relatively bleak export outlook. In one sense, this might be unrealistic, as at present, the Australian Wine Export Council and corporate wineries are devoting resources to marketing, as the processing capacity of the industry expands. In another sense, setting capital exogenous would capture the partly irreversible nature of vineyard investments better than having capital endogenous.

Supposing no export demand growth occurs, and that capital is set exogenously for both winegrapes and wine at the levels of the 2003 base scenario. Production of premium wine is 39 Ml less for red and 20 Ml less for white than otherwise, with a smaller reduction for non-premium wine. There are reductions in exports of each wine, and small increases in domestic consumption. Adjustment to an absence of export growth occurs through less labour being hired in the winegrape and wine industries than otherwise, so that output falls. There is also a small increase in domestic consumption. Since export demand is relatively elastic, the price falls arising from the increase in excess supply are small despite the lack of export demand growth. Exports of premium wine are 39 Ml less for red (-7 per cent) and 19 Ml less for white (-5 per cent) than in the base projection, with export prices per litre falling by $0.21 and $0.16 respectively. Growers suffer price falls of $65 and $48 per tonne for premium red and premium white winegrapes relative to the 2003 base (column 5, table 3.6). Another way of thinking about this scenario is that as long as the industry has the capacity to process the available winegrapes, losses through an absence of further global demand growth for Australian wine are kept manageable. But if a lack of processing capacity leads to a sizeable proportion of premium winegrapes being processed as bulk wine, returns to growers could be severely depressed.

3.6. Summary

In analysing an exceptional growth phase of the wine industry, I find using FEDSA-WINE that expanding export growth explains a significant proportion of output growth and, for the premium red segment, most of the observed price increase in the period from 1987 to 1999. Changing domestic preferences are also important in premium red output growth, albeit from a relatively low base in 1987, but not premium white output. A preference swing against non-premium wine has a negative effect on that segment's output.[13] Increased consumer taxes have had a negative effect on all segments. Productivity gains in the period may have more than offset losses borne by producers from the hike in taxes, but may have only partly compensated domestic consumers for rising taxes. Australia's general economic growth boosted wine industry growth, mainly through the aggregate household expenditure effect.

I have kept a major contributor to industry growth, the observed increase in winegrape plantings, separate from other effects. While better data and additional theory may help attribute increased plantings to other causes, the explanation of the supply increase at least for the premium segments will remain incomplete within this CGE framework. The almost irreversible nature of vineyard investments indicates that adding an agricultural land allocation equation to

[13] Movements in preferences are evident from changing wine budget shares. In 1987, the shares were 14 per cent for premium red wine, 30 per cent for premium white wine and 56 per cent for non-premium wine (based on table 3.2). The respective shares in 1999 were 35 per cent, 31 per cent and 34 per cent.

FEDSA-WINE to allow agricultural industries to respond endogenously to variations in the rate of return on land may not necessarily improve the explanatory power of the model.

While accounting for growth in the industry, as presented in this chapter, is itself a useful exercise, the main purpose of the decomposition exercise is to make it easier to project the model into the present decade. The projection then provides more appropriate sales weights for the wine industry for analysing the effects of the GST package introduced in July 2000, as presented in chapter 4, than a database from the 1990s when the industry was smaller and less export-oriented. The rapidity of winegrape plantings in the late 1990s potentially is a bigger issue for the wine industry than the GST package, however, so this is then discussed in detail in chapter 5.

Chapter 4

General equilibrium impact of the GST package on the wine industry

4.1. Introduction

For more than a century government policies in Australia and overseas have contributed much to the boom-bust cycles in the Australian wine industry (Osmond and Anderson 1998). While the 1990s boom was mainly the result of sustained export demand growth, a key question given the influence of government policy historically on the wine industry is how major changes in taxation policy in 2000, and possible future amendments to wine taxation in particular, are likely to affect the industry.

The proposal of the late 1990s to introduce a broad-based goods-and-services tax (GST) package on 1 July 2000 reinvigorated the debate on wine tax policy. A question arises. Would the switch to a GST help or hurt the wine industry? As it turned out, wine is one of the few commodities subject to a wholesale sales tax (WST) that the Coalition government targeted for continued taxing at the wholesale level. More than that, it has had an increase in taxation under the GST package. The increase came in two forms. One was the

(WET) at the wholesale level of 29 per cent which, with a subsequent GST of 10 per cent at the retail level, is equivalent to a 4 to 6 percentage point rise at the wholesale level.[1] The other source of revenue arises from wine that is consumed on licensed premises. This means the GST provides a new source of taxation on wine through the on-premise service charge. Consequently, the 29 per cent WET on wine imposed by the Commonwealth in place of the previous WST will raise the wine tax rate effectively by almost one fifth. And being an ad valorem rather than volumetric tax, it hurts the producers and consumers of premium wine more than those at the non-premium end of the spectrum.

The first scenario reported in this chapter depicts the comparative static long-run impacts of introducing the GST and the 29 per cent WET on the wine industry, assuming that there is sufficient time for capital stocks to adjust in each industry (returning the rates of return on capital to pre-tax shock levels). In the second scenario, the underlying assumption affecting capital allocation is altered to reflect a stronger degree of risk-aversion among investors. In the third and fourth scenarios, I depict the effect of policy uncertainty. This entails shocking wine consumption tax shifters by the mean of these two extremes, one being no WET at all under the GST, the other a volumetric WET to raise the tax rate to the equivalent of the pre-GST beer rate. I use systematic sensitivity analysis (SSA) to vary the rate between these two politically possible extremes. Finally, the fifth and sixth scenarios examine the impacts of introducing a top-up tax on wine in a volumetric form, set equal to the pre-GST beer rate.

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[1] If p is the pre-tax wholesale price, for a 29% top-up tax, a 10% GST and 33% retail margin, the wholesale tax equivalent $t = 0.10p(1 + 0.29)(1 + 0.33) + 0.29p = 0.46p$. Appendix F details the arithmetic involved for off-premise plus on-premise consumption.

4.2. The FEDSA-WINE simulation model

Parameter choice

Much of the analysis of this chapter depends on the disaggregation of wine into three categories. However, most available estimates of cross-price and own-price elasticities include wine as a single aggregated commodity. They also rely on data from periods prior to the marked taste changes of the past few years (Abdulla and Duffus 1988; Clements and Selvanathan 1991). Because the share of premium wine in consumption has increased sharply over the past 15 years, estimates of domestic demand elasticities drawing on pre-1990s data may be more applicable to non-premium than premium wine. The only study to include disaggregated wine types and to be 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 1995a).[2] 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, modified from the CIE study because I believe, based on the unit values of the raw data, it included a disproportionate super-premium weighting in the premium categories. The FEDSA-WINE demand system is of the restrictive Stone-Geary type implying preference independence (Klein and Rubin 1949). This means that there is no specific substitution effect between any of the commodities in the demand system. Clements and Selvanathan (1991) were not able to reject the assumption of preference independence for wine. It would appear

[2] The CIE study (1995) also calculates conditional income and price elasticities for the three wine types. The cross-price terms are significant between the two premium wine types but small and not statistically significant between non-premium and premium wines. In the fifth scenario reported in section 4.4, I impose Slutsky parameters on the model, using the Clements-Smith (1983) methodology, to ensure that the wine types are specific substitutes.

that over the 12 years to 1999, taste changes have had a much larger impact on wine consumption than cross-price effects (see chapter 3). Nevertheless, the fifth and sixth scenarios in section 4.4 compare the introduction of a volumetric tax under the GST using two different assumptions, with specific substitution possibilities and with preference independence (i.e., Stone-Geary type) between wine types.

The export demand elasticities in FEDSA-WINE are –8.0 for premium red and white and –4.0 for non-premium wines. Although Australia's share of the global trade is small, around four-fifths of exports are to four destinations, the UK, the USA, New Zealand and Canada. In the UK, Australia's exports account for 13 per cent of consumption at present, and in New Zealand, over 50 per cent (Berger, Spahni and Anderson 1999; AWEC 2000). Therefore, it is appropriate to apply smaller elasticities than one might infer from Australia's share of global trade. In addition, premium wines are differentiated to some degree, thereby commanding price premiums and reducing the elasticities. For non-premium wines, exports are a much smaller proportion of production than for premium wines. Hence, the smaller elasticity for non-premium wine reflects its lesser export orientation. Since these elasticities are open to debate, I check their influence on scenarios one and two in section 3 of this chapter using systematic sensitivity analysis.

The Armington or import substitution elasticities for wine consumption are 3.0. These are of little interest as imports are a small proportion of total consumption: Armington parameter choice therefore will influence the magnitude of results only marginally.

Closure

The scenarios examined in this paper all concern the long run. National employment is fixed, with wages therefore varying with labour income.[3] Regional shares of national employment are endogenous. In the first scenario, we assume that capital is reallocated between industries to leave the rate of return unchanged from the base case in all industries. At the macroeconomic level, real government spending and real investment are exogenous. The latter implies that foreigners fund any increase in capital stocks, as domestic savings are sufficient only to maintain investment at base case levels. In scenarios one to four, the balance of trade is exogenous, although a small surplus is imposed to pay a return to foreigners on capital that is in addition to that of the base case. Real consumption is the only endogenous component of domestic absorption in these scenarios. The Commonwealth public sector borrowing requirement (PSBR) is exogenous and the income tax rate (both personal and corporate) endogenous.[4] The PSBR of each state government in the database also is exogenous, by endogenising transfers from the Commonwealth to the states. The numeraire is the consumer price index. Appendix D contains full details of the closure.

On the supply side, as is explained in chapter 3, there is an element of irreversibility in investment in winegrapes production. This might also apply to wine processing. The assumption of capital reallocation used in scenario one

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[3] In percentage change terms, let v denote real returns to labour, l the number employed (assuming constant hours per worker) and w the labour cost (take-home wage + direct taxes). Then $v = w + l$. Hence, if by assumption $l = 0$, then $v = w$.

[4] Dixon and Rimmer (1999) calculate that the GST package entails a sizeable fiscal stimulus (i.e., an increase in the PSBR) in its early years. I do not model this, as I report only long-run results. Hence, the modelled long-run (corporate and personal) income tax cuts of each scenario in this chapter are much smaller than the direct tax cuts delivered on 1 July 2000. One interpretation of this is that the fiscal stimulus results in future tax cuts being smaller than otherwise.

implies relatively elastic supply. This is more appropriate for the long run than the short run. Even with an element of irreversibility, it appears inappropriate to have a zero supply response (although vine-pull schemes are a symptom of a belief that the industry does not respond to downturns as it should). Depressed returns, for example, might result in a run-down of existing capital rather than sufficient investment to maintain capital stocks, consistent with the long-run closure of FEDSA-WINE. [5]

A crucial assumption in analysing any movement from direct taxation towards indirect taxation is the labour market closure. Meagher et al. (1985) model the effects of imposing a Commonwealth tax on wine, from a zero rate, at the rate applying to other alcoholic beverages, in a short-run environment. The authors keep aggregate domestic absorption exogenous in real terms. They suggest that one interpretation of this is that revenue collected from the wine tax is returned to consumers as a cut in direct (income) taxes. They assume that real before-tax wages are exogenous and employment endogenous. Therefore, real after-tax wages increase with the direct tax cut. The direct inflationary impact of the wine tax induces a wage-price spiral. This has an adverse effect on employment and on the international competitiveness of domestic industries.

Dixon and Rimmer (2000) also identify the wage-tax trade-off assumption as a crucial part of modelling a generalised movement from direct to indirect taxation, as happens with introducing the GST package. They use the dynamic MONASH model of the Australian economy, in which national

[5] Land is a form of specific capital in FEDSA-WINE without any theory of reallocation. If one believes that the model overstates the supply responsiveness of vineyards, one way of reducing this would be to transfer part of the factor returns from mobile capital to specific land within the database.

employment may vary from the baseline in the first few years following the modelled shocks. If real before-tax wages are allowed to fall, both employment and real after-tax wages may rise in the short run. But if workers wish to maintain real before-tax wages, by demanding wage increases to match the inflationary impact of the GST despite the direct tax cut, employment will fall.

As already mentioned, the policy results presented in this chapter depict the long-run impacts of the GST package as modelled using FEDSA-WINE. This closure therefore by-passes the short-run issue of whether workers will accept reduced before-tax real wages. The model includes a detailed fiscal extension of the revenues and expenditures of the Commonwealth and two regional governments, namely South Australia and a composite of remaining states (appendix A). As for the tax changes assumed in the GST scenario, indirect taxes on intermediate inputs into production are reduced by about one third. Most taxes on capital creation are removed, except for new taxes on housing construction, and some state duties are removed. It turns out that the broad-based tax on household consumption excluding food increases consumption tax revenue by about 40 per cent in this scenario, despite the removal of most wholesale sales taxes (the exceptions being alcoholic beverages, tobacco and fuel).[6]

[6] Some details of the GST package changed during this study due to compromises between the Coalition government and the Democrats. FEDSA-WINE, with only 29 sectors (of which six are wine related), is not sufficiently disaggregated to capture all details in other sectors. As discussed in this chapter, in modelling the GST package, the critical estimates for the wine industry are unit cost changes relative to other industries and international competitors, and consumer price changes relative to CPI. The equations derived in appendix F are important in calculating appropriate wine tax shocks as part of the GST package.

4.3. Effects on the grape and wine industry of the GST package

In the GST package, wine consumers are subjected to an increase in taxes. After allowing for the GST on the mark-up for wine served on licensed premises, a top-up tax of 21.8 per cent would be necessary, in addition to the GST, to raise the same revenue as the current 41 per cent WST on wine (see appendix F). The Coalition government instead, after negotiating with the Democrats, settled on a 29 per cent top-up tax (the so-called 'wine equivalent tax' or WET) but with exemption of $300,000 of direct (cellar door plus mail order) sales from the WET, plus partial exemptions for a winery's direct sales up to $580,000.[7] How significant is the exemption? About 6 per cent of domestic sales are direct at present. Given that larger wineries will usually have in excess of $580,000 of direct sales, the proportion of domestic sales that will be exempt from the top-up tax is likely to be only a fraction of the 6 per cent. The exemption therefore will have little effect on the average top-up tax paid by consumers. Hence I ignore the tax concessions on direct sales in the following analysis.

The first scenario

Looking first at the broad GST package, it raises consumption taxes. At the same time, through the removal of most wholesale taxes, it lowers taxes on intermediate inputs into production and investment. This change in tax mix will lower the costs of production relative to CPI. If we assume a constant rate of return on capital (making capital an unconstrained factor) and adjustment in the labour market through wages rather than employment levels, then, in the absence

[7] The latter concession is in addition to the 15 per cent WST rebate (to encourage wine tourism) on direct sales. Wineries with more than $580,000 of direct sales do not receive the WET exemption at all.

of terms of trade effects, the fall in production costs will lower the marginal product of capital and raise the marginal product of labour permanently. This in turn will increase the capital-to-labour (K/L) ratio permanently in all sectors. It will also raise national capital stocks, as by assumption, national employment is unchanged.

In the first scenario, national capital stocks increase relative to the base case by 3.2 per cent. The increased income arising from the increase in capital leads to an increase in real consumption of 1.5 per cent. And real after-tax wages rise by 1.5 per cent. I use utility as the measure of welfare, ignoring any externalities, as all real domestic absorption other than real consumption is held exogenous. Utility, calculated as the increase in real supernumerary consumption per capita (based on the utility function of FEDSA-WINE, appendix A, excerpt 7), increases by 3.2 per cent in South Australia and 2.8 per cent in the rest of Australia. South Australia does slightly better than the rest of Australia in the scenario because two important industries in the state, cars and wine, gain from the package.[8] The main interest in utility outcomes for various scenarios is not in national welfare in this chapter (given concerns about costless long-run reallocation of capital that follow and uncertainty over demand parameters for the three wine types), but in the results for South Australia relative to the rest of Australia.

[8] To test the sensitivity of the outcome for South Australia to the fate of specific industries, I ran the scenario again with capital stocks kept exogenous for winegrapes, wine and cars. In this circumstance, South Australia's utility gain would be slightly less than the gain in the rest of Australia.

Table 4.1: Effects of 29% top-up wine tax + GST package (main scenario) (mean % change from base case)[a]

Scenario:	1				2			
Capital assumption:	**Industry rate of return as for base case**				**Risk-related capital accumulation**			
Wine output Fan decomposition	Local market	Export	Import share	**Total**	Local market	Export	Import share	**Total**
Premium red:								
Aust.	1.5	0.3	0.0	1.8	0.6	0.8	0.0	1.3
	(0.0)	(0.1)	(0.0)	(0.1)	(0.0)	(0.3)	(0.0)	(0.3)
SA[b]	0.1	0.8	0.0	0.9	0.1	0.8	0.0	0.9
ROA[b]	1.9	0.2	1.3	3.4	0.6	0.1	1.3	2.1
Premium white:								
Aust.	0.9	0.1	0.0	1.0	0.3	0.5	0.0	0.8
	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(0.2)	(0.0)	(0.1)
SA[b]	0.2	0.0	0.0	0.2	0.1	0.1	0.0	0.3
ROA[b]	1.0	0.0	1.1	2.1	0.3	0.1	1.1	1.5
Non-premium:								
Aust.	1.6	0.1	0.0	1.8	1.0	0.2	0.0	1.1
	(0.0)	(0.1)	(0.0)	(0.1)	(0.0)	(0.1)	(0.0)	(0.1)
SA[b]	0.3	0.9	0.1	1.2	0.2	0.6	0.1	1.0
ROA[b]	1.6	0.1	0.2	2.0	0.9	0.1	0.2	1.2
Prices[c]	Input costs	Consumer			Input costs	Consumer		
Premium red	-4.5	0.0			-4.3	0.2		
Premium white	-4.5	0.3			-4.2	0.4		
Non-premium	-4.9	-1.7			-4.6	-1.5		
All sectors	**-3.3**	**0.0**			**-3.3**	**0.0**		
Wine tax revenue	19.0				17.4			
Wine consumption	Price effect	Expend. effect	Total		Price effect	Expenditure effect	Total	
Premium red	-0.0	4.2	4.1		-0.2	1.9	1.7	
Premium white	-0.2	2.5	2.3		-0.3	1.2	0.9	
Non-premium	0.6	1.2	1.8		0.5	0.6	1.1	
Macroeconomic								
Real appreciation	2.9				2.5			
Capital stocks	3.2				1.0			
Real consumption	1.5				0.4			
Real after-tax wage	1.5				-0.3			
Utility – South Australia	3.2				2.5			
– Rest of Australia	2.8				0.7			

a The export demand elasticity ranges are –8±6 for premium wines, and –4±3 for non-premium wine. Estimated standard deviations, based on these parameter ranges, for national output changes are in parentheses.
b At the regional level, local sales are specific to the region. The export and import contributions include both interstate and international trade.
c Price relative to CPI.

Source: Author's FEDSA-WINE projections.

At the industry level, the outcome of the GST depends largely on the movement in costs relative to other industries. If the cost decrease is of a larger magnitude than the economy-wide average, this should induce a relatively larger movement of productive resources into the industry than the national average. The premium red and premium white wine industries export around half of their output by 2003, and so changes in their international competitiveness are also relevant.

The package introduces new taxes on service industries, many of which produce non-tradables (although tourism and education make relatively important contributions to exports). The GST package thus raises the price of non-tradables relative to tradables, resulting in a real exchange rate appreciation. Hence, the appreciation effect must be subtracted from an industry's cost reduction to calculate its gain in international competitiveness.

Premium red wine, the most export-oriented segment of the wine industry, has an input cost reduction of 4.5 per cent (using CPI as a numeraire), as does premium white, while that for non-premium wine is 4.9 per cent. The industry average cost reduction is 3.3 per cent. In the scenario, the real exchange rate appreciates by 2.9 per cent (table 4.1). Therefore, the wine industry improves its competitiveness relative to other industries in the domestic market and, based on the unit cost reduction minus the real appreciation effect, in the international market.

Wine sold for domestic consumption introduces a complication. In addition to its relative cost reduction, there is also a change in its real consumer price. For non-premium wine, the tax increase with the GST package is more than offset by the unit cost reduction. For premium wines, however, the price increase is slightly larger than CPI (less than 0.1 per cent for red and 0.3 per cent for white) due to the assumption that a higher proportion than that for non-premium wines is consumed on licensed premises. This makes premium wine consumption more exposed to the GST on the on-premise mark-up, and therefore subject overall to a higher effective tax increase.

One way of decomposing the effects of the tax package is to use the Fan method (see appendix A, section 17). This explains the change in output of a given industry as the sum of the domestic or local market contribution, the import share contribution (arising from domestic buyers shifting from imported to domestic products) and the export contribution. The Fan decomposition is a useful tool for explaining results, as contributions may be in opposite directions. For example, lowering the price of wine under a GST relative to other consumer goods and services may induce an increase in domestic wine sales, which will decrease the availability of wine for export.

For each of the three wine types, at the national level, the local market contribution explains most of the proportional increase in output in the first scenario. For premium red wine, this contribution is 1.5 per cent out of the total increase in output of 1.8 per cent. For premium white wine, the contribution is 0.9 out of 1.0 per cent (table 4.1). Although the consumer price of both premium wines rises slightly, the expenditure effect, through the increase in real incomes, dominates the local market contribution. Consequently, the increase in the supply of wine available for export is small, despite an increase in international competitiveness. The local market contribution explains virtually all the output increase for non-premium wine, due to the relatively small export weighting in total non-premium sales. Tax revenue collected from on-premise and off-premise wine consumption rises by 19.0 per cent due to a rise in the effective tax rate, relative to the pre-GST WST rate, and a slight increase in domestic consumption.

We can separate the price and expenditure effects formally. With the number of households and consumer preferences constant in the scenario, from equations E_x3lux and E_x3_q in appendix A (ignoring the regional dimension), we obtain:

$$x_i = \phi_i(v - p_i) \qquad (4.1)$$

where

$$\phi_i = -\varepsilon_i / \gamma \qquad (4.2)$$

The variables x_i and p_i denote percentage changes in the domestic consumption and price of household good i, and v is the percentage change in total supernumerary expenditure. The coefficient ϕ_i is the supernumerary proportion of total expenditure and ε_i is the expenditure elasticity of good i. The Frisch parameter γ equals the (negative) ratio of total expenditure to luxury expenditure. From (4.1), the expenditure effect is $\phi_i v$ and the price effect $-\phi_i p_i$.

From the database, ϕ_i is 1.10, 0.66 and 0.33 for premium red, premium white and non-premium wines respectively.[9] The national increase in v is 3.78 per cent in the first scenario. Domestic consumption of the respective wine types increases by 4.1 per cent, 2.3 per cent and 1.8 per cent (table 4.1). The change in consumption of premium red consumption calculated from (4.1) comprises a price effect of -0.02 (= 1.1 x –0.02) and an expenditure effect of 4.16 (= 1.1 x 3.78), for

[9] The coefficient ϕ_i (i.e., $B3LUX_i$ in appendix C) is not constant, being updated by variables calculated within the household demand equations of the model.

a total increase of 4.14 per cent. The two effects calculated for premium white wine are –0.18 (= 0.66 x –0.27) and 2.49 (= 0.66 x 3.78), totalling 2.31 per cent. And for non-premium wine, the price effect is 0.56 (= 0.33 x – -1.69), the expenditure effect 1.25 (= 0.33 x 3.78) and the total 1.81 per cent. Decomposition shows us that expenditure effects dominate price effects, an outcome that motivates the second scenario.

Systematic sensitivity analysis (SSA) can indicate the extent to which parameter choice influences modelled outcomes (Arndt 1996; Arndt and Pearson, 1996). In this study, where I use imposed rather than estimated export demand elasticities, SSA is especially important. Hence, the wine export demand elasticities were varied uniformly from their base values by plus or minus 75 per cent. This SSA method implies that any point in the range is equally likely to be the true parameter value as any other, with no bias towards mid-range values. For premium and non-premium wines, the ranges tested were from –2.0 to –14.0 and –1.0 to –7.0, respectively. The standard deviations for the contributions to national wine output percentage changes, based on the parameter range, appear in table 4.1. In the first scenario, the estimated standard deviations are small (0.1 per cent or less) for each wine type.

There is also some interest in the effects of varying the choice of expenditure elasticities for wine. But it is not possible to vary these using SSA and still maintain global homotheticity. This is because they are conditional parameters updated by variables within the linear expenditure system, as shown in appendix A, excerpt 3. Nevertheless, in a (non-homothetic) version of the model without updates of the expenditure elasticities, I used SSA to estimate standard deviations arising from varying them. In the first scenario, with substantial expenditure effects, varying the expenditure elasticities by plus or minus 75 per cent of their base values results in standard deviation estimates that are a significant proportion (i.e., almost half) of the local market effect. Yet the standard deviation of total output is smaller than the sums of the components, due to interchanging of sales between local and export markets. [10]

One impact of the GST package is to lower the costs of production for the wine industry. This will translate into increased outputs for the industry if negative price effects do not erode such gains. Parameter choices within the model over a reasonably wide range (for export demand elasticities, and in the non-homothetic SSA runs, for expenditure elasticities) do not critically affect the impact on outputs, as there is a degree of interchangeability between domestic and export sales. But the supply response and in particular capital reallocation warrants further investigation.

The second scenario

In the first scenario, the rate of return on capital is assumed to remain unchanged in the long run. That causes the modelled change in aggregate real consumption to be larger than changes reported in other studies modelling GST scenarios (e.g., Dixon and Rimmer (1999), using the dynamic MONASH framework, with an expectations-based theory of capital accumulation). Is a larger-than-otherwise expenditure effect (as a consequence of costless capital reallocation) likely to result in an unduly optimistic long-run outcome for the wine

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[10] The WFA initially commissioned a GST study (Wittwer and Anderson 1998; Wittwer and Anderson 1999). Subsequently, I reported SSA results for varying wine's expenditure elasticities by ±75 per cent without acknowledging the departure from homotheticity (Wittwer 2000).

industry arising from the GST package? This is a particular concern because in the first scenario, for each wine type, the expenditure effect is much larger than the price effect.

An alternative assumption is that the underlying theory of investment in the model extends to capital accumulation in the medium or long run. That is, to reflect a degree of risk aversion among investors, the rate of return on capital attracts premiums (discounts) as capital stocks increase (decrease). In the second scenario, changes in the rates of return on capital are exogenously imposed on each industry in proportion to modelled changes in industry capital stocks in the first scenario. Using this method in the static framework, I restrict (somewhat arbitrarily) the national increase in capital stocks to 1.0 per cent. This is closer to the medium- to long-run increase reported by Dixon and Rimmer (1999). This in turn reduces the increase in real income. Consequently, the increase in macroeconomic real consumption is now only 0.5 per cent (table 4.1).

The wine segments still benefit from larger-than-average cost reductions in the GST package. Since the change in macroeconomic real consumption is smaller than in the first scenario, the relative export-orientation and change in international competitiveness of an industry are now increasingly important in determining the impact on that industry. The gain in wine's international competitiveness is now larger than in scenario one, after subtracting the slightly smaller real exchange rate appreciation. The altered rate-of-return assumption dampens the capital-to-labour ratio increase, relative to the first scenario, in all industries. While there are smaller increases in capital stocks in the premium wine segments relative to the first scenario, the labour inflow into these export-oriented segments compensates by being larger. For both premium wine types, the total increase in output arising from the GST package is slightly smaller than the first scenario, but the export contribution is now larger (0.8 of a total increase of 1.3 per cent for red, and 0.5 of an increase of 0.8 per cent for white, table 4.1). For each wine type, the diminished expenditure effect results in a smaller local market contribution. The diminution of the premium red wine output gain is greater than for premium white wine, relative to scenario one (1.3 instead of 1.8 per cent for red, and 0.8 instead of 1.0 per cent for white), because its expenditure elasticity is larger than white wine's. For the non-premium segment, the smaller expenditure effect has a greater effect on output (increasing by 1.1 per cent instead of 1.8 per cent, as in scenario one), despite the segment's even smaller expenditure elasticity, due to the relative large proportion of local sales in total sales.

The two scenarios provide a contrast at the regional level. In the first scenario, the various segments of the wine industry in South Australia benefit much less than those in the rest of Australia from the GST package. For example, South Australia's premium red wine output increases by only 0.9 per cent, compared with 3.4 per cent interstate (table 4.1). The Armington (1969) assumption of imperfect substitution by source applies to interstate as well as international trade. The industry in South Australia is more export-oriented than in the rest of Australia, accounting for almost 70 per cent of the value of national exports, compared with 50 per cent of the value of output (ABS 1999). The local market effect makes a larger contribution to the percentage output gain in the wine segments in the rest of Australia than in South Australia, as is evident in the region-specific Fan decomposition outcomes shown in table 4.1.[11] For premium red wine, the local (state-specific) contribution in South Australia is only 0.1 per cent, compared with 1.9 per cent in the rest of Australia (table 4.1). However, with the alternative assumption of the second scenario, the local market contributions for each wine type decrease in the rest of Australia, with little change in South Australia.

In the second scenario, at the regional level, utility per capita increases by 2.5 per cent relative to the base case in South Australia, compared with only 0.7 per cent elsewhere (table 4.2). Most industries are projected to have smaller gains in the second scenario than the first. The diminution of South Australia's gains is smaller than interstate, because the outputs of the state's relatively important premium wine segments and car industry differ little from scenario 1. For wine, this reflects the additional gain in international competitiveness. For cars, the large decrease in the tax paid by consumers induces a positive price effect that still dominates the industry outcome, as in scenario 1.

In additional SSA runs, I check the extent to which changing the intra-domestic elasticities of substitution on grape inputs and domestic sales of wine alters regional outcomes. The standard deviations of output for the three wine types range from 0.1 to 0.3 per cent (mostly due to the standard deviation in interstate exports from South Australia to the rest of Australia), over intra-domestic parameter ranges of ±75 per cent. This parameter therefore does not affect regional wine industry outcomes critically.

[11] Note that although South Australia's wine segments gain less from the package than those interstate, the gains to the winegrape segments are similar, due to the assumption within the model that winegrapes have higher substitutability between regions than wine.

Using SSA to depict policy uncertainty in the wine industry

Under the proposed GST with a top-up ad valorem wine WET, interest remains in alternative tax proposals, including a volumetric WET. Some lobbyists continue to advocate a volumetric tax on wine as a more direct means of addressing the alleged negative externalities associated with alcohol abuse. Some groups are also seeking higher taxes on wine, given that taxes on beer and spirits are higher than on wine in Australia (table F.1). Others argue that Australia's wine tax is already excessive by the standards of other wine-producing nations, which may provide a case for lower taxes (Berger and Anderson 1999).

The sole purpose of most varieties of wine grapes is as an input into wine production. Hence, grape prices are highly sensitive to changes in market conditions for wine and, at least in the short run, taxation policies. This sensitivity might explain why there was no consumption tax on wine in Australia until 1984, apart from a two-year period in the early 1970s. Much of impending massive increase in wine grape supply may coincide with first vintage under a GST, in 2001. In response to industry concerns of falling prices, and the possibility that the tax hike on wine under the GST may shoulder a disproportionate share of the blame for this, the Commonwealth government may consider, in extreme political circumstances, reducing the top-up tax on wine. A possible minimum tax on wine therefore is a GST with no top-up tax.

In the third scenario, systematic sensitivity analysis is used to address this policy uncertainty. The fourth scenario repeats the simulation with the altered rate-of-return assumption of the second scenario. The maximum shock applied to wine in the third and fourth scenarios is equal to that beer rate of taxation using a volumetric top-up tax. The minimum shock applied is equal to a GST with no top-up tax. The mean shocks entail a decrease in the tax on premium wine and a substantial increase in the tax on non-premium wine. These are equivalent to introducing a partly volumetric top-up tax.

For premium wines, the local market contribution (driven by positive price and expenditure effects) accounts for more than the mean increase in output for premium wines. This is because a lower rate of taxation induces more imports and diverts sales from exports. But the standard deviations with respect to the policy range are quite large. The mean output gains are higher than in the first and second scenarios, being 4.6 and 4.2 per cent for premium red wine for the third and fourth scenarios respectively. The corresponding gains for premium white wine are 2.6 and 2.4 per cent, respectively. The standard deviations are smaller than for the local market contributions alone, again indicating substitution between domestic and overseas sales. One interesting point is that the output gains in scenarios one and two for premium wines are below the range of gains implied by the means and standard deviations in scenarios three and four. This indicates that the 29 per cent WET on wine as part of the GST package is not a good outcome for the premium segment of the industry (using the pre-GST beer rate of taxation as a worst-case tax scenario). For the direct sales of wineries at least, the 15 per cent rebate and WET exemption (for small wineries) provide some consolation to the industry.

Table 4.2: Wine tax policy uncertainty in GST package (mean % change from base case)[a]

Scenario:	3				4			
Capital assumption:	Industry rate of return as for base case				Risk-related capital accumulation			
Wine output Fan decomposition	Local market	Export	Import share	**Total**	Local market	Export	Import share	**Total**
Wine								
Premium red:								
Aust.	5.4	-0.5	-0.3	4.6	4.3	0.1	-0.2	4.2
	(3.1)	(0.5)	(0.2)	(2.3)	(3.0)	(0.5)	(0.2)	(2.3)
SA[b]	1.0	4.0	-0.1	4.8	0.9	3.9	-0.1	4.7
ROA[b]	6.2	0.0	-2.3	3.9	4.8	0.2	-2.2	2.8
Premium white:								
Aust.	3.5	-0.4	-0.5	2.6	2.8	0.1	-0.4	2.4
	(2.1)	(0.3)	(0.4)	(1.3)	(2.1)	(0.3)	(0.4)	(1.3)
SA[b]	0.7	3.0	-0.1	3.6	0.6	3.0	-0.1	3.6
ROA[b]	3.3	0.0	-2.0	1.3	2.6	0.2	-1.9	0.8
Non-premium:								
Aust.	0.8	0.2	0.1	0.9	0.1	0.1	0.0	0.3
	(2.7)	(0.0)	(0.1)	(2.6)	(2.7)	(0.0)	(0.1)	(2.6)
SA[b]	0.0	-0.7	0.3	-0.4	0.0	-1.0	0.4	-0.3
ROA[b]	0.8	-0.2	0.7	1.5	0.1	-0.1	0.6	0.6

Prices[c]	Input costs (3)	Consumer (3)	Input costs (4)	Consumer (4)
Premium red	-4.3	-5.6	-4.1	-5.5
Premium white	-4.3	-5.8	-4.1	-5.7
Non-premium	-4.8	2.3	-4.5	2.5
All sectors	**-3.3**	**0.0**	**-3.3**	**0.0**

	3	4
Wine tax revenue	1.9	0.7

Wine consumption	Price effect (3)	Expend. effect (3)	Total (3)	Price effect (4)	Expenditure effect (4)	Total (4)
Premium red	6.7	4.3	11.0	6.6	1.8	8.5
Premium white	4.2	2.5	6.7	4.1	1.1	5.3
Non-premium	-0.5	1.2	0.7	-0.5	0.5	0.0

Macroeconomic	3	4
Real appreciation	2.8	2.4
Capital stocks	3.2	1.0
Real consumption	1.5	0.4
Real after-tax wage	1.5	-0.3
Utility – South Australia	3.6	2.9
– Rest of Australia	2.7	0.6

a The shocks ascribed to the power of the consumption tax are: premium red -3±14, premium white -3±14 and non-premium 10.5±27.5. Estimated standard deviations, based on these ranges of shocks, for national output changes are in parentheses.
b At the regional level, local sales are specific to the region. The export and import contributions include both interstate and international trade.
c Price relative to CPI.

Source: Author's FEDSA-WINE projections.

The non-premium segment presents a different picture. The range of shocks imposed implies that there is only a small probability that the tax rate on non-premium wine will decrease. The outcome for the segment is dominated by the local market contribution. In the long run, the non-premium wine segment can withstand a moderate consumer tax increase without a loss of output, due to the relative cost reduction of the industry as a result of the GST. A revenue-neutral volumetric WET (which the mean shocks in scenarios three and four approximate, with respective wine tax revenue gains of only 1.9 and 0.7 per cent) as part of the GST package appears not to be output reducing for the non-premium segment, as non-premium output expands in scenario three, and slightly so in scenario four. But raising the volumetric tax per unit of alcohol above the revenue-neutral rate would remove the gains in competitiveness arising from the GST package entirely.

The proportion of premium wine in total production is larger in South Australia than the rest of the nation. Therefore, we might expect its wine industry to gain more from the introduction of a partly volumetric tax than that interstate, and for South Australia to gain from such a tax. This appears to be so, with utility per capita increasing in South Australia by 3.6 per cent in scenario three, compared with 3.2 per cent in scenario one. The lower increase in wine tax revenue in scenario three (1.9 per cent) than scenario one (19.0 per cent) explains part of the additional gain in utility in South Australia, with the remainder attributable to the change in tax instrument.

In summary, introducing a volumetric WET will have a positive price effect on premium wine output and a negative price effect on non-premium wine. The outcome would be positive for the premium segments and ambiguous for the non-premium segment. The latter is more sensitive to policy changes than the premium segments because exports sales are a relatively small proportion of total sales. A volumetric tax implies a large increase in taxes on non-premium wine, so the difference between the no top-up tax option and a volumetric WET option (at the pre-GST beer rate of taxation) is greater for non-premium than premium wines. Hence, the estimated standard deviations arising from policy uncertainty are greater for the non-premium segment. It therefore appears more vulnerable to changes in WET options than the premium segments.

Modelling a volumetric top-up tax under alternative demand assumptions

In standard microeconomic theory, when we examine the impact of a change in the price of commodity *j*, holding nominal income and all other prices constant, the change in demand for each good is divided into the income effect and substitution effect. This section looks at a change in the assumption in FEDSA-WINE concerning the substitution effect. The substitution effect may have two parts, specific substitution, in which the marginal utility of income is held constant, and general substitution, in which goods compete for an extra dollar of income. The Stone-Geary-based linear expenditure system, as used in FEDSA-WINE, assumes preference independence. This implies there are no specific substitution possibilities.

The Stone-Geary assumption may be appropriate in a model in which all commodities represent broad aggregations of different classes of goods. As disaggregation increases, some goods become more alike and consequently are more likely to display specific substitution at least within a group of goods. Clearly, the three wine types in FEDSA-WINE theoretically, at least, are candidates for specific substitutability. Supposing we treat premium and non-premium wines as such, instead of assuming preference independence. This will alter the magnitudes of modelled impacts when the relative prices of the wines change. This will be the case if we model the introduction of a partly volumetric tax on wine, as the tax per unit value will rise for low unit value wines relative to high unit value wines.

CIE (1995b) used the methodology of Clements and Smith (1983) to modify their CGE model in simulating these effects. The results differed little from those of the Stone-Geary form if wine and beer were substitutes. But when individual wine types (i.e., 'ultra-premium', 'premium' and 'non-premium') were substitutes, the magnitudes of output gains to the ultra-premium and premium segments, and output losses to the non-premium segment doubled approximately.

This section compares results from the standard version of FEDSA-WINE with a version including the Clements-Smith modification to demand (summarised in appendix G). The comparison is confined to introducing a volumetric top-up tax with the GST, at a rate equivalent to the pre-GST beer rate of taxation. This imposes a large tax increase on non-premium wine, and a moderate corresponding tax increase on premium wines. If the three wine types are substitutable, the simulated change should favour premium wine consumption at the expense of non-premium consumption. The intention here is to impose conditional Slutsky parameters on the three wine types to ensure that they are specifically substitutable.

The Clements-Smith modification to FEDSA-WINE, in the form presented in appendix G, alters closure possibilities. No longer is it possible to have both the Commonwealth budget constraint and trade balance (i.e., *chb* and *delb* in appendix B) exogenous. The closure used in scenarios five and six has the trade balance endogenous and real consumption exogenous for both simulations, with and without the modified demand system, as in Meagher et al. (1985). Therefore, the expenditure effect of the GST package is virtually removed from the simulation. This presents no difficulty, as the purpose is to compare industry-level (rather than welfare) outcomes at a given level of expenditure.

The modelled impact of a volumetric top-up tax on wine introduced at the equivalent of the pre-GST beer rate is an output change to the non-premium wine segment of –5.4 per cent, assuming preference independence between wine types. If the three wine types are substitutable, using the parameters shown in appendix G, the change is –7.6 per cent (table 4.3). For premium wines, the local market effect switches sign, from being slightly negative with preference independence to being positive if the wine types are substitutes. With either demand form, the modelling indicates that introducing the beer rate of taxation under a GST will still result in output gains for the premium segment. This is because lower production costs offset most of the tax increase, so that consumer prices rise only slightly, unlike those for non-premium wine. To put this in perspective, the rate of taxation on the premium segments with a volumetric tax at the equivalent of the pre-GST beer rate of taxation is only slightly higher than the 29 per cent WET imposed with the GST package.

A surprising effect is that on non-premium grapes. One of the possible reasons for not introducing a volumetric tax is that the adverse effects on production may be concentrated in regions producing a high proportion of non-premium grapes. The modelling in this section does not support this proposition. While the local sales effect (i.e., as inputs to wine production) decreases output by 3.1 per cent with the Clement-Smith modification to the model, the export effect (i.e., dried and table grape exports) increases output by 2.8 per cent. The total change in output is a decrease of only 0.5 per cent. With the Stone-Geary form, the two effects are smaller and the net change in output is zero (table 4.3).

Table 4.3: Pre-GST beer rate on wine in GST package, % change from base case[a]

Scenario:	**5**				**6**			
Capital assumption:	**Clements-Smith modification**				**Stone-Geary form**			
Fan decomposition	Local market	Export	Import share	**Total**	Local market	Export	Import share	**Total**
Non-premium grapes	-3.1	2.8	-0.1	-0.5	-2.2	2.3	-0.1	0.0
Wine								
Premium red	0.0	1.7	0.0	1.7	-0.3	1.9	0.0	1.6
Premium white	1.2	1.2	-0.1	2.2	-0.4	1.4	0.1	1.2
Non-premium	-8.1	0.2	0.3	-7.6	-5.9	0.2	0.3	-5.4

Source: Author's FEDSA-WINE projections.

The export effect for non-premium grapes shown in table 4.3 implies a switch away from usage of such grapes in winemaking towards dried and table grape sales. Do historical data support this? Exports of fresh grapes reached a new high in 1998-99, when 31.0 kt were exported. But exports of dried grapes collapsed, from 41.1 kt in 1993-94 to 14.7 kt the following year, due in part to drought. In 1998-99, however, exports were only 13.7 kt. Total production of grapes for non-wine usage in 1999 was 189 kt, out of total production of multipurpose grapes of about 400 kt (ABS 1999). The modelled outcome using the Clements-Smith demand form shown in table 4.3 is for a diversion of approximately 12 kt of multipurpose grapes from wine production to grape exports. This is within the bounds of historically observed variations in exports.

Regional considerations arising from a volumetric tax

The long-run impact on the Sunraysia and Riverland regions (i.e., the major regions producing non-premium or multipurpose grapes) of a volumetric tax set at the beer rate may be negative, but, according to the modelled outcome, not substantially so. However, the FEDSA-WINE 2003 database may understate the value of inputs of premium varieties of grapes into non-premium production. The Murrumbidgee Irrigated Area (MIA), for example, is not renowned (in aggregate) for producing grapes for high quality wines. Yet it produces only premium varieties of winegrapes. This implies that MIA grape growers are more vulnerable to wine tax changes than those in other warm-climate irrigated regions, where multipurpose grapes provide a means of alleviating the effects on tax changes. If MIA-sourced grapes are used substantially in non-premium wine production, the region may suffer from the introduction of a volumetric tax. On the other hand, if such grapes are used mainly in premium production, or for export, the adverse effects in the region from such a tax would be smaller.

Another issue in considering the potential impacts of introducing a volumetric tax concerns input changes by 2003. Given the rapid winegrape supply increase, we would expect the proportion of premium varieties used in non-premium production to be greater than in 1999. This change has not been imposed exogenously on the model. By the same token, producers will be reluctant to upgrade to better quality grapes for non-premium production if this entails steep increases in prices for grape inputs. Moreover, it appears that premium winegrapes being planted in irrigated regions are for use in the rapidly growing commercial segment of the wine export market.

4.4. Discussion

The premium segments of the wine industry could still gain from a GST package that includes a substantial increase in consumption taxes on wine. The simulated results indicate that this could even apply if a volumetric top-up tax on wine were introduced with the GST package, at the equivalent of the pre-GST beer rate.[12] This is because the package is likely to increase the international competitiveness of the export-oriented premium segments, partly offsetting the adverse impact on the domestic market of the tax hike. For non-premium wine, the total outcome is more dependent on domestic sales than for premium wines. Any increase in the top-up tax on non-premium wine beyond the 29 per cent WET imposed on 1 July 2000 (such as introducing a volumetric tax) would eliminate the benefit of lower input costs arising from the GST package.

How will individual wineries fare with the introduction of the GST package? Outcomes will depend on the degree of export orientation, the value of turnover and the proportion of direct sales in turnover. Wineries faring worst would be domestically focused, with sufficient turnover that the cellar door exemption does not apply. For such wineries, the hike in consumer taxes could outweigh the cost reductions arising from the GST. If a volumetric top-up tax became part of the GST package, the average unit value of sales would also

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[12] Table F.1 shows that for premium wines, a 29% WET is almost equal to the pre-GST beer rate of taxation (the corresponding WETs are 29.4 per cent for red and 31.7 per cent for white).

influence the outcome, with such a tax penalising low unit value produce more in ad valorem equivalent terms.

The picture for individual wineries can never be as simple as that depicted by modelling. Large corporate wineries account for most exports in Australia, and also produce most bulk or non-premium wine. This implies that they account for significant proportions of both the segments most insulated from and most exposed to domestic wine consumption tax arrangements. In any case, even for highly export-oriented firms, insulation from domestic tax arrangements is still partial. If the Coalition had chosen to maintain pre-GST wine consumption taxes instead of increasing them, the gains to the industry from the GST package would have doubled approximately.[13]

The two main reasons for having a top-up tax on wine are to collect revenue and to address any net negative externalities arising from wine consumption. A GST eliminates the first reason by, in theory, raising revenue from all consumption of goods and services in the economy. In relation to the second reason, the most direct instrument would be to tax the source of the externality, namely alcohol, with a volumetric tax. Until now, segments of the wine industry have resisted a volumetric tax, but given the justification for it, the issue may not settle. On the other hand, the perceived health benefits of moderate wine consumption may encourage the industry to argue that the net negative may be minimal or even positive.[14] If the Commonwealth chose to impose a volumetric

[13] If there is no change in consumer taxes on wine in scenario one (equal to a 22 per cent WET), the price effect on consumption is 4.2 per cent for premium red wine, 2.6 per cent for premium white and 1.4 per cent for non-premium wine. The output gains are now 3.6, 2.1 and 2.5 per cent for the respective wine types, instead of 1.8, 1.0 and 1.8 per cent as in table 4.1.

[14] A number of papers presented at the Novartis Foundation (1998) symposium noted a J-curve relationship between alcohol consumption and the incidence of cardiovascular disease.

tax, which would increase the tax on low value per volume wines, the non-premium segment would almost certainly suffer output losses. On the other hand, a volumetric tax, even at the beer rate, may have surprisingly little effect on multipurpose grape output, due to a diversion from usage in winemaking into dried or table grape sales. But not all grapes used in non-premium winemaking are multipurpose, so that growers of lower grade premium winegrape varieties may be vulnerable to income cuts arising from the introduction of a volumetric tax.

Although the economic justification for higher than average consumption taxes on wine is to address the adverse social consequences of alcohol abuse, such tax decisions in practice relate at least in part to the political environment. For example, with the possible exception of New Zealand, all other major wine-producing nations have lower wine consumption taxes than Australia (Berger and Anderson 1999). This is to do with the political sensitivity of grape growers in particular, whose mostly single-use primary product is vulnerable to magnified price fluctuations when wine prices vary.

It is likely that political sensitivities (more so than debate over the size of the net externalities of wine consumption that will be very difficult to resolve) will continue to play a part in deciding the top-up taxes imposed on alcoholic beverages in Australia under a GST. For example, the Coalition has raised the effective tax rate on all forms of alcohol in the GST package. But it has granted a top-up tax exemption to small wineries for direct sales and, in an apparent attempt both to encourage consumption of low alcohol beer and appease the beer industry, on the first 1.15 per cent of alcohol by volume for beer. No such exemptions apply for spirits, taxed at the highest rate for all alcoholic beverages prior to GST (except for wine with a pre-tax wholesale price in excess of about $40), and an even higher rate under the GST. A high proportion of spirits are imported, with the domestic spirits industry apparently lacking the lobbying power to gain concessions.

According to the FEDSA-WINE results, it is difficult to argue against a volumetric tax on the grounds of adverse regional effects. For grape growers in warm-climate irrigated regions, if they are producing multipurpose rather than premium winegrapes, the adverse effects of such a tax may be reduced through a diversion to sales as dried or table grapes. But with rapid industry growth, we cannot be certain of the destination of warm-climate premium grapes. An increasing tonnage may be used in non-premium wine production due to increased availability in the next few vintages, although wineries may be reluctant to switch to premium winegrapes for non-premium production unless prices become more attractive relative to multipurpose inputs. What is most probable is that an increasing proportion of winegrapes from warm-climate regions will be used in wine produced for export. The export-orientation of wine originating from irrigated regions (ostensibly most affected by such a tax) may be increasing more rapidly than that of some regions near capital cities, particularly Melbourne, where many boutique wineries rely heavily on cellar-door sales.

A political argument against switching to a volumetric WET may relate to the timing of such a tax. Data for the 2000 vintage indicate that prices of premium winegrapes grown in warm-climate regions have dropped relative to 1999, whereas those in cooler climate regions have changed little (AWBC, personal communication).[14] It may be politically difficult to introduce a tax that ostensibly penalises warm-climate growers relative to other growers when their prices are already dropping. This may only be a transient circumstance, as prices in cooler climates might also drop in the next vintage or two, as projected in chapter 3 for premium red winegrapes.

Lobbying for lower taxes by premium red wine grape and wine producers in particular may escalate, if prices in cooler-climate dry-land regions start to fall. Smaller producers may favour a volumetric tax on the basis that they generally produce super-premium wines that would be penalised less by the volumetric instrument.[15] But their major concern will be with the level of taxation. Small producers relying only on the domestic market will not benefit from the enhanced international competitiveness of the industry (although their competitiveness relative to other domestic industries may increase). Therefore, if their total turnover is sufficiently high that the tax increase of the 29 per cent WET under the GST outweighs the benefit of the cellar-door tax exemption, they could argue that they are worse off under the GST.[16] On the other hand, the direct sales tax exemption may decrease the effective consumer tax on the produce of a substantial number of small wineries, although the threshold turnover value may amount to no more than the value of wine produced by five or so hectares of

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[14] This may indicate simply that warm-climate regions, with a shorter lag between planting and bearing than in cooler-climate regions, have lost their price premiums for shortages first. Chapter 5 discusses this further.

[15] If the producer price of wine falls through changing technology, an increasing number of producers will favour retaining the ad valorem top-up tax (or no tax at all). What is more likely, given the increasing emphasis on quality in the industry since the late 1980s, is that while prices for a given quality will fall, overall quality will continue to rise, masking observed price falls. On this basis, most small producers are likely to favour a volumetric rather than an ad valorem WET tax — although they may choose to lobby against having any WET at all.

[16] Dixon and Rimmer (1999) have projected a small fall in aggregate consumption from the GST package, implying that the expenditure effect of the GST on wine could also be negative.

vineyards. If the Commonwealth government lower taxes on wine, this will induce a positive price effect, translating to increased domestic consumption, thereby reducing the pressure on wineries to increase their exports as supply increases.

This chapter opened with a reference to the historically influential role of government policy on Australia's wine industry. It now appears that the industry is largely shaping its own destiny. In an industry that has undergone extraordinary change over the past 15 years, many wineries over time have altered the destination of sales, quality of wine and consequently unit values of sales. Expanding exports have contributed to the prosperity of the industry. Industry fears that consumer taxes on wine can adversely affect their livelihood persist. The results of modelling presented in this chapter indicate that although there is a degree of interchanging between domestic and export sales, a rise in wine taxes will still translate to reduced wine industry output in the long run (implying reduced industry profits in the short run).

The Coalition government's GST package will have only a marginal impact on the industry for two reasons. First, the opportunity to create efficiency gains in the industry from tax reform has been whittled away to some extent. This is because the government has chosen to raise taxes further on a commodity already taxed prior to the introduction of the GST. From the perspective of the wine industry, since the tax reform package was designed to broaden the tax base, it would have been expected that the tax burden on commodities subject to a WST prior to the introduction of the reforms would either decrease or not change.

The second reason for the marginal impact is that already, the industry is growing rapidly. By far the greatest challenge facing the industry is to deal with the rapid increase in premium grape and wine supply in the first few years of the new millennium. The ability of the industry to respond to this challenge is the subject of chapter 5.

Chapter 5

Is the impending winegrape supply boom a blessing or a curse?

5.1 Introduction

Growing exports contributed much to rising prosperity within the winegrape and wine industry in the 1990s. In the mid-1980s, the industry was much as described by Johnson (1983, cited in chapter 1), with a plethora of high quality wines, produced in small quantities, kept more-or-less secret from the rest of the world. In addition, a high proportion of production was of non-premium wine. By the turn of the millennium, Australia's profile on the world market had grown considerably. It had become the leader of New World producers, whose exports comprise a growing, if still small, proportion of global trade (Anderson and Berger 1999). Despite the unequivocal success of Australia's wine industry in the 1990s, concerns still abound as to what will happen to the industry in the present decade. Stanford (1998) raised the question of whether growers' vineyard investments were excessive in the late 1990s.

In this chapter, I examine the rapid growth phase of the first years of the new millennium from several perspectives. First, I discuss some long-term aspects of the supply side of the Australian industry. Next, I consider whether the rapid increase in winegrape plantings in the late 1990s is rational in economic terms.

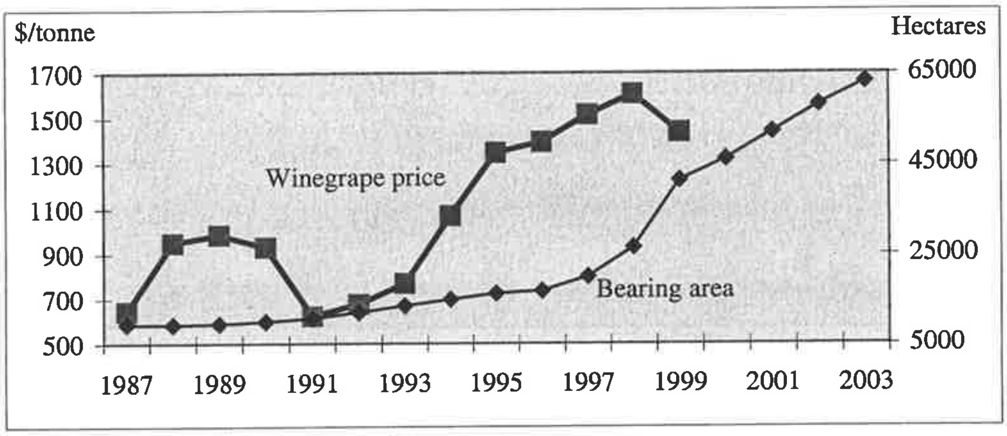
The discussion then turns to possible ways in which the industry might deal with the increased availability of wine, and other factors that may influence the pattern of sales.

5.2 Long-standing strengths of the Australian wine industry

Market-driven export growth is relatively new to the Australian wine industry.[1] On the other hand, many of the strengths underpinning the industry in its present phase have been developed over a number of decades. The long-standing research and training effort has played a big part in the Australian industry's pursuit of excellence. For example, investments in formal grape and wine research, education and training at Roseworthy Agricultural College (now part of the University of Adelaide) date back to its establishment in 1883. Its Diploma in Oenology course commenced in 1934. Other research agencies include the Australian Wine Research Institute established in 1955 and the Cooperative Research Centre for Viticulture. More recently, the industry has established its own Grape and Wine Research and Development Corporation. Charles Sturt University now offers formal courses in viticulture and oenology. Other universities, including the University of South Australia, are now involved in wine marketing.

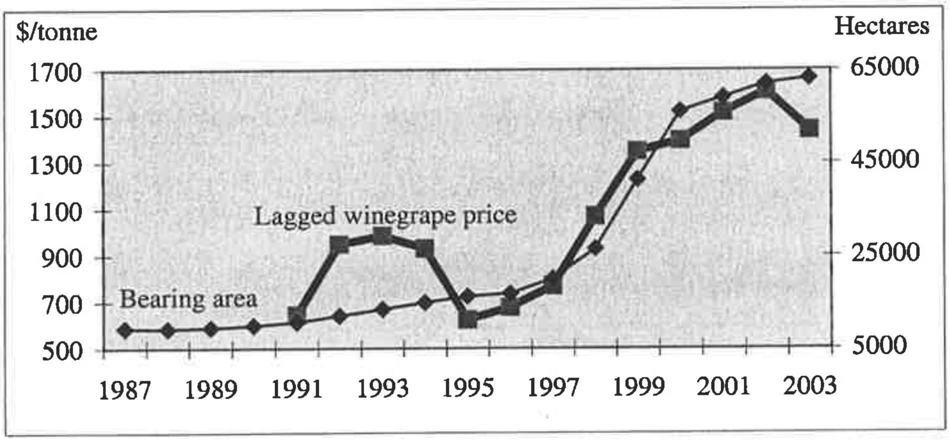
[1] Osmond and Anderson (1998) discuss the role of policy in driving previous export booms.

Figure 5.1: Red winegrape price and bearing area, Australia, 1987 to 2003.



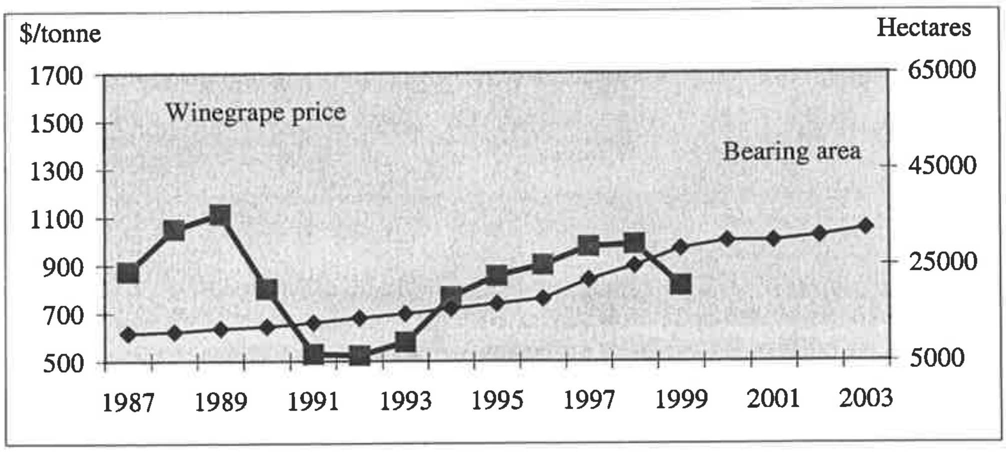
Sources: ABS (1999); Australian Wine and Brandy Corporation, unpublished data; PISA (1997).

Figure 5.2: Lagged red winegrape price and bearing area, Australia.



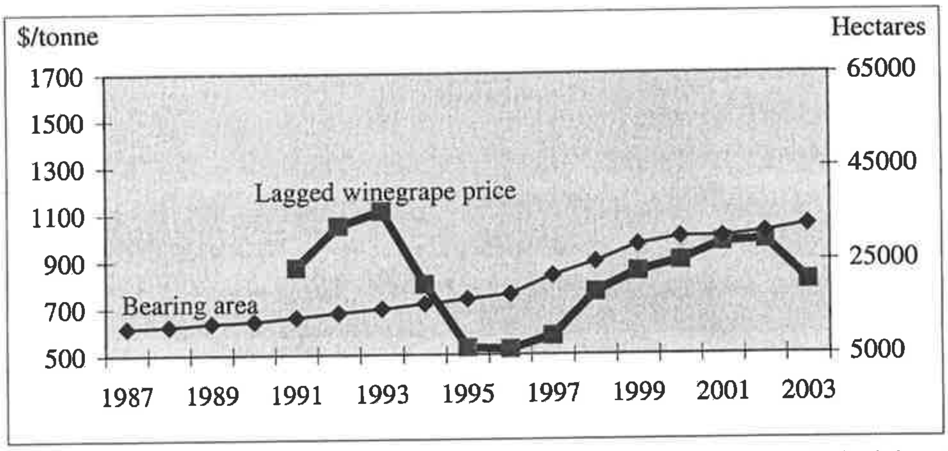
Sources: ABS (1999); Australian Wine and Brandy Corporation, unpublished data; PISA (1997).

Figure 5.3: White winegrape price and bearing area, Australia, 1987 to 2003.



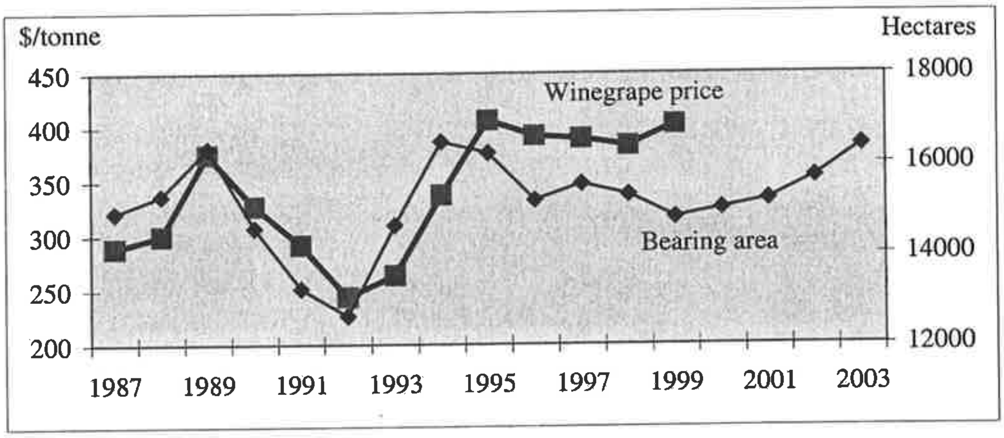
Sources: ABS (1999); Australian Wine and Brandy Corporation, unpublished data; PISA (1997).

Figure 5.4: Lagged white winegrape price and bearing area, Australia.



Sources: ABS (1999); Australian Wine and Brandy Corporation, unpublished data; PISA (1997).

Figure 5.5 Non-premium winegrape price and bearing area, Australia, 1987 to 2003.



Sources: ABS (1999); Australian Wine and Brandy Corporation, unpublished data; PISA (1997).

The industry is a world leader in terms of research output. Rankine (1996) claims that despite Australia supplying less than 2 per cent of the world's wine until very recently, it has contributed 20 per cent of the global flow of research papers on viticulture and oenology. The industry has remained at the global frontier of wine research and technology through its long history of applied research and associated tertiary education and training courses.

International marketing campaigns by the major corporate wineries, plus a growing number of smaller firms, and generic promotion by the Australian Wine Export Council, have become integral parts of the growing export-orientation of the industry. Australia's supply growth and leadership of New World producers appears to be no accident, but rather a consequence of the long-standing and more recently developed strengths of the domestic industry.

5.3 Have investors in vineyards in the 1990s been rational?

The dramatic increase in winegrape plantings in 1998, and again in 1999, has raised some fears that the industry is heading towards a period of oversupply. I consider the response of growers by examining data for year-by-year prices and the bearing area.

A critical issue concerns the timing of vineyard investments in response to a change in market signals. Figures 5.1, 5.3 and 5.5 plot winegrape prices against the bearing area of vineyards in Australia for each of the segments. Figures 5.2 and 5.4 plot prices lagged by four years against the bearing area for premium winegrapes. Each segment reveals a different pattern. The premium red segment started the period emerging from a time of great pessimism, in which the South Australian and Commonwealth governments introduced a short-lived vine-pull scheme to encourage disinvestment in grape growing. Except for price falls in the recessive early 1990s, premium red winegrape producers enjoyed growing prosperity throughout the past dozen years. Prices rose for seven consecutive vintages, before dropping slightly in 1999 (figure 5.1). Based on the new plantings of the late 1990s, the bearing area of premium red winegrapes will increase by over 50 per cent between 1999 and 2003 (having more than doubled between 1996 and 1999). There is a close fit between prices lagged four years and the bearing area for the 1990s, but as prices fall in the present decade, the bearing area may continue rising (figure 5.2).

Unlike for red winegrapes, growth in the bearing area of white winegrapes has been gradual, which may fit a standard theory of investment (figure 5.3). This appears to be because premium white winegrape prices neither slumped to the depths, in the mid-1980s, nor soared to the heights, in the mid- to late-1990s, of premium red winegrape prices, thereby providing a reasonable fit to a net present value rule for vineyard investments. By contrast, the change in bearing area in response to prices of non-premium winegrapes appears to contain no lag, as is evident in figure 5.5. This is because producers can switch between sales for wine inputs and table or dried grapes as relative prices change. In addition, most non-premium winegrapes are grown in irrigated warm-climate regions, where the lag between planting and commercial bearing is shorter than in dry-land, cooler climate vineyards. And the time between production and selling is usually much shorter for non-premium than premium wine, since the former spend no time on oak.

Recall some of the unusual characteristics of viticulture, with substantial fixed costs implying considerable irreversibility. Winegrape growing is extremely capital intensive, with an investment required per hectare currently of at least \$A30,000 plus the costs of land and water rights. Also, there is a lag of at least three years for dry-land viticulture before there is a positive cash flow, as discussed above. During several years of high and rising prices, as occurred in the late 1990s, growers may be able to recoup new investments quickly. After recovering those sunk costs, many growers would be able to maintain profitability in the event of a sharp fall in winegrape prices. Therefore, while a sustained boom in the wine industry has led to rapid plantings of vineyards, a substantial subsequent fall in grape prices is unlikely to lead to a rapid exit of growers from the industry. The response of grape growers is an area for further research.[2]

5.4 The scope for accelerated wine sales

There is confidence within the industry in Australia (whose share of world wide production will still be less than 5 per cent by 2003) that it will increase its volume of exports rapidly from those of the present, and thereby maintain profitability. Part of the basis for this confidence is that the demand for Australian wine globally has been growing faster than its supply. This view was reinforced at the Wine Industry Outlook Conference in Adelaide in November 1999 by, among others, Bruce Kemp, the recently retired CEO of Southcorp Wines, one of Australia's leading exporters of wine. It is possible that export prices have been kept below market-clearing levels in order to build and maintain

[2] A formal framework for examining the investment decision of winegrape growers in the 1990s is the real options theory elaborated by Dixit & Pindyck (1994).

consumer loyalty. This may reduce the chance of such consumers substituting to wine from other New World destinations as supplies increase and prices fall. In any event, if a shortage has prevailed until now, there is considerable scope to expand exports without a dramatic impact on producer prices.

From the perspective of wineries, falling winegrapes prices are not bad news, as they provide a means of cutting input costs. Bottled wine at the lower end of the premium spectrum continues to account for most export sales. Such wines originate largely from winegrapes grown in irrigated regions. Lower winegrape prices increase the competitiveness of Australian wine production, and reduce the degree of substitution of grapes from offshore vineyards for Australian-sourced grapes. And falling prices for irrigated winegrapes need not imply unsustainable losses for grape-growers, assuming that growers have recovered part of the fixed costs of their investments during several years of high prices.

A relatively high rate of investment in new vineyards may continue for several years, particularly in super-premium dry-land areas where prices remain high (PGIBSA 2000). The rate of investment will slow with falling prices, but such falls are not inevitable in all regions, given that wineries may continue to pay premiums for quality. Nevertheless, if growers are to preserve price premiums, they may need to respond to the demands of wineries for increasing quality over time, which may entail additional production costs.

5.5 Factors contributing to further sales growth

In the 12 months ending March 2000, the volume of exports of Australian wine reached 268 Ml (AWEC 2000). This was a twelve-fold increase over the volume of 13 years beforehand. For premium red wine, growth has been even larger, increasing almost 25-fold in this period — and with rising prices in real terms. Even within the industry, such spectacular export growth may have been inconceivable a decade or so ago, although the Winemakers' Federation of Australia (WFA) (1995) drafted a vision of export-led growth in the mid-1990s. It is possible that the industry took the WFA's vision seriously (or that the price signals in the following years were stronger than WFA dared anticipate), and strove for export growth with greater confidence than otherwise.

Analysts have persistently underestimated the potential for export-led growth in the wine industry. For example:

> The capacity of the Australian winegrape and wine industry to capitalise on export opportunities will depend on its capacity to improve its competitiveness ... and attract the capital required to expand vineyards and winemaking capacity. If competitiveness is not improved, export market opportunities will be seized by traditional wine exporting nations (eg France and Italy) and emerging exporters such as Chile, South Africa and some East European nations.
>
> (Industry Commission 1995, p. 7)

The above statement gives too little weight to the long-standing strengths of the Australian industry. It also fails to consider the distortions under the Common Agricultural Policy that have masked wine producers from changing market conditions in Western Europe, and the appellation controls that limit the ability of EU producers to innovate. The long-standing absence of market mechanisms in Eastern Europe also inhibits responsiveness there. And the investment of the late 1990s has already demonstrated the ability of the industry to attract capital.

The foundation of export growth until now has been an emphasis on providing budget-priced, reliable premium wines. Higher-priced super- and ultra-premium Australian wines are also becoming increasingly available in overseas markets, although they comprise a relatively small proportion of total export volumes. With the ongoing efforts of the Australian industry to maintain and increase its international competitiveness, it may well be within the capability of the industry to double its exports in the four years from 1999 to 2003 without a crash in producer prices (see table 3.6). As already discussed, a fall in prices, particularly in permanently irrigated, warm climate regions, as has already started to happen in the 2000 vintage, need not have an adverse effect on profitability. Many growers may already have recovered a substantial proportion of sunk costs before the fall.

Turning to specific means of managing the accelerating premium winegrape supply, I consider each of the following influences on sales over the next few years:

- further increases in export demand;
- a real depreciation of the Australian dollar;
- a reduction in domestic consumer taxes on wine;
- large increases in wine stocks until export markets mature; and
- increased production of non-premium wine from premium grapes.

Further increases in export demand

In the vintages of 1999 and 2000, the first signs emerged that winegrape prices were starting to plateau or even fall, particularly for the produce of irrigated regions. At the same time, there is evidence of accelerating export sales. Export approvals for premium red wine increased by 38 per cent in the twelve months to December 1999, compared with the previous year. The annual increase amounted to 30 Ml. For premium white wine exports, growth was 29 per cent or 22 Ml, with much smaller changes for bulk wine exports (AWEC 2000). Unit values in Australian dollar terms changed little in this time. This is consistent with a belief within the industry that the major problem with Australian exports in the late 1990s was an acute shortage of wine for export. Rapid supply growth is the obvious means of redressing this. With growing supply, prices are falling for irrigated winegrapes, but there is little evidence so far that prices have fallen sharply enough to erode profits or even halt investment (PGIBSA 2000).

In the long term, the largest contribution to absorbing domestic supply is going to come from exports. In FEDSA-WINE, exports are treated as being sold to a single market whereas in reality, overseas' markets are segmented. For example, Australia already has a substantial share of the UK market, growing from 2 per cent in the late 1980s to 13 per cent in 1999 (Berger et al. 1999; AWEC 2000). This combined with rising per capita consumption in the UK makes it the largest single export market for Australian wine at present. Assuming that UK per capita consumption is close to a plateau, further export expansion in this market will rely on further increasing Australia's market share. Alternatively, UK merchants may re-export some Australian wine to Europe, a practice that occurs already for wine from other sources, and to small degree for Australian wine. In volumetric terms, Australia's exports to the UK grew by approximately 10 Ml per annum for most of the 1990s. Yet between the calendar years of 1998 and 1999, Australia's exports to the UK grew by over 30 Ml, due to growing availability (AWEC 2000).

The only other market where Australian wines presently account for a significant proportion of wine consumption is New Zealand (over 50 per cent). By contrast, in the second largest export market, the USA, Australia's share of domestic consumption is only 2 per cent (Berger et al. 1999; AWEC 2000). Consequently, the growing availability of Australian wine on the world market alone is unlikely to result in sharply decreasing prices. The increasing availability of other New World wines poses a potential threat to Australian producers. However, Australian may retain or increase its market share through continuing product differentiation along national or brand lines, thereby reducing the degree of price competition from rivals.

Germany is the largest importer of wine in the world, with Australian wine accounting for only 0.5 per cent of total imports (Berger et al. 1999). The reason Australia has until now exported little wine to Germany, despite it being the world's biggest red wine importer, is due to insufficient premium red wine being available for export. At present, Germany buys mostly from France and Italy. But since its imports are twelve times Australia's current premium red wine export volume, there is potential for that market alone to absorb all of Australia's expected output increase without significantly reducing German imports from other EU countries or Australian producers' prices. The agreement with the European Union to phase out European names for wine types, together with a marketing campaign should assist Australia in expanding exports to Germany.

The Japanese market, despite its potential size, may require a long-term sales strategy from the Australian industry, beyond the first decade of the new millennium. The Japanese market arguably is the only one in the world outside Europe where Old World exporters have outperformed Australia over the past decade (Berger et al. 1999). Indeed, Japan is the only non-European market of any size in which Australian exports are not growing. Possibly, Australia's reputation was tarnished through exports of non-premium quality wine early in the period of export expansion, in a market where quality and reputation are paramount.

The growing supply of premium winegrapes in the new millennium presents the Australian industry with an opportunity to expand exports in the premium segment of the market, and to enhance its already formidable reputation for value-for-money wines. Increased availability of premium inputs is an advantage, not a disadvantage, in a global market in which consumers are substituting quality for quantity. The rate of expanding supply may entail some transient growing pains for some firms within the industry, but it would appear that there is ample scope for increased sales in existing established export markets.

The future of the small ultra-premium segment of the Australian wine market differs from that of the rest of the industry. As information about ultra-premium wines spreads globally through sources such as *Wine Spectator*, interest in Australian wines will grow. The Barossa Valley contains a number of wineries that for years have produced wines that, on a quality basis, are nowhere near world parity prices. This is evident when wines receive a high rating in *Wine Spectator*: a number of Barossa wineries ration such wines, but growing global interest inevitably places upward pressure on prices. The Barossa and Clare Valley regions are unique, containing small holdings of some of the oldest vineyards in the world. South Australian has never suffered an outbreak of phylloxera, so that no massive grubbings of vineyards have occurred in response to the disease. Wine consumers increasingly are appreciating the value of such treasures, in a way that was not apparent in the 1970s when the Senate Standing Committee (1977) equated rising productivity with mass production from low quality grapes, or in the mid-1980s when the Commonwealth and South Australian governments introduced a vine-pull scheme.

Elsewhere, super- and ultra-premium wines are being produced in Australia in growing quantities as individual grape-growers and winemakers pursue excellence. Some small wineries may be reluctant to pay the fixed costs associated with marketing, both within Australia and overseas. This may limit the prices they can set for their produce, as the market they face (i.e., cellar door) is much smaller than otherwise. But information on small wineries is becoming more accessible globally through the internet and wine magazines. This should encourage all wineries in Australia to maximise the quality of their produce and broaden their market base.

A real depreciation of 10 per cent

In the wake of the Asian crisis in the late 1990s, the Australian dollar depreciated in real terms against other major currencies. In the first five months of 2000, against the US dollar, the domestic currency devalued by more than 10 per cent (although less so on a wine trade-weighted basis). Sustained changes in the real exchange rate could alter projected outcomes, particularly for export-oriented industries including premium red and white wine. Relative to the 2003 base of chapter 3, a real devaluation of 10 per cent raises wine output by only 6 Ml and increases exports by 14 Ml, with a decrease in domestic consumption (column 2, table 5.1). Multipurpose grapes are diverted from winemaking to direct exports, explaining the small output reduction for non-premium wine. During the present phase of rapid expansion, any real depreciation will favour export growth slightly, with a converse effect from any rapid recovery of the real exchange rate to pre-Asian crisis levels.

Winegrape prices fall slightly relative to CPI, as the costs of production have fallen slightly. This is because the primary factor costs fall in all industries relative to CPI, driven by a decline in the price of labour (i.e., a non-traded input). Producer prices for wine, on the other hand, increase due to the rising prices of imported inputs used in production. For consumers, the price change is ambiguous, as is evident using the new GEMPACK software AnalyseGE to evaluate equation E_p3r from appendix A (Pearson, Hertel and Horridge 2000). Domestic consumer prices fall slightly, while imports rise. For premium white and non-premium wines, the import weight dominates the outcome, so that consumer prices rise. The domestic weights dominate for premium red wine so that consumer prices fall. Why does the domestic consumer price fall when the producer price for wine rises? Equation E_p3r defines the percentage change in the consumer price by source as a function of weighted percentage changes in producer prices, taxes and margins. Since producer prices rise and taxes do not change, there must be a decline in the price of margins. This is so. Retail markups (part of the 'trade' margins commodity) and on-premise markups (part of the 'hotels' margins commodity) each account for significant proportions of the retail price of wine. These are relatively non-traded commodities, so by the definition of a real exchange depreciation, their prices decline relative to traded commodities in the scenario.

Table 5.1: Projections to 2003 under different assumptions

	1999[a]	Base 2003[b] (1)	mid-point % change '99-'03	2003[c] (2)	(2) – (1)	2003[d] (3)	(3) – (1)
Domestic consumption (Ml)							
Red premium wine	62.5	90.9	37.1	87.1	-3.8	108.3	17.4
White premium wine	69.9	87.2	22.1	84.6	-2.6	97.8	10.6
Non-premium wine	240.7	237.6	-1.3	234.5	-3.1	252.3	14.7
Wine, total	**372.6**	**415.7**	10.8	**406.2**	**-9.5**	**458.3**	42.6
Production (Ml)							
Red premium wine	270.5	576.1	72.2	580.7	4.6	614.7	38.6
White premium wine	242.1	377.6	43.7	382.5	4.9	392.3	14.7
Non-premium wine	339.6	355.1	4.5	351.9	-3.2	425.4	20.3
Wine, total	**852.2**	**1308.8**	42.3	**1315.1**	**6.3**	**1,432.4**	73.6
Wine exports (Ml)							
Red premium wine	87.8	247.0	95.1	256.6	9.6	243.5	-3.5
White premium wine	82.6	145.5	55.1	149.9	4.4	143.8	-1.7
Non-premium wine	45.7	73.8	47.0	73.9	0.1	74.8	1.0
Wine, total	**215.5**	**466.2**	73.6	**480.4**	**14.2**	**462.1**	-4.1
Wine imports (Ml)							
Red premium wine	4.2	8.1	63.2	6.6	-1.5	11.6	3.5
White premium wine	4.3	6.9	46.9	5.9	-1.0	8.6	1.7
Non-premium wine	15.8	11.3	-33.4	9.5	-1.8	13.2	1.9
Wine, total	**24.3**	**26.3**	**7.9**	**22.0**	**-4.3**	**33.4**	7.1
Winegrape prices ($/tonne)							
Red premium grapes	1,437	1,263	-12.9	1244	-19	1,215	-48
White premium grapes	813	827	1.7	815	-12	796	-31
Non-premium grapes	402	389	-3.3	388	-1	372	-17
Wine stocks (Ml)							
Red premium wine	580	1,250	78.5	1,247	-3	1,278	28
White premium wine	350	600	22.2	602	2	608	8
Non-premium wine	160	140	-13.3	396	-2	404	6

Sources and notes for table 5.1:

a From table 3.2.
b FEDSA-WINE projections, no tax changes.
c 2003 projections with a real depreciation of 10 per cent relative to the base case.
d 2003 projections with no WET under the GST.

Removing the top-up tax on wine under the GST

Is it possible that lobbying by the wine industry will result in the top-up tax (or WET) on wine being removed from the GST package? In chapter 4, I argue that this is one possible extreme among taxation options for the industry. What would be the impact of introducing the GST package (not part of the base assumptions of column 2 in table 5.1) without a top-up tax on wine? In the scenario, I assume that the removal of the tax is permanent, and that industry capital stocks adjust to restore rates of return to pre-shock levels. Domestic consumption increases by 43 Ml and exports decrease by 4 Ml relative to the base case, in the long run (column 6, table 5.1). The lower costs of production arising from the GST, as discussed in chapter 4, combine with reduced wine taxes to lower consumer prices by around 14 per cent relative to CPI.[3] Domestic sales in addition to those of the base case, net of imports, absorb 7 per cent of the projected output increase between 1999 and 2003. This indicates that, despite the growing export orientation of the industry, changes in domestic wine taxes may still have a marked effect on industry sales and output.

For wineries with a smaller-than-average proportion of exports in total sales, the benefit of removing the top-up tax would be larger than the industry average. In particular, some smaller wineries continue to rely exclusively on domestic sales. They therefore may gain sufficiently to justify lobbying for removal of the WET. In the historical modelling in chapter 3, the long-run incidence of the tax was mainly on consumers, yet the assumption of lobbying for lower taxes is that producers also benefit. However, the sunk costs of investing in

[3] The price effect is much larger than the expenditure effect for each wine type.

vineyards imply that in the event of a shock, there is a degree of irreversibility in rcsource allocation. In addition, FEDSA-WINE assumes constant returns to scale, so scale effects arising from higher turnovers would be among benefits to firms not captured within this framework. For these reasons, FEDSA-WINE may underestimate the long-run impact of reduced consumer taxes on the industry.

Increased production of bulk wine from premium grapes

There is a small amount of evidence in export data of differentiation in the bulk end of the market. Australian exports of non-bottled wine to the UK, for example, had a unit value 75 per cent higher than those to New Zealand in 1999 (AWEC, 2000). This might indicate that virtually all bulk exports across the Tasman are of cask-quality wine, belonging unambiguously in the non-premium category, whereas those to the UK include some 'commercial' wine.

There are several reasons why, at least in the next few years, wineries may choose to process more premium winegrapes into bulk wine. The first is increased premium winegrape supply. In response to domestic shortages in the mid- to late-1990s, Australia spasmodically imported significant quantities of bulk wine from elsewhere, rather than increase multipurpose grape usage in winemaking (ABS 1999). The second is that exports of bulk wine may bypass domestic bottling costs, which are high by world standards (Industry Commission 1995, p. 194). This has been happening increasingly since the late 1990s, with bulk wine sold to the UK and France. Some of it, after bottling, is re-exported. The third reason concerns marketing issues. Australia's reputation in international wine markets grew in stature in the 1990s. The major Australian wine corporations may have established brand names in the major markets, namely the UK, the

USA, New Zealand and possibly Canada. But Australian wines are now regarded highly enough for generic sales to be profitable for both wineries and retailers. With increased availability, more bulk commercial wine may be bottled as own-brand products by supermarkets, as a budget-priced Australian wine. In the short- to medium-term, some Australian wineries may prefer to sell at least some wine to UK merchants in bulk for re-export, rather than attempt to establish brand names in new markets. In this way, sales of Australian wine in markets such as Germany will increase more rapidly than is evident from Australia's export data. And the UK market will not reach a 'saturation' point for Australian wine as quickly as such data might imply once re-exports are considered.

The above is an example of how the Australian industry might extend its effective marketing capacity. The processing and storage capacity of the premium industry may also be of concern in the immediate future. The processing capacity of wineries has expanded in an attempt to match increased vineyard plantings. In addition, a growing number of institutions are providing courses in various disciplines within the industry, thereby ensuring that human capacity, in terms of viticultural, winemaking and marketing skills, is also growing.

At present, 20 per cent of Australian wine is produced from multipurpose grapes. Among such grapes, sultana dominates. With increasing premium winegrape supply, multipurpose grape usage in non-premium winemaking may decline. Domestic and export sales of Australian non-premium white wine totalled 143 Ml in 1999, compared with 60 Ml for non-premium red wine (ABS, 1999; AWEC, 2000). But most of the growth in supply will be in premium red winegrapes. Sultana is used mostly in non-premium white wines, with limited usage in cheap red wines. The main resistance to increased usage of premium varieties of grapes in non-premium production in the future will arise from the price of such grapes: if wineries can purchase irrigated premium winegrapes for similar prices as multipurpose grapes, such resistance will fade. Overall, growing premium winegrape availability, together with changing technology, should help raise the quality of wine in all tiers of the market, including the bottom end.

Increased stockholding

The stocks held in wineries typically exceed one year's output. In the case of premium red wine, I have projected an increase in stocks from an estimated 482 Ml in 1999 to 1,250 Ml in 2003, or in terms of the stocks to production ratio, from 1.7 to 2.2. As export volumes grow in subsequent years, this ratio may decline. An alternative possibility is that as output growth slows, wineries will devote resources to raising more wine to super- and ultra-premium quality. This would entail increased oak maturing (rather than using oak chips, as in wines in the commercial end of the market), and a prolonged interval between the vintage of a wine and its release. For ultra-premium wines, this is typically two years or more, although changing technologies have reduced this interval.

To stylise how the stocks to production ratio could alter over time, consider changes in terms of four effects. The first is the supply growth effect: as supply grows, the ratio rises for a time. Second, sales growth will have the effect of lowering the ratio. Wineries striving to raise quality through oak storage and delays before release for red wines, in particular, will increase the ratio through the third, quality effect. And fourth, the technology effect will decrease the time needed before commercial release, thereby lowering the ratio.

In terms of these effects, a build-up of stocks during the present growth phase need not necessarily indicate that prices must eventually fall through eventual release of stocks. The additional costs of prolonged stockholding may be outweighed by quality gains. On the other hand, wineries may be anxious not to have lower quality commercial wines in stock for prolonged periods, if at all.

5.6 Summary

The increasing proportion of Australian wine made from premium winegrapes in the first few years of the new millennium will enhance the average quality of output, assuming that other factors of premium production (i.e., winemaking skills) are not in short supply. Changing technologies will continue to lower inputs per unit of output for a given quality of wine. Should the growth rate of plantings in the industry slow, as is anticipated (although present prices may encourage further dry-land plantings at least), the industry may enter a phase in which the proportion of super- or ultra-premium wines in total production and exports increases. This will further enhance the international status of the Australian industry. Indeed, such a phase might be the appropriate time to consider serious attempts to increase its share of the East Asian market, by competing with exporters from Western Europe who already have a significant presence in the market.

If we were considering a commodity with little product differentiation, Australia's supply growth would be of concern in a global market in which wine consumption per capita is generally declining. But there appears to be a consistent pattern in consumption and trade data: while consumption declines, the unit value of internationally traded wine is rising (Anderson and Berger 1999). This indicates that consumers worldwide are substituting quality for quantity. Australia has led the New World producers in responding to the changing demands of consumers.

Australian wine companies have demonstrated confidence in the future of the industry. Not only have they increased their formidable domestic production capacity, but have also invested overseas, in order to utilise new technologies developed in Australia. In addition, Australian viticulturalists and winemakers are exporting their services as consultants. This is accelerating the rate of technology transfer from Australia, which is a leader in wine R&D investments. In the Old World, Australia is also involved in wine ventures, notably in the south of France and Sicily. One way of interpreting these off-shore ventures is that it will reduce Australia's prominence among New World exporters, while assisting the Old World re-establish its market pre-eminence. On the other hand, the globalisation of the Australian industry could assist in increasing sales in existing markets and making inroads into continental Europe in particular, where, until now, exports have been small.[4] In addition, flying winemakers bring new ideas and new winegrape varieties to Australia (Williams 1995).

Further increases in export demand will be the most important factor in increasing sales of Australian wine as supply increases during the present decade. Further sales appear possible in the UK market where Australian wine's share of national consumption is growing. In Canada and the US, Australia wine's share of consumption remains small, providing scope for further growth. And Australia's share of the German market remains very small. A sustained real depreciation of the Australian dollar would assist exporters in retaining price competitiveness.

[4] In the year ending March 2000, exports to continental Europe totalled 36 Ml out of total exports of 268 Ml (AWEC 2000).

Removal of the top-up tax on wine would accelerate domestic sales during a time of rapid supply growth.

The wine industry has been an outstanding performer among agribusinesses since the late 1980s, measured in terms of export growth and its focus on quality. It has converted research input into quality and productivity gains. It has achieved its success with limited help from any tier of government. Consequently, it is an example for other industries (Anderson 2000b). The most reasonable conclusion, in analysing the impending growth of the Australian industry, is that this is a supply response that global markets have clearly signalled. The industry is quite different from that of the mid-1980s, as growth at that time had largely been in cask wine production to cater for a growing number of people new to wine. At that stage, only fragments of the industry were in reasonable shape to commence exporting. Since then, the industry has evolved, emphasising premium production, negotiating bilateral agreements to assist trade, and marketing successfully, to the point where export sales are now accelerating.

Chapter 6

Summary and areas for further research

6.1 A summary of findings and lessons learnt

Findings

The main contribution of the present study has been to analyse (a) the sources of growth in the wine industry since the late 1980s and (b) the GST reform package of 1 July 2000. For both analyses, it was important to disaggregate this heterogeneous industry into three parts: premium red, premium white and non-premium. Many of the changes in the industry over the past 15 years are masked if wine is treated as a single entity.

The justification given in this study for using a CGE rather than partial equilibrium approach to model tax options under the GST package for a small industry is that indirect effects critically affect the outcome. These include the impact of the GST package on the price of other goods (i.e., CPI), as the price movement of wine relative to other goods has an impact on the domestic demand for wine. Indirect effects also influence the impact of the package on the industry's costs of production and on its international competitiveness.

Unlike earlier CGE studies of wine taxes, this one was undertaken during a time of extremely rapid growth in the industry. Therefore, it was necessary to update the 1996 database to a period after the introduction of the GST, to take account of expected changes in the composition of production and sales. In seeking to project the industry's future, it is helpful to analyse first the sources of past growth. The latest growth phase commenced in the late 1980s. Expanding export growth explains a significant proportion of output growth and, for the premium red segment, most of the observed price increase in the period from 1987 to 1999. Changing domestic preferences are also important in output growth of premium red wine, while a preference swing against non-premium wine has a negative effect on that segment's output. Increased consumer taxes have had a negative effect on all segments. Productivity gains in the period may have more than offset losses borne by producers from the hike in taxes, but may have only partly compensated domestic consumers for rising taxes. Australia's general economic growth boosted wine industry growth, mainly through demand rising as part of the aggregate household expenditure effect.

In projecting forward to 2003, the CGE model results suggest the Coalition government's GST package will have a positive but relatively small effect on the industry. It is relatively small for two reasons. First, the opportunity to create efficiency gains in the industry from tax reform has been whittled away to some extent by raising wine taxes further. The second reason is that the industry is growing rapidly, and that dominates the effect of tax changes By far the greatest challenge facing the industry is to deal with the rapid increase in premium red grape and wine supply in the first few years of the new millennium.

If we were considering a commodity with little product differentiation, Australia's supply growth would be of concern in a global market in which wine consumption per capita is generally declining. But consumers worldwide are substituting quality for quantity. All of Australia's wine industry growth is in the premium end of the market. Further increases in export demand will be the most important factor in increasing sales of Australian wine as supply increases during the present decade.

The wine industry has been an outstanding performer among Australian agribusinesses since the late 1980s. It has converted research input into quality and productivity gains. It has achieved its success with limited help from any tier of government. Consequently, it is a shining example for other industries. The impending accelerated growth of the Australian industry is a supply response that global markets have clearly signalled. The industry has evolved since the mid-1980s by building on long-established strengths, plus emphasising premium production, negotiating bilateral agreements to assist trade, and marketing successfully. That has allowed export unit values to keep rising despite export volumes accelerating.

Lessons

Several lessons for other analysts arise from this CGE-based study. One is the importance and usefulness of appropriate regional disaggregation in modelling. Previously, CIE (1995b) had modelled various wine tax scenarios with 17 grape-growing regions in their CGE model of Australia. Such detail possibly obscures the main differences between different groups of regions, and presents difficulties in matching winegrape inputs to wine types.

On the other hand, the disproportionate size of the wine industry in South Australia makes it an ideal candidate for analysis within a national CGE model with two regions, South Australia and the rest of Australia. In the decomposition simulation (chapter 3), this provides an estimate of the impact of wine industry growth on South Australia's economy. The booming wine industry viewed in isolation is income increasing for South Australia, but income decreasing for the rest of Australia, a conclusion arising from a bottom-up approach that would not be apparent with top-down regional modelling. The GST package applicable from 1 July 2000, despite increasing the rate of taxation of domestic wine consumption, is output expanding for the wine industry due to the reduction in production costs (plus the rise in prices of other consumer goods and services). Due to the relatively high weighting of the industry in South Australia's production base (together with expanding motor vehicles output), this means the region gains slightly more from the GST package than the rest of Australia in the FEDSA-WINE simulations.

An important lesson from disaggregation is that for most industry-specific studies, the 107 sector input-output tables published by ABS are still too aggregated to capture some of the salient characteristics of a particular industry. Therefore, for specific industry studies, modellers need to put effort into further disaggregation, as the default database is usually inadequately detailed. This insight is not new, as noted by Dixon and Parmenter (1994, p. 89).[1]

Unpublished ABS input-output data entailing disaggregation of the wine

[1] The authors write: 'The availability of programs such as GAMS or GEMPACK mean that computational difficulties are not currently a binding constraint in CGE modelling on either disaggregation or on the use of industry-specific specifications. What is now required for the creation of practical, decision-oriented CGE models is a willingness by model builders to increase the amount of information incorporated in their models. To do this, they will need to work closely with their national statistical agencies. They will also need to work in teams rather than as individuals. Research teams will be necessary to handle the work loads involved in implementing highly disaggregated CGE models containing thoughtful theoretical specifications for each industry.'

industry, unfortunately, were not helpful in the present study, as disaggregation was not between premium and non-premium segments. However, sufficient data were available from other sources (i.e., ABS 2000b; AWBC unpublished data; AWEC 2000; PISA 1997).[2]

One decision I wish I had made earlier in the study was to modernise the TABLO code of the model by switching from share to level terms in equations of the model. The multi-regional model MMRF with the modernised code has been available since the mid-1990s (Naqvi and Peter 1995).[3] As in MMRF, I also aggregated sources for each type of transaction in the database into one matrix. Each of these changes to the original version of FEDSA-WINE has made it simpler to follow the theory of the model and change the database. Horridge et al. (1993) with ORANI-F, and again in 1998 with ORANI-G (on which both MMRF and now FEDSA-WINE are based), clearly had objectives of this nature in mind in presentation; now other practitioners do not have to reinvent the wheel in using and adapting a CGE model. The practice of naming each equation after the variable it solves, originally used in ORANI-F, provides a further advantage to users of TABMATE (used to write and check TABLO code and generate the associated fortran code), as this software now generates a closure, or list of exogenous and endogenous variables, automatically.[4] Modernising the TABLO

2 I chose a 29 sector aggregation to utilise annual national accounts data in compiling the 1996 database. In retrospect, I should have kept several manufacturing industries as disaggregated as in the published ABS input-output tables. By not having wood, paper and glass products in separate industries, I may have missed salient differences between premium and non-premium wines in the real depreciation scenario of chapter 5, section 5. Premium wines, for example, would suffer cost increases from imported oak usage following a real depreciation that would not apply to non-premium wine.

3 Naming conventions for variables and levels coefficients also make CGE models easier to use.

4 Dr Mark Horridge, joint author of the documentation of ORANI-F and ORANI-G, wrote TABMATE and other programs that make life easier for GEMPACK users. Appendices B and C are examples of the output generated by TABMATE.

code of a GEMPACK-based CGE allows the practitioners to make better use of upgraded software — and compare models variants with greater ease.

Commentators frequently assert that the results of CGE modelling are highly dependent on parameter choice. The use of systematic sensitivity analysis (SSA), as in chapter 4, checks the extent to which parameter choice influences modelled outcomes. However, CGE modellers should not allow this to provide a false sense of security, as other factors may have an even greater influence on outcomes. One factor is the functional form: by altering the household demand equations in chapter 4, section 3, to allow specific substitutability between wine types, the differential impacts of introducing a volumetric tax on wine on the various segments of the industry are magnified. Another consideration is that of the database used for comparative static simulations. I projected the database to 2003, instead of relying on data from the mid-1990s, as the higher proportion of exports in sales by 2003 has some influence on outcomes. The nature of supply responsiveness assumed may also bear critically on modelled outcomes.

6.2 Areas for further research

The supply response

As discussed in chapter 5, viticulture differs from other cropping. It is extremely capital intensive. There are high initial sunk costs and a delay of several years before full yields are realised, although new technologies are reducing the lag period. Moreover, vineyards have exceptional longevity (potentially more than a hundred years). This implies that the supply response of the industry is asymmetric. Sustained rising prices in the mid- to late-1990s resulted in a rapid increase in red winegrape plantings. Yet falls of a similar magnitude and duration, relative to other crops, would not lead to a similar exit. Rather, given the high initial sunk costs, growers would continue to produce winegrapes if marginal returns exceeded those of alternative crops. The cost structure of alternative crops would need to include the fixed costs of switching in addition to marginal costs, whereas only marginal costs would apply to staying with winegrapes. The cost structure of the industry and its implications for supply responsiveness provide a potential area for further research. Winegrapes are a candidate for specific theoretical specifications in the production equations of a CGE model.

FEDSA-WINE contains only a static treatment of investment and capital accumulation. Some CGE models contain dynamics, including the MONASH model. Would it have been worthwhile including equations to add dynamic behaviour to FEDSA-WINE? The MONASH modelling, for example (Dixon and Rimmer 1999), tells a somewhat different story about the effects of the GST than that in a static setting, as in chapter 4. In particular, there are doubts about whether there will be any positive aggregate expenditure gain arising in the long run from the GST package (even more so after factoring in compliance costs). The inclusion of dynamics would thus provide further insights into the effects on the industry. That would of course involve additional costs, in terms of data requirements and model development. Further, the underlying theory of investment would need to reflect the special characteristics of vineyard investments. To this end, Dixit and Pindyck (1994) have devised a model of investment, based on financial options theory, stressing the irreversibility of most investment decisions and the uncertainty of returns. This model may characterise the grape-grower response in the 1990s, particularly for red winegrapes, more appropriately than models based on orthodox theory. Red winegrape prices did not start rising until the 1992 vintage, after which they rose for seven successive vintages. The Dixit-Pindyck approach could apply to some other crops (at a more disaggregated level than is available in Australia's published input-output tables), notably olives and various tree crops.[5]

Further disaggregation

Until the late 1980s, there was little in the wine market to indicate that disaggregation would become important. The Senate Standing Committee (1977) recognised that a histamine scare had caused a preference swing against red wine. But the key issue as discussed in George (1974), Tsolakis (1983) and Meagher et al. (1985) was the effects of introducing a consumer tax on wine, which until 1984 had incurred state franchise taxes, but no Commonwealth tax. These earlier studies stressed the possible importance of substitutability with non-wine beverages. For example, Meagher et al. dealt with substitutability between different non-wine beverages by using the Clements-Smith (1983) modification to include conditional Slutsky own-price and cross-price estimates in a sub-system of demand.

The use of three (instead of one) winegrape and corresponding wine sectors has enriched the explanation of what has happened to both supply and demand for Australian wine since the mid-1980s in this study. From the perspective of producers, at a disaggregated level, changes in consumer preferences have had a greater effect on the industry than consumption tax

[5] An application to infrastructure projects, as Emery and McKenzie (1996) have done for Canadian railway construction, is another use of the theory.

increases historically (chapter 3), although the latter have received most attention in the literature.

Rapid export growth and continuing high prices for premium winegrapes have contributed to an unprecedented supply response for red winegrapes, not matched by white and multipurpose varieties. What insights can we gain from further disaggregation? CIE (1995b) utilised quantity data for winegrapes for each of 17 regions. No corresponding price data were available. This appeared not to be an optimal level of regional disaggregation of wine segments, as stated in section 1 of this chapter, but limited further regional disaggregation in the two-region FEDSA-WINE model might be useful. Now that AWBC is compiling winegrape price data for all fifty or so wine regions of Australia, this should be sufficient to aid further meaningful disaggregation in the future.

The process of working through regional data has helped isolate some key regional characteristics. In summary, South Australia produces over half the nation's premium wine but less than a third of non-premium wine. The state's wine industry also is far more export-oriented than the rest of Australia's, although the unit value of exports by the latter is at least 20 per cent higher. And the MIA is the exception among warm-climate irrigated regions, in that it produces only premium winegrapes. These features, except the last, are included in the FEDSA-WINE database. From these features we can infer that possibly a higher proportion of South Australia's premium exports are of 'commercial' rather than 'super-premium' exports than in the rest of Australia.

There are two main reasons for further disaggregation. One is to obtain a better understanding of sales of warm-climate sourced wines, and how sensitive warm-climate regions are likely to be to tax changes. In chapter 4, I question whether warm-climate regions will suffer adversely from introducing a volumetric tax. Further data might help determine whether the MIA is a special case, given that it produces only single-purpose commercial premium winegrapes. Perhaps agonising over further disaggregation complicates the issue of potential for further growth. Growth is likely to occur in two directions. One is exports, the other is specialisation in super-premium wines in tourism-oriented regions. Grapegrowers and winemakers in all regions are adapting to one or both of these directions.

The second reason for disaggregation (and potentially the most important) is to separate the rapidly growing commercial from super-premium wines within the premium categories. At present most premium exports are of commercial rather than super-premium wines, and with the rapid supply increase, this will continue for at least another few years, with a possible gradual climb in the average quality.

Table 6.1 provides a further disaggregation of the industry using the following assumptions:

- that three fifths of bottled exports are of super-premium quality, and the remainder of commercial premium quality;
- that half of bulk wine exports to destinations other than New Zealand are of commercial premium rather than non-premium quality; and
- that one fifth of domestically-sourced bottled wine is commercial rather than super-premium quality.

Table 6.1: Further disaggregation of grape inputs, 1999

		Premium grape inputs (kt)		Non-premium grape inputs (kt)		Total
		Irrigated	Dry-land	Irrigated	Dry-land	
Wine type						
South Australia						
Red	Super-premium	23.0	143.2	0.0	0.0	166.2
	Commercial	92.8	0.0	0.0	0.0	92.8
White	Super-premium	5.0	78.0	0.0	0.0	83.0
	Commercial	55.8	1.7	0.0	3.4	60.9
Non-premium		38.4	0.0	59.4	0.0	97.8
Total		215.0	222.9	59.4	3.4	500.7
Rest of Australia						
Red	Super-premium	21.7	68.7	0.0	0.0	90.4
	Commercial	29.5	0.0	0.0	3.6	33.1
White	Super-premium	13.4	90.9	0.0	0.0	104.3
	Commercial	46.9	0.0	0.0	0.0	46.9
Non-premium		101.2	0.0	195.9	3.8	300.9
Total		212.7	159.6	195.9	7.4	575.6
Table grapes						
Red		0.0	0.0	18.3	8.3	26.6
White		0.0	0.0	82.2	9.3	91.5

Source: ABS (1999); author's assumptions.

The estimate from table 6.1 is that about one third of premium winegrapes are used in non-premium wine production.[6] The irrigated areas, namely Sunraysia, the MIA and the Murray regions, account for all these grapes by assumption. At the same time, non-premium and multipurpose grapes account for about two-thirds of grape inputs to non-premium wine production. This proportion is still high enough to indicate that producers can switch a significant proportion of production to table grapes in the event of a downturn in the non-premium wine market, as may occur with the introduction of a volumetric tax. A clear exception is the MIA, where viticulture consists almost entirely of single-purpose premium winegrapes.

[6] From column one, irrigated premium grape inputs into non-premium production are 140 kt (38.4 + 101.2 kt) out of 428 kt (215.0 + 212.7 kt) produced.

There, and in the case of individual growers in other irrigated regions specialising in premium winegrapes, producers would need to rely on further growth in exports of commercial wine to reduce losses from such a tax.

Commercial wines may be produced mainly from mechanically harvested fruit (a practice that limits the viable life of a vineyard), may be wooded with oak chips rather than being stored in more expensive oak casks, and per litre of output may receive nowhere near the amount of winemakers' time as premium wines. Nevertheless, such wines are palatable and predictable, and will continue for the time being to be the cornerstone of Australia's growing exports. Indeed, without the use of oak chips and large volume production processes, the industry would not be able to process the increasing supply of Australian winegrapes. It is such wines that have accounted for much of the movement away from non-premium wines by Australian consumers since the mid-1980s. Further, with changing technology in viticulture and winemaking, the quality of these wines is likely to move closer to that of present-day super-premium wines.

The inclusion of a commercial segment between the premium and non-premium categories would entail splitting bottled domestic sales into commercial and super-premium components. This disaggregation could prove difficult, as splitting of ABS domestic sales data would require a price division. Retail price data, as used in past studies, are not comprehensive. In addition, there would be a need to split both bottled and bulk wine exports data. At present, a significant component of bulk exports may be of commercial quality wine sold to the UK (i.e., made from commercial premium winegrapes and possibly wooded using oak chips). Shipping in bulk reduces freight and bottle costs: the monopoly operating in Australian glass manufacturing raises the bottling costs faced by Australian wineries (Industry Commission 1995, p. 194). Bulk wine of commercial quality could be the most rapidly increasing export in the next few years as supply grows.

In summary, the data are becoming available for further disaggregation into new endogenous winegrape sectors.[7] Consumption and export data compiled by ABS and AWEC disaggregate by container and type of wine (i.e., red or white). Further disaggregation in available statistics appears unlikely at this stage and would need to be based on technical criteria, for example, wooding in oak barrels rather than with chips. The industry continues to change rapidly, and perhaps an understanding of key differences between different segments of the industry is more important than a formal disaggregation within a model.

An alternative disaggregation might be to use data at the firm level to distinguish between typical 'small', 'medium' and 'large' wineries. Halliday (2000) publishes an annual survey of Australia's and New Zealand's wineries, containing the quantity of sales, although some corporate wineries do not disclose this. These 'typical' wineries could be part of a small module within FEDSA-WINE, based on exogenous differences in sales and costs of the three wine types (i.e., a top-down disaggregation). This module could deal with specific issues, such as the direct sales WET exemption.

Modelling of the international wine market

An important issue facing the Australian wine industry in the next few years concerns the pattern of international trade. In the 1990s, between 75 and 85 per cent of the value of Australia's exports were to four relatively wealthy

English-speaking destinations, the UK, the USA, New Zealand and Canada. In the year ending March 2000, Australia's exports totalled 268 Ml. These are projected to exceed 460 Ml by 2003 (table 3.6). This implies that sales to existing major destinations and other potentially large markets will increase rapidly. Major wineries within Australian frequently express their confidence in the domestic industry, stating that their problem until now has been a shortage of Australian wine on the international market. The first decade of the 21st century may present the industry with the converse task, of making sufficient sales to profit from the rapid increase in supply.

Modelling in a framework including endogenous international wine markets will provide a means of exploring growth in sales of Australian wine. Berger, Spahni and Anderson (1999) have compiled international production, consumption and bilateral trade data on the wine industry. In addition, Berger (2000) is developing a prototype 7-region global wine trade model. At present, no attempt has been made to disaggregate wine into premium and non-premium segments in international data, since countries do not report data to the UN Statistical Office at that level of detail. To disaggregate further will require sourcing data from national industry bodies.

World trade patterns reveal some interesting insights and a useful check on a priori assumptions. For example, based on the annual mid-point percentage change in exports between 1989 and 1997 in US dollars, exports in Argentina (19.3 per cent), Chile (21.1 per cent), New Zealand (18.2 per cent), South Africa (22.4 per cent) and the USA (15.8 per cent) have grown at a similar annual

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[7] AWBC established a new information advisory committee in July 2000 that will look at these and related issues.

percentage rate to those of Australia (17.5 per cent). This implies that the real depreciation of the Australian dollar in the mid-1980s had at best a partial effect on export growth, as US exports also expanded despite a real appreciation against other currencies. Heien and Sims (2000) attributed growth in US imports of Canadian wine between 1989 and 1994 to a bilateral trade agreement that commenced in 1989. Yet the value of Southern Hemisphere (including Australia) exports to Canada grew from $US14 million in 1989 to $US75 million in 1997 (a mid-point growth rate per annum of 17.1 per cent), compared with growth from $US22 million to $US68 million (12.8 per cent per annum) for US exports (Berger et al. 1999). Canada's total wine imports in this time grew from $US259 million to $US409 million (5.6 per cent per annum). Given these data, reducing regulatory barriers to trade in Canada extended beyond the bilateral agreement with the USA, and may have been only one of a number of factors explaining Canada's import growth (see Anderson 2000a).

Compilation of the data for modelling the world wine market has provided important insights not apparent from one country's trade data. Disaggregation into premium and non-premium segments may provide further insights into production and consumption over the past decade or so, and into the future. Among changes observable from available data, New World exports as a proportion of global exports have risen dramatically in the past decade. At the same time, European production has declined with cuts in government assistance. While European producers may be attempting to raise production quality, New World producers, given their export growth, have been more successful in catering for the changing tastes of consumers, who are drinking less but higher quality wine than previously (Berger et al. 1999). This might imply that European producers still operate in a relatively distorted market, and one whose appellation controls are not encouraging innovations.

Improved data and forecasts at a disaggregated level may help our understanding of export destinations in the future. We can make some guesses as to the type of wine that will sell best in existing markets. For example, New Zealand is likely in the future to buy mainly non-premium wine from Australia. On the other hand, a serious campaign to increase sales in Japan should involve the premium end of the market, given the current high unit value of imports in Japan (Berger et al. 1999). Further disaggregation of national data may reveal patterns of interest in existing trade to other destinations.

Water allocation issues

The introduction of market mechanisms to water allocation may explain part of the increase in vineyard area in irrigation regions in Australia in the late 1990s. With reforms in water allocation, producers increasingly will have to consider an array of price signals, both in allocation of inputs and choice of outputs. They will seek to allocate water at the margin to its most profitable activity. This includes the option of trading in water rights. One likely trend is that producers will use water decreasingly for pastures and increasingly in horticulture, including grape growing. Water allocation reforms in all probability have the potential for greater impacts on regional economies than a change in the tax instrument on domestic wine consumption. The issue of water allocation may be a worthwhile topic for explicit modelling within future CGE studies of the wine industry.

The current area of vineyards for all types of grapes in Australia is 122,000 hectares (ABS 1999), of which possibly little more than a half is permanently irrigated. There are over two million hectares of irrigated agriculture in Australia (Industry Commission 1995, table 8.1). Therefore, despite the record plantings of the late 1990s, vineyards only account for about three per cent of irrigated agriculture by area. Yet, in some regions, water availability may limit further vineyard development. The constraint may arise from lack of efficient water allocation rather than an absolute shortage of irrigation water. Dry-land vineyards typically require drip irrigation in the first few years as they become established. This implies that with time, producers can divert water to other purposes, including new vineyards, particularly if water rights are tradable. Hence, marketing of water reduces the possibility of regional constraints in vineyard expansion. But Crase, O'Reilly and Dollery (2000) note thin markets for permanent water entitlements arising from market failures. Impediments to optimal allocation of water will hinder the development of activities with high returns to water usage.

In the McLaren Vale area south of Adelaide, there are fears that vineyard expansion could contribute to rising salinity in underground water reserves. To what extent this affects the long-term interests of growers in the region depends on how rapidly new plantings appear. As the irrigation requirements of maturing vines decline, the pressure on rising salinity will come from new plantings utilising underground water. This may be only a temporary problem, which will wane as the rate of new plantings slows. The establishment of vineyards is subject to local government approval. It may be appropriate to enact transparent restrictions on new plantings (or the rate of new plantings) at the level of local government, given this local concern. Alternatively, such restrictions should apply only to vineyards that are irrigated, as some growers do not irrigate at any stage of the life of a vineyard.[8]

6.3 Conclusion

The outstanding record of the Australian wine industry in attaining export-led growth is itself a worthy topic for research, as demonstrated in chapters 3 and 5. The debate on industry taxation is set to continue: a highly taxed commodity already facing potential downward price pressures due to a global supply response faces increased taxation under the GST package. The industry is characterised by an unusual amount of heterogeneity, in terms of products and firm structures. This means that the outcome of policy changes could vary widely between firms and regions. But taxation policy is only one of a number of issues facing the wine industry.

Other key economic issues include the nature of the supply response, returns to R&D and water allocation. Beyond these issues, others worthy of further research include appellation and labelling regulations, wine tourism, the impact of global technology transfers, environmental impacts and marketing. Even though other agribusinesses could learn much from the success of wine, the industry has many challenges of its own ahead.

[8] Such growers tend to utilise water-conversing practices, including the use of mulch. Given the pressures on bore water usage in some regions, it is possible that growers in dry-land winegrape regions will increasingly desist from irrigation while establishing vineyards.

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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;
       (All,i,COM)(All,j,IND)(All,r,REG) MAKE(i,j,r)= p0(i,r)*q1(i,j,r);
       (change) (All,r,Reg)FRISCH(r) = FRISCH(r)*[v3_r(r) - v3lux(r)]/100.0;
```

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);

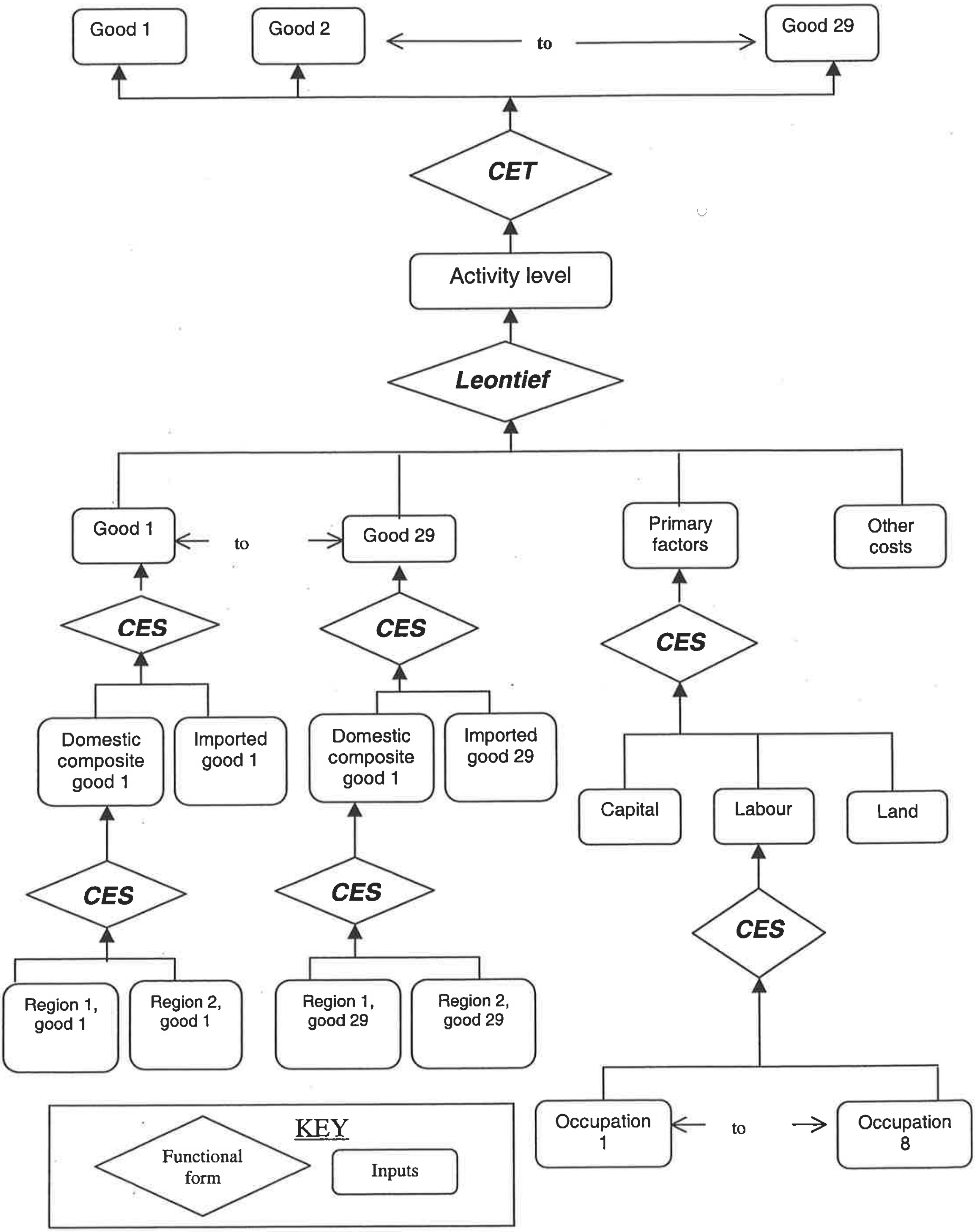
   (all,s,REG)INT_X(s) = Sum{i,Com,INTER_EXP(i,s)};
   (all,r,REG)INT_M(r) = Sum{i,Com,INTER_IMP(i,r)};
(All,r,Reg)EXP_r(r)=Sum{i,COM,{BAS4(i,r)+TAX4(i,r)+Sum{u,MAR,MAR4(i,r,u)}}};
(All,r,Reg)IMP_r(r)=Sum{i,COM,IMP_CIF(i,r)};
Formula (All,r,Reg)GDPEXP(r,"B2") = INV_r(r);
 (All,r,Reg)GDPEXP(r,"B3") = CON_r(r);
 (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:

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

We write this as:

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

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);
```

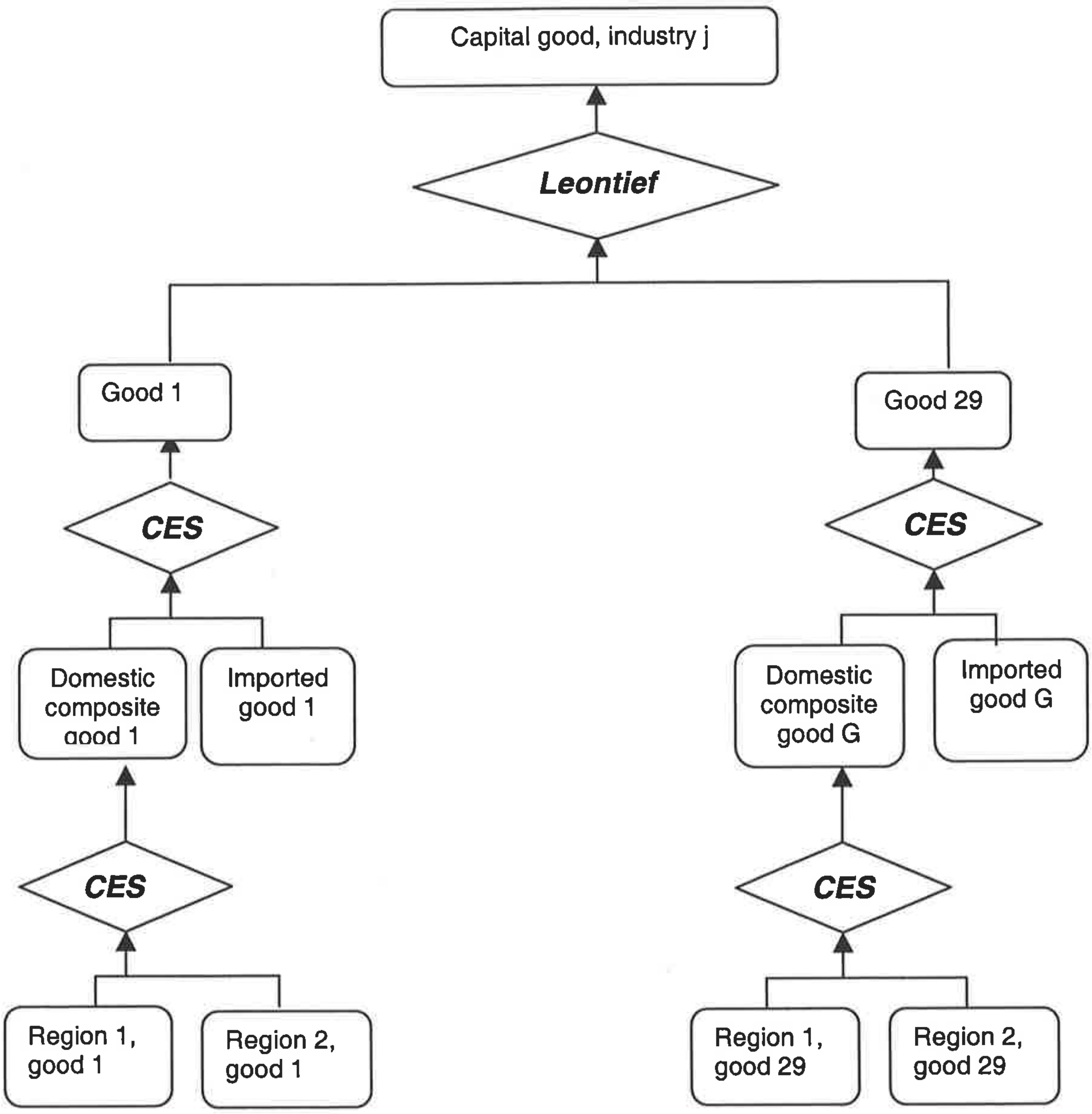
At the next level the primary factor costs are minimised for a given primary input requirement. Labour (a composite of occupations), capital and land (denoted by variables, *employ*, *k_rjst* and *x_agland*) have CES substitution possibilities. Note that since agricultural land is usually fixed in supply, *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):

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

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:

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

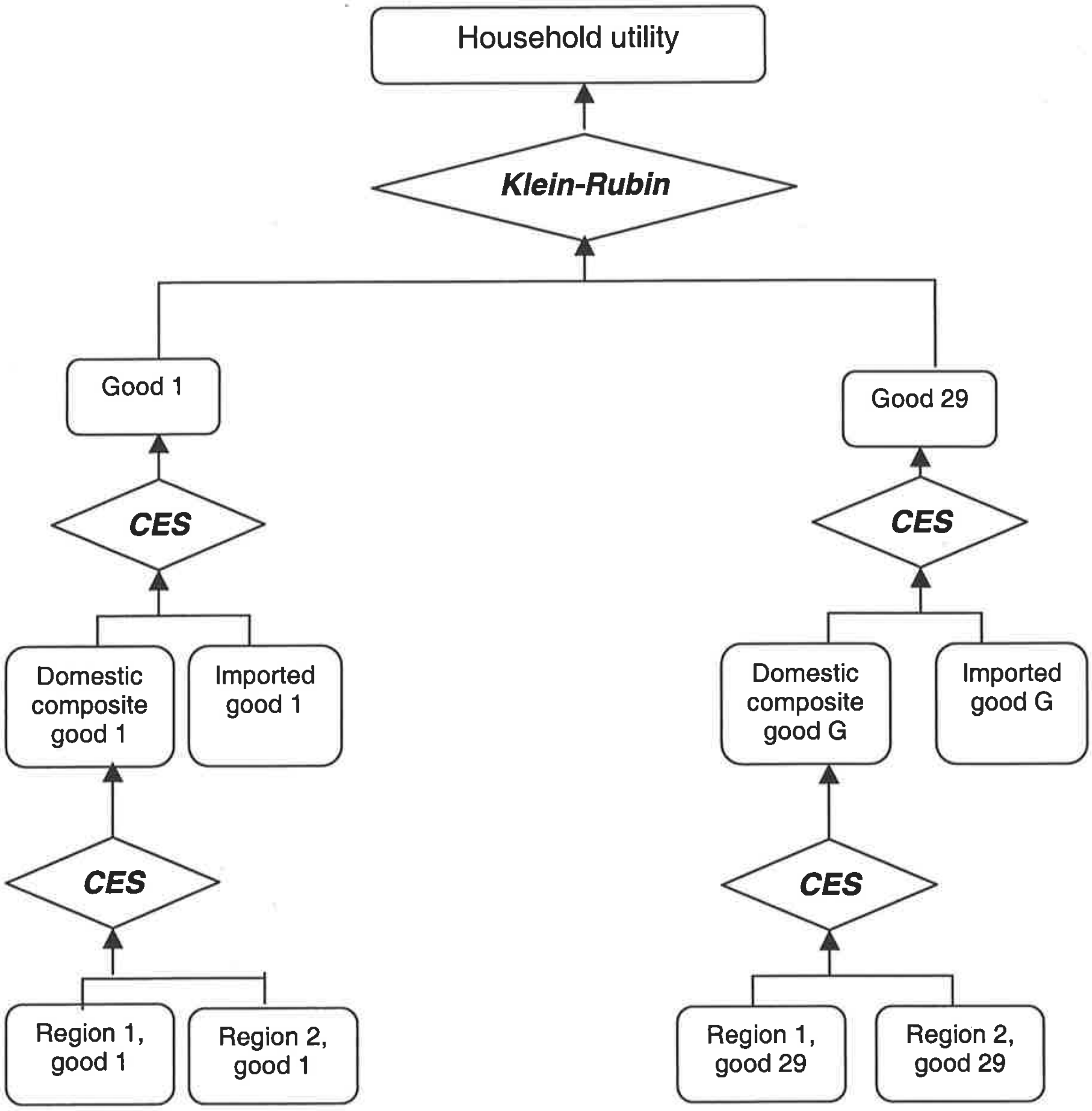
where:

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

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:

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

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

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

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:

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

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:

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

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} =

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

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}):

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

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);
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