ORANI-WINE: Tax Issues and the Australian Wine Industry*

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In this paper the construction and application of ORANI-WINE is described. This is a special-purpose version of ORANI specifically designed for analysing policy questions bearing upon the alcoholic beverages sector of the Australian economy and on associated agricultural activities, especially viticulture. Details of the modifications made to ORANI are provided, and projections from ORANI-WINE of the effects of the imposition of a specific tax on domestically produced wine, equivalent to that on beer and malt in the base period, are reported. The approximately 58 per cent increase in the purchasers' price of wine induces a 16 per cent reduction in wine output, a two per cent increase in spirit production, but little effect on beer and malt output. Grape industry output is reduced nine per cent. The projections also emphasize mild inflationary effects on the economy, which impinge most severely on the export sectors (agriculture and mining). Rural employment falls two per cent.

I. Introduction

I.1 Background on ORANI

ORANI is a very detailed multisectoral model of the Australian economy in the tradition pioneered by Johansen (1960). The theoretical structure of the model is founded in orthodox assumptions of neoclassical microeconomics. Thus domestic producers and investors are assumed to choose their produced and primary inputs to minimize costs subject to technological constraints. Output mixes are chosen to maximize revenue subject to production possibility constraints. Households maximize utility subject to a budget constraint. Imports are treated as imperfect substitutes for domestic commodities of the same commodity class. Exports of the ecomony's major export commodities are endogenous. All economic agents are assumed to be price takers, and domestic prices are set equal to unit costs so that no activity earns *pure* profits. Macro-economic magnitudes (aggregate employment, the balance of trade, various price indexes, etc.) are computed as explicit aggregations of microeconomic variables. The model has been implemented using Australian data which distinguish 113 domestic industries, 115 commodity categories and nine occupational categories of labour. A facility has been included for the disaggregation (via a tops-down method) of economy-wide projections from the model to the 6-State level. A complete description can be found in Dixon, Parmenter, Sutton and Vincent (1982), hereafter cited as DPSV.

This level of detail was necessary to support the primary role for which the model was constructed, namely, its role as a vehicle for policy analysis in a wide range of public-sector institutions.[1] A review of many of the applications of the model which have been made to date is given in Parmenter and Meagher (1985).

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[1] ORANI was developed as part of the IMPACT Project, an economic research project sponsored by a number of Australian government agencies (especially the Industries Assistance Commission), now in co-operation with the University of Melbourne, La Trobe University and the Australian National University. The main function of the Project is the development and dissemination of policy information systems. See Powell (1977).

Despite its versatility, the standard version of ORANI has not always proved to contain sufficient detail about particular sectors of the economy to satisfy the requirements of users with special interests. This problem has arisen most commonly within the Industries Assistance Commission (IAC) which now routinely uses ORANI in its deliberations. For example, in its recent inquiry into the steel industry (IAC 1983), information was required on the effects of alternative tariff packages on the range of products produced within the Australian steel sector, but also on the economy-wide implications of protection for the sector as a whole. A multisectoral model like ORANI is ideal for the latter purpose but typically (and in particular in the case of the standard version of ORANI) will contain insufficient disaggregation of the steel sector to discharge the former requirement.

The approach which has been taken in cases such as this has been the creation of special purpose versions of ORANI in each of which a more detailed model of the sector of special interest is embedded, replacing the simpler specification of the standard version but retaining the linkages between the sector and the rest of the economy.

An example of such a modification is the treatment of the agricultural sector. In the first version of ORANI, agriculture was specified as composed of single-product industries in accordance with input-output conventions. This specification has now been replaced with one which models explicitly the multi-product nature of most Australian agriculture and the regional differences in production technology which characterize it.

The respecification of the agricultural sector was considered to be of sufficient importance to warrant its permanent incorporation in the standard version of the model (see DPSV, subsection 28.2.1).

ORANI is now sufficiently accessible to outside users for independent researchers[2] to be able to make their own special-purpose versions. The experience of policy analysts in the IAC has already been cited in this regard. Other examples concern regionalization of the model. Groups at the Centre for Regional Economic Analysis of the University of Tasmania and at the University of Western Australia are currently working on versions of ORANI which include State detail about major sectors in the two State economies.[3]

I.2 Outline of the Paper

In the rest of this paper we describe the construction and application of ORANI-WINE, a version of ORANI specifically designed for analysing policy questions bearing upon the alcoholic beverages sector of the Australian economy and thus on associated agricultural activities, especially viticulture. The most important such policy issue is the question of the indirect tax treatment afforded to different commodities produced in the sector. At present, heavy indirect taxes are levied on beer and spirits, and on imported wine. Until recently, domestically produced wine was exempt and even now is taxed at only a very low rate. The removal of this form of assistance from the wine industry is often canvassed. ORANI-WINE allows us to analyse the effects of the imposition of indirect taxes on domestically produced wine and the effects of changes to the tax rates applied to other alcoholic beverages.

The paper is organized as follows. In section II we provide details of the modifications to the standard version of ORANI which were made in order to construct ORANI-WINE. Section III reports projections from ORANI-WINE of the effects of the imposition of a tax on domestically produced wine. Conclusions are drawn in section IV.

II. The Specification and Implementation of ORANI-WINE

II.1 Input-Output Structure

The standard ORANI data base distinguishes only two alcoholic beverages, namely *Beer and malt* and *Alcoholic beverages nec.* The latter includes both spirits and wine. The

[2] To facilitate the use and adaptation of the model by outside users, regular courses are conducted by the IMPACT Centre.

[3] The methodology for regional versions of ORANI was pioneered at the IMPACT Centre. See Higgs, Parmenter and Rimmer (1983).

Table II.1: Commodity and Industry Structure of the Grapes and Alcoholic Beverages Sectors of the ORANI-WINE Data Base: Basic Value of Output by Commodity and Industry ($1974/75m.)

Commodity \ Industry	Grapes	Wine and brandy	Alcoholic beverages nec	Beer and malt	Output by commodity
Grapes	97.4				97.4
Wine		176.5			176.5
Alcoholic beverages, nec		19.6	12.5		32.1
Beer and malt				468.7	468.7
Output by industry	97.4	196.1	12.5	468.7	

Source: See text.

standard version of the model is therefore unable to deal explicitly with the tax differential which exists between domestically produced wine and other alcoholic beverages, imported and domestically produced. Nor is it able to focus specifically on the grape-growing industry, support of which is the main justification for continuation of the current indirect-tax exemption for domestically produced wine. The reason is that grape growing is aggregated into the model's *Other farming, import competing* activity.

The first step in the construction of ORANI-WINE was to distinguish a specialist grape-growing industry and three industries which manufacture alcoholic beverages: the *Wine and brandy* industry, the *Beer and malt* industry, and a specialist producer of alcoholic beverages other than wine, brandy and beer (*Alcoholic beverages nec*). Four separate commodities are assumed to be produced by these industries. They are *Grapes, Wine, Beer and malt* and *Alcoholic beverages nec*. The last of these is a composite commodity including mainly brandy and other potable spirits. The matrix of output by commodity and industry for the sector is shown in Table II.1.

A number of data sources (ABS 1974/75, 1975/76, 1976, 1981; BAE 1973, 1979; and IAC 1978) were used to compile data on the sales patterns of grapes and of wine, and on the cost structures of the *Grapes* and *Wine and brandy* industries. These data were then used to split the corresponding commodity rows and industry columns of the standard ORANI data base.[4]

II.2 Consumption Specification

A crucial theoretical issue is the specification of consumers' substitution possibilities between different alcoholic beverages. The household-demand specification implemented in the standard version of ORANI assumes additive preferences and thus excludes specific substitution effects between commodities. This assumption is more likely to be appropriate when applied to broad aggregates, which do not interact in the utility function a great deal. However, the specification of preferences must be more flexible when dealing with more disaggregated commodity groups such as beer, wine and spirits. The objective of this sub-section is to indicate briefly how we allow the three alcoholic beverages to interact fully in the utility function, while maintaining the assumption of additive preferences for the other commodities. For full details and derivations of all results in this sub-section, see Clements and Smith (1983).

II.2.1 Demand equations in relative prices

We write p_i, q_i for the price and quantity consumed of good i (i=1,...,n), $M = \Sigma^n_{i=1} p_i q_i$ for total expenditure ("income" for short) and $w_i = p_i q_i / M$ for the i^{th} budget share. Under

[4] For computing convenience aggregations of industries in the tertiary sector were made to keep the total number of sectors in ORANI-WINE the same as that in standard ORANI.

general conditions the demand equation for good i can be written in differential form as (Theil 1980)

$$w_i d(\log q_i) = \theta_i d(\log Q) + \sum_{j=1}^{n} v_{ij} d\left(\log \frac{p_j}{P'}\right), \quad (II.2.1)$$

where $\theta_i = \partial(p_i q_i)/\partial M$ is the i^{th} marginal share; $d(\log Q) = \Sigma_{i=1}^{n} w_i d(\log q_i)$ is the Divisia volume index of the change in the consumer's real income; $d(\log \frac{p_j}{P'}) = d(\log p_j) - d(\log P')$ is the change in the relative price of j, where $d(\log P') = \Sigma_{i=1}^{n} \theta_i d(\log p_i)$ is the Frisch price index; and

$$v_{ij} = \frac{\lambda p_i u^{ij} p_j}{M} \quad (II.2.2)$$

is the $(i,j)^{th}$ price coefficient, where λ is the marginal utility of income and u^{ij} is the $(i,j)^{th}$ element of the inverse of the Hessian matrix of the utility function $[\partial^2 u/\partial q_i \partial q_j]^{-1}$. The price coefficients are subject to the constraint that the row sums of $[v_{ij}]$ are proportional to the corresponding marginal shares,

$$\sum_{j=1}^{n} v_{ij} = \phi\theta_i \qquad i=1,\ldots,n, \quad (II.2.3)$$

where $\phi = (\partial \log \lambda/\partial \log M)^{-1}$ is the income flexibility.

II.2.2 The structure of preferences

Now let the n goods be divided into two groups, alcoholic beverages (comprising beer, wine and spirits) and everything else. Further, let preferences be such that the utility function is the sum of n-2 sub-utility functions, one for alcoholic beverages and one for each of the remaining n-3 other goods,

$$u_A(q_1,q_2,q_3) + \sum_{i=4}^{n} u_i(q_i) \quad , \quad (II.2.4)$$

where the alcoholic beverages are the first three goods. Under (II.2.4) the Hessian $[\partial^2 u/\partial q_i \partial q_j]$ is block-diagonal, with alcoholic beverages a block-independent group and all the other goods preference independent. Equation (II.2.4) is a generalization of additive preferences as the sub-utility function for alcohol $u_A(\ )$ is not additive.

II.2.3 Implications for the demand equations

We return to the general demand equation (II.2.1) to consider its form when preferences are given by (II.2.4). As (II.2.4) implies that the inverse of $[\partial^2 u/\partial q_i \partial q_j]$ is block-diagonal, it follows from (II.2.2) that $v_{ij} = 0$ for $i \in S_A$, $j \notin S_A$, where S_A is the alcoholic beverages group. Thus, for $i \in S_A$, (II.2.1) becomes

$$w_i d(\log q_i) = \theta_i d(\log Q) + \sum_{j=1}^{3} v_{ij} d\left(\log \frac{p_j}{P'}\right) \cdot (II.2.5)$$

In words, under (II.2.4) the relative prices of goods outside the alcoholic beverages group do not affect the demand for any such beverage.

For the other goods ($i \notin S_A$), the relevant part of the utility Hessian is diagonal and it follows from (II.2.2) that $v_{ij} = 0$ for $i \neq j$. In addition, (II.2.3) implies $v_{ii} = \phi\theta_i$, so that for $i \notin S_A$ (II.2.1) becomes

$$w_i d(\log q_i) = \theta_i d(\log Q) + \phi\theta_i d\left(\log \frac{p_i}{P'}\right) \cdot \quad (II.2.6)$$

Accordingly, (II.2.4) implies that the demand for each of the other goods depends only on its own relative price and on income.

II.2.4 The composite demand equation for alcohol

We write $W_A = \Sigma_{i=1}^{3} w_i$ and $\Theta_A = \Sigma_{i=1}^{3} \theta_i$ for the budget and marginal shares of the group, and define the group volume and Frisch price indexes as $d(\log Q_A) = \Sigma_{i=1}^{3} (w_i/W_A) d(\log q_i)$ and $d(\log P'_A) = \Sigma_{i=1}^{3} (\theta_i/\Theta_A) d(\log p_i)$ respectively. If we then add (II.2.5) over i=1,2,3 we obtain, after some algebra,

$$W_A d(\log Q_A) = \Theta_A d(\log Q) + \phi\Theta_A d\left(\log \frac{P'_A}{P'}\right) \cdot \quad (II.2.7)$$

This is the composite demand equation for alcoholic beverages as a group under (II.2.4). As can be seen, only income and the relative price of the group

$$\left(d\left(\log \frac{P'_A}{P'} \right) = d(\log P'_A) - d(\log P') \right)$$

affect the demand for the group as a whole.

Note that (II.2.7) is an "uppercase" version of (II.2.6), the demand equation for a good which appears additively in the utility function. This reflects the fact that alcoholic beverages *as a group* is additive in (II.2.4).

II.2.5 Conditional demand equations

Combining (II.2.5) and (II.2.7) to eliminate $d(\log Q)$ and $d(\log P')$, we obtain

$$w_i d(\log q_i) = \theta'_i W_A d(\log Q_A) + \sum_{j=1}^{3} v_{ij} d\left(\log \frac{p_j}{P'_A} \right), \quad \text{(II.2.8)}$$

where $\theta'_i = \theta_i/\Theta_A$ is the conditional marginal share of i. This is the demand equation for $i \epsilon S_A$, given the demand for the group as a whole $W_A d(\log Q_A)$. As the variables on the right of this equation are exclusively concerned with the group S_A to which the i^{th} commodity belongs, it is known as a conditional demand equation. We use the definition of $d(\log P'_A)$ and (II.2.3) to formulate (II.2.8) in terms of absolute (undeflated) prices as

$$w_i d(\log q_i) = \theta'_i W_A d(\log Q_A) + \sum_{j=1}^{3} \pi^A_{ij} d(\log p_j) \ , \quad \text{(II.2.9)}$$

where $\pi^A_{ij} = v_{ij} - \phi\Theta_A\theta'_i\theta'_j$ is the $(i,j)^{th}$ conditional Slutsky coefficient. This coefficient describes the effect of a change in the price of j on the demand for i $(i,j,\epsilon S_A)$ under the condition that the total consumption of the group remains constant.

II.2.6 Unconditional demand equations in absolute prices

Finally, we obtain the unconditional demand equation for $i \epsilon S_A$ under (II.2.4) by substituting (II.2.7) in (II.2.9) and using the definition of $d\left(\log \frac{P'_A}{P'} \right)$ to give

$$w_i d(\log q_i) = \theta_i d(\log Q) + \sum_{j=1}^{n} \pi_{ij} d(\log p_j) \ , \quad \text{(II.2.10)}$$

where

$$\pi_{ij} = \begin{cases} \pi^A_{ij} + \phi\Theta_A(1 - \Theta_A)\theta'_i\theta'_j & j \epsilon S_A \\ -\phi\theta_i\theta_j & j \notin S_A \end{cases} \quad \text{(II.2.11)}$$

is the (i,j)th Slutsky coefficient. The corresponding equation for $i \notin S_A$ under (II.2.4) is the absolute price version of (II.2.6), which has the same form as (II.2.10) with the Slutsky coefficients now given by

$$\pi_{ij} = \phi\theta_i(\delta_{ij} - \theta_j) \qquad j=1,\ldots,n, \quad \text{(II.2.12)}$$

where δ_{ij} is the Kronecker delta.

The interpretation of (II.2.10) is straightforward. The variable on the left is (i) the contribution of good i to the Divisia volume index $d(\log Q)$, and (ii) the quantity component of the change in w_i, $dw_i = w_i d(\log p_i) + w_i d(\log q_i) - w_i d(\log M)$. The marginal share θ_i tells us what fraction of an additional dollar of income is spent on good i, with $\Sigma^n_{i=1}\theta_i = 1$. By dividing both sides of (II.2.10) by w_i, we find that θ_i/w_i is the income elasticity of demand and that π_{ij}/w_i is the compensated price elasticity. Demand homogeneity and Slutsky symmetry imply the following constraints on the π_{ij}'s:

$$\sum_{j=1}^{n} \pi_{ij} = 0, i=1,\ldots,n; \quad \pi_{ij}=\pi_{ji}, \quad i,j=1,\ldots,n. \quad \text{(II.2.13)}$$

II.2.7 Constructing the Slutsky matrix for ORANI-WINE

Equations (II.2.11) and (II.2.12) give the nxn matrix of Slutsky coefficients when the utility function is of the form (II.2.4). We now describe the numerical information used to construct this matrix for ORANI-WINE. This matrix has four blocks,

$$\underset{nxn}{[\pi_{ij}]} = [w_i \text{ x (compensated elasticity of } q_i \text{ with respect to } p_j)]$$

$$= \begin{array}{c} i \epsilon S_A \\ \\ i \notin S_A \end{array} \left[\begin{array}{c:c} \overset{j \epsilon S_A}{\text{I}} & \overset{j \notin S_A}{\text{II}} \\ 3 \text{ x } 3 & 3 \text{ x } (n\text{-}3) \\ \hdashline \text{IV} & \text{III} \\ (n\text{-}3) \text{ x } 3 & (n\text{-}3) \text{ x } (n\text{-}3) \end{array} \right] \quad \text{(II.2.14)}$$

Block I of (II.2.14) ($i,j \epsilon S_A$) is defined in the first part of (II.2.11). For the conditional Slutsky coefficients π^A_{ij} and the conditional marginal shares θ'_i for the three alcoholic beverages, we use the econometric estimates of Clements and Johnson (1982). They estimated finite-change versions of (II.2.7) and (II.2.9) and the estimates of the conditional demand parameters are given in Table II.2. As these parameters have been estimated subject to homogeneity and symmetry constraints analogous to (II.2.13), we need only give the upper triangle of the conditional Slutsky coefficients. For the marginal share of the group, we use Θ_A = .0576, from Clements and Johnson (1982, Table 5). For the income flexibility, we use ϕ = -1/1.82, from DPSV (p.194).

Block II of (II.2.14) ($i \epsilon S_A$, $j \notin S_A$) is defined in the second part of equation (II.2.11). For $i \epsilon S_A$, we calculate the unconditional marginal shares as $\theta_i = \Theta_A \theta'_i$ using the values described in the previous paragraph; for $j \notin S_A$ we use the marginal shares in the standard version of ORANI, after appropriate renormalization (to preserve $\Sigma^n_{i=1}\theta_i = 1$). Block III is defined in (II.2.12) for $i,j \notin S_A$. No additional parameters are needed to construct this block. Finally, Slutsky symmetry implies that block IV is the transpose of block II.

II.2.8 The uncompensated price and income elasticities

As stated previously, π_{ij}/w_i is the compensated price elasticity of demand for commodity i with respect to the price of j. This can be converted to the corresponding uncompensated elasticity η_{ij} by adding back the income effect of the price change,

$$\eta_{ij} = \frac{\pi_{ij}}{w_i} - w_j \frac{\theta_i}{w_i} \quad , \quad i,j=1,...,n. \qquad \text{(II.2.15)}$$

ORANI-WINE uses these η_{ij}'s as part of its data base. To evaluate (II.2.15) we use the π_{ij}'s and the θ_i's described previously. The budget shares (the w_i's) are from Clements and Johnson (1982, Table 2) and the standard version of ORANI after appropriate renormalization (to preserve $\Sigma^n_{i=1} w_i = 1$). We give in Table II.3 the own-price elasticities η_{ii}, together with the expenditure elasticities θ_i/w_i.

Table II.2: Conditional Demand Parameters for Alcoholic Beverages, 1955/56 – 1976/77

Beverage	Conditional marginal share θ'_i	*Conditional Slutsky coefficients* π^A_{i1} x 100	π^A_{i2} x 100	π^A_{i3} x 100
Beer	.590	-.390	.150	.240
Wine	.099		-.293	.144
Spirits	.311			-.384

Source: Clements and Johnson (1982, Table 5).

II.3 A Facility for Tax Analysis

The solution of a Johansen model relies on a matrix inversion and a matrix multiplication. That is, a linear percentage-change version of the basic non-linear model is constructed which can be represented as

$$\mathbf{A}\mathbf{z} = 0 , \qquad \text{(II.3.1)}$$

where $\mathbf{z}$ is an nx1 vector of percentage-change variables and $\mathbf{A}$ is an mxn ($n > m$) matrix of coefficients. We then compute

$$\mathbf{z}_1 = -\mathbf{A}_1^{-1}\mathbf{A}_2\,\mathbf{z}_2, \qquad \text{(II.3.2)}$$

where $\mathbf{z}_1$ and $\mathbf{z}_2$ are respectively (mx1) and ((n-m) x 1) vectors of endogenous and exogenous variables, and $\mathbf{A}_1$ and $\mathbf{A}_2$ are the corresponding (mxm) and (mx(n-m)) submatrices of $\mathbf{A}$. In principle, the matrix $-\mathbf{A}_1^{-1}\mathbf{A}_2$ contains the elasticities of all the endogenous variables with respect to all the exogenous variables, the elasticities being evaluated at the initial values of the variables. If multiplied (as in II.3.2) by the vector of percentage changes in the exogenous variables (some of which may actually be zero), this matrix would yield the corresponding changes in the endogenous variables. In practice, the ORANI system is too large for the computation II.3.2 to be made with the full system. Rather, the system is condensed by

(a) the elimination of a large number of equations and endogenous variables by elementary algebraic substitutions. Solution values for the eliminated endogenous variables are obtained, if required, by back-solution subsequent to II.3.2; and

(b) combining selected exogenous variables to form composite variables. The percentage change in a composite variable must then be calculated *a priori* from the given percentage changes in the variables that go into its formation. Commodity tax rates are included among the exogenous variables that are subject to this treatment.

In the ORANI model, commodity tax rates are formulated as a weighted sum of a real tax rate (defined in terms of the Consumer Price Index), a specific rate and an *ad valorem* rate. This formulation is designed to allow the user a full range of options for modelling the tax structure via suitable choice of the weights. The tax facility implements the required option and computes the changes in the revelant composite variables that result from given rate changes. The computer programs that perform these functions are not fully integrated with the ORANI programs, but exist as side calculations with a limited number of interfaces to the main system. This strategy results in some loss of computational efficiency and requires iterative solution of the model for changes expressed in nominal specific or *ad valorem* terms. However, it also obviates the necessity for the user to be familiar with details of the long and difficult ORANI code, an advantage without which user-initiated special purpose applications like ORANI-WINE would probably not be feasible. (For a fuller description and other applications of the tax facility see Meagher (1986) and Meagher and Parmenter (1985).)

Table II.3: Uncompensated Own-price and Expenditure Elasticities for 115 Commodities from the ORANI-WINE Data Base

	Commodity	Own-price elasticity	Expenditure elasticity
1	Wool	0.000	0.000
2	Sheep	-0.269	0.490
3	Wheat	0.000	0.000
4	Barley	0.000	0.000
5	Other cereal grains	0.000	0.000
6	Meat cattle	-0.269	0.490
7	Milk cattle	-0.031	0.056
8	Other farming export	-0.280	0.509
9	Grapes	-0.280	0.509
10	Other farming import comp.	-0.285	0.509
11	Wine	-0.375	0.725
12	Alcoholic beverages nec	-0.756	1.843
13	Poultry	-0.008	0.015
14	Services to agriculture	0.000	0.000
15	Forestry	-0.618	1.124
16	Fishing	-0.287	0.521

17 Iron	0.000	0.000
18 Other metallic minerals	-0.618	1.124
19 Coal	-0.618	1.124
20 Crude oil	-0.618	1.124
21 Non-metallic nec	-0.618	1.124
22 Services to mining	0.000	0.000
23 Meat products	-0.288	0.490
24 Milk products	-0.032	0.056
25 Fruit & veg. products	-0.240	0.428
26 Marge, oils & fats	-0.239	0.432
27 Flour & cereal products	-0.082	0.147
28 Bread, cakes	-0.071	0.124
29 Confectionery	-0.225	0.405
30 Food products nec	-0.277	0.495
31 Soft drinks, cordials	-0.227	0.409
32 Beer & malt	-0.372	0.771
33 Tobacco	-0.273	0.482
34 Prepared fibres	0.000	0.000
35 Man-made fibres, yarn	-0.150	0.274
36 Cotton, silk, flax	-0.152	0.274
37 Wool & worsted yarns	-0.151	0.274
38 Textile finishing	-0.151	0.274
39 Textile floor covers	-0.817	1.483
40 Textile products nec	-0.757	1.378
41 Knitting mills	-0.153	0.274
42 Clothing	-0.161	0.274
43 Footwear	-0.153	0.274
44 Sawmill products	-0.714	1.299
45 Plywood, veneers	-0.712	1.295
46 Joinery & wood products	-0.651	1.182
47 Furniture, mattresses	-0.811	1.467
48 Pulp, paper	-0.618	1.124
49 Fibreboard	-0.618	1.124
50 Paper products nec	-0.619	1.124
51 Newspapers & books	-0.623	1.124
52 Commercial printing	-0.619	1.124
53 Chemical fertilisers	-0.618	1.124
54 Industrial chemicals	-0.618	1.124
55 Paints, varnishes	-0.660	1.201
56 Pharmaceuticals	-0.622	1.124
57 Soap & detergents	-0.621	1.124
58 Cosmetics, toiletry	-0.621	1.124
59 Chemical products nec	-0.618	1.124
60 Oil & coal products	-0.632	1.129
61 Glass	-0.812	1.477
62 Clay products	-0.815	1.483
63 Cement	-0.716	1.303
64 Ready-mix concrete	0.000	0.000
65 Concrete products	-0.618	1.124
66 Non-metal mineral products	-0.618	1.124
67 Basic iron & steel	-0.618	1.124
68 Other basic metals	-0.618	1.124
69 Structural metal	-0.689	1.254
70 Sheet metal products	-0.812	1.477
71 Metal products nec	-0.714	1.295
72 Motor vehicles, parts	-0.642	1.131
73 Ship & boat building	-0.815	1.483
74 Locomotives	0.000	0.000
75 Aircraft building	-0.618	1.124
76 Scientific equipment	-0.703	1.273
77 Electronic equipment	-0.820	1.483
78 Household appliances	-0.820	1.483
79 Electrical machinery	-0.769	1.398
80 Agricultural machinery	-0.815	1.483
81 Construction equipment	-0.815	1.483
82 Other machinery	-0.815	1.483
83 Leather products	-0.259	0.469
84 Rubber products	-0.625	1.131
85 Plastic products	-0.732	1.328
86 Signs, writing equipment	-0.618	1.124
87 Other manufacturing	-0.645	1.165
88 Public utilities	-0.626	1.124
89 Residential building	0.000	0.000

90	Building nec	0.000	0.000
91	Wholesale trade	-0.618	1.124
92	Retail trade	-0.621	1.124
93	Motor vehicle repair	-0.625	1.123
94	Other repairs	-0.619	1.124
95	Road transport	-0.108	0.193
96	Railway transport	-0.209	0.379
97	Water transport	-0.156	0.283
98	Air transport	-1.234	2.258
99	Communication	-0.622	1.124
100	Banking	-0.621	1.124
101	Finance & life insurance	-0.623	1.124
102	Other insurance	-0.621	1.124
103	Investment, real estate	-0.619	1.124
104	Other business services	-0.620	1.124
105	Ownership of dwellings	-0.982	1.776
106	Public administration	-0.618	1.124
107	Defence	0.000	0.000
108	Health	-0.635	1.124
109	Education, libraries	-0.621	1.124
110	Welfare services	-0.620	1.124
111	Entertainment	-0.629	1.124
112	Restaurants, hotels	-0.630	1.124
113	Personal services	-0.624	1.124
114	Business expenses	0.000	0.000
115	Non competing imports	-0.764	1.387

III. Results: an Analysis of the Effects of Imposing an Indirect Tax on Wine

The ORANI model provides projections for a wide range of variables at both the macro and the industry/commodity levels. The range includes commodity prices, factor prices, commodity usage (for intermediate inputs, capital creation, household consumption and exports), factor usage, commodity imports, capital costs and rates of return. However, we can obtain an adequate appreciation of the effects of the wine tax if we confine our attention to changes in the macroeconomy and to changes in output and household consumption, especially in the alcoholic beverages sector. Consequently we shall not attempt any systematic discussion of the projections for the other variables, but introduce them selectively when they contribute to our understanding of changes in the nominated variables.

III. 1 The Specification of the Tax Shock

With the exception of a three-year period between 1970 and 1972, the production of wine in Australia has remained exempt from excise tax, giving it a considerable price advantage over the other alcoholic beverages. In 1974/75, the base period for the calculations reported in this paper, the revenue collected from commodity taxes on household consumption of alcoholic beverages (excluding wine) comfortably exceeded the basic value of the beverages consumed (see Table III.1). Our purpose, therefore, is to investigate the effects of bringing the tax on wine more into line with that on other alcoholic beverages.

Commodity taxes can be imposed in a variety of ways. Sales taxes, for example, are specified in *ad valorem* terms (usually as a percentage of the wholesale price), whereas excise taxes are specific. Specific taxes can be levied against the entire volume of the beverage consumed or only against its alcoholic content. Hence there is no single criterion by which a tax on wine can be judged to be comparable with the taxes on other beverages. This does not constitute a serious problem, however, as the results of the analysis will be largely conditioned by the amount of the additional tax required, an amount that will be large by any criterion. Differences arising from alternative specifications are likely to be second order by comparison.

In the event, we have chosen to impose a specific tax of $1.37 per unit of consumption,[5] the unit being the physical quantity that

[5] For imported wine, which was already taxed at the rate $0.12 per unit in the base period, the additional tax imposed is $1.25 per unit.

Table III.1: Household Consumption of Alcoholic Beverages in the ORANI-WINE Data Base

Commodity	(1) Consumption at basic values ($1974/75 m)	(2) Commodity tax revenue ($1974/75 m)	(3) Implied tax rate ((2)/(1))
Wine			
— domestic	133.52	0.0	0.0
— imported	7.53	0.93	0.12
Alcoholic beverages nec	53.61	155.08	2.89
Beer and malt	350.82	480.10	1.37

Source: ORANI-WINE database.

could be purchased for one dollar at basic values in 1974/75. That is, the tax is imposed at the average rate of commodity tax on the commodity *Beer and malt* in the base period. This is sufficient to increase the purchasers' price of wine by approximately 58 per cent.

III.2 Macro Results

At the level of the macroeconomy, the wine tax exerts its influence via the Consumer Price Index (CPI). The weight of wine in the CPI is about 0.9 per cent; therefore in the absence of any economic adjustment to the change, the tax would increase the CPI by approximately 0.5 per cent. However real wages (as paid by producers) are assumed to remain constant and hence the initial increase in the CPI induces a corresponding increase in money wages and prices. The CPI increases again and a wage-price spiral ensues. By the time the spiral is exhausted and the economy returns to equilibrium, the CPI has risen by a total of 1.67 per cent (see Table III.2).

The burst of domestic inflation caused by the wine tax has its major repercussions in the traded sectors of the economy. Exporters are assumed to face fairly elastic demand for their products in foreign markets and can pass on cost increases only at the expense of rapidly declining sales. Hence they become caught in a cost-price squeeze as money wages rise. Import competing industries likewise find their competitiveness being eroded. Consequently exports fall, imports rise and the balance of trade moves towards deficit.

Table III.2: Projected Macroeconomic Effects of a Wine Tax

Macro variable	Projection (percentage change)
Consumer price index	1.67
Aggregate imports	0.49
Aggregate exports	-1.69
Balance of trade (% of GDP)	-0.33
Aggregate employment	-0.65
Employment by occupation	
Professional	-0.30
Skilled white collar	-0.43
Semi- and unskilled white collar	-0.41
Skilled blue collar, metal & electrical	-0.73
Skilled blue collar, building	-0.25
Skilled blue collar, other	-0.81
Semi- and unskilled blue collar	-0.69
Rural workers	-2.05
Armed services	0.0

Table III.3: The Projected Effects (in Percentage Changes) of a Wine Tax on Industry and Commodity Outputs in the Domestic Alcoholic Beverages Sector

Commodity \ Industry	Wine and brandy	Alcoholic beverages nec	Beer and malt	Total commodity outputs
Wine	-18.05			-18.05
Alcoholic beverages nec	2.52	0.81		1.85
Beer and malt			-0.76	-0.76
Total industry outputs	-16.00	0.81	-0.76	

The nontraded sector on the other hand is relatively unaffected, since aggregate domestic final demand is assumed to remain constant in real terms.[6] However, it does suffer some reduction in intermediate demand for its output because of the contraction in the traded sectors.

These considerations are reflected in the results for employment. Professional and white collar workers are concentrated in the nontraded service industries; skilled blue collar workers in the building sector are similarly insulated from the effects of foreign competition. Hence, employment in these occupations declines less than aggregate employment. Conversely, the agricultural sector is especially dependent on foreign markets and the employment of rural workers falls much more than any other category.

III.3 The Alcoholic Beverages Sector

The output changes (by industry and commodity) in the alcoholic beverages sector are set out in Table III.3. For all three commodities produced in the sector, the share of sales to household consumption is large (see Table III.4). Hence, the changes in commodity outputs can be understood in terms of the effect of the wine tax on the pattern of consumption demand.

In ORANI-WINE, substitution in consumption can occur between commodities of different types (e.g., wine and beer) and between commodities of the same type from different sources (e.g., domestic and imported wine). Substitution of the first kind is governed by demand equations of the following form:

$$x_i^{(3)} = \epsilon_i c + \sum_{k=1}^{115} \eta_{ik} p_k^{(3)} \qquad (i=1,\ldots,115) \ , \qquad \text{(III.3.1)}$$

where $x_i^{(3)}$ is the percentage change in the quantity of commodity of type i consumed by households,[7] $p_i^{(3)}$ is the percentage change in the purchasers' price of the commodity, and c is the percentage change in total consumption expenditure. The parameters ϵ_i and η_{ik} ($k=1,\ldots,115$) are the expenditure and own- and cross-price elasticities described in section II (especially subsection II.2.8).

Now, by assumption, real aggregate household expenditure remains constant when the wine tax is imposed. Hence, the percentage change in nominal expenditure is equal to the percentage change in the CPI, i.e., $c = 1.67$. Given also the relevant changes in purchasers' prices $p^{(3)}$, the changes in consumption of the various alcoholic beverages

[6] More precisely, aggregate household consumption expenditure, aggregate investment expenditure and aggregate government expenditure are all assumed to remain constant in real terms. One interpretation of these assumptions is that the revenue collected from the wine tax is returned to consumers as a cut in direct taxes which increases take home pay but does not alter wages as a cost of production. For an applicaton of the ORANI model in which this issue is handled explicitly, see Meagher (1986).

[7] We follow the notation of DPSV. Thus, inter alia, the superscript 3 distinguishes inputs to household consumption from inputs to current production and capital creation (superscripts 1 and 2, respectively) and from outputs (superscript 0).

Table III.4: Base Period Sales Shares for the Alcoholic Beverages Sector

Usage \ Commodity	Wine	Alcoholic beverages nec	Beer and malt
Intermediate –			
Wine and brandy	0.150		
Alcoholic beverages nec		0.040	
Beer and malt			0.081
Industrial chemicals		0.210	
Restaurants, hotels			0.082
Other	0.018	0.012	0.017
Total	0.168	0.262	0.180
Household consumption	0.832	0.522	0.755
Exports		0.216	0.065
Total	1.000	1.000	1.000

Source: ORANI-WINE database.

can be decomposed into expenditure and price effects, as set out in Table III.5. We see that the own-price effect dominates the change in the demand for *Wine*. For the other two beverages, the main contributions come from the change in the price of *Wine* and the change in total expenditure. In the case of *Alcoholic beverages nec*, the cross-price elasticity is positive and the price effect reinforces the expenditure effect. In the case of *Beer and malt*, the cross-price elasticity is negative and the price effect largely cancels the expenditure effect. In both cases, the remaining price effects are not insignificant and the source of the aggregate change in demand cannot be characterized as simply as it was for *Wine*. To complete Table III.5 we have shown how the changes in household consumption are allocated between domestic and imported supplies. As can be seen, substitution between the two sources of supply is not a crucial feature of our results.

The most surprising result in Table III.5 is that the net effect of an increase in the purchasers' price of *Wine* is to decrease slightly the consumption of *Beer and malt*. The parameters described in section II.2 imply that, within the alcoholic beverages group, *Wine* and *Beer and malt* are substitutes (see equation (II.2.9) and Table II.2). However, the wine tax increases the price of the composite alcoholic-beverages commodity and thus induces a fall in the consumption of alcoholic beverages as a whole (cf. equation II.2.7). For *Beer and malt* (but note not for *Alcoholic beverages nec*) the within-group substitution effect is insufficient to outweigh the shift in the pattern of consumption away from the alcoholic beverages group.

Returning now to Table III.3, it is clear that the changes in output of the commodities *Wine* and *Beer and malt* are closely explained by the changes in consumption demand (domestic commodities) reported in Table III.5. The increase in the output of the commodity *Alcoholic beverages nec* falls somewhat below the increase in its consumption demand due to

(a) a reduction in intermediate demand following a contraction of 1.17 per cent in the *Industrial chemicals* industry (cf. Table III.4); and

(b) an assumed zero growth of export demand for this commodity.

While the output of the commodity *Alcoholic beverages nec* increases by 1.85 per cent, the output of the specialist industry *Alcoholic beverages nec* increases only by 0.81 per cent. The difference is taken up by the increase of 2.52 per cent in the production of this commodity by the *Wine and brandy* industry.

The output mix of the two commodities produced by the *Wine and brandy* industry is governed by a CET (constant elasticity of transformation) function, giving rise to the supply equations

$$x_{ij}^{(0)} = z_j + \sigma_j^{(0)}\left(p_i^{(0)} - \tilde{p}_j^{(0)} \right) \quad (i=11,12),$$

where $x_{ij}^{(0)}$ is the percentage change in the output of commodity i produced by industry j (i.e., the *Wine and brandy* industry), z_j is the percentage change in the industry's activity level, $p_i^{(0)}$ is the percentage change in the basic value of commodity i and $\tilde{p}_j^{(0)}$ is a weighted sum of the prices of all the commodities produced by the industry (in this case *Wine* and *Alcoholic Beverages nec*), the weights being the industry's base period output shares. The parameter $\sigma_j^{(0)}$ is the elasticity of transformation. In the present calculation,

$$\sigma_j^{(0)} = 2.0$$
$$z_j = -16.00 \quad \text{(see Table III.3)}$$
$$p_{11}^{(0)} = -8.52$$
$$p_{12}^{(0)} = 1.77$$
$$\tilde{p}_j^{(0)} = -7.49\ ,$$

so that

$$x_{11,j}^{(0)} = -18.05$$
$$x_{12,j}^{(0)} = 2.52$$

as recorded in Table III.3.

Table III.5: Projected Effects of a Wine Tax on Household Consumption of Alcoholic Beverages

Category	Symbol	Commodity: *Wine*	Commodity: *Alcoholic beverages nec*	Commodity: *Beer and malt*
Commodity number	i	11	12	32
Expenditure elasticity	ϵ_i	0.725	1.843	0.771
Price elasticities	$\eta_{i,11}$	-0.375	0.058	-0.021
	$\eta_{i,12}$	0.058	-0.756	-0.547
	$\eta_{i,13}$	-0.104	-0.373	-0.372
Percentage change in price (a)	$p_i^{(3)}$	55.13	1.38	1.29
Percentage change in consumption (price and expenditure effects)				
due to change in expenditure	$\epsilon_i c$	1.21	3.07	1.29
due to change in price of *Wine*	$\eta_{i,11}p_{11}^{(3)}$	-20.67	3.20	-1.17
due to change in price of *Alcoholic beverages nec*	$\eta_{i,12}p_{12}^{(3)}$	0.08	-1.05	-0.76
due to change in price of *Beer and malt*	$\eta_{i,32}p_{32}^{(3)}$	-0.13	-0.48	-0.48
due to changes in all other prices(b)	$\tilde{x}_i^{(3)}$	-0.35	-0.87	0.31
total	$x_i^{(3)}$	-19.86	3.87	-0.81
Percentage change in consumption (domestic and imported sources of supply)				
domestic commodity	$x_{(i1)}^{(3)}$	-20.05	3.42	-0.81
imported commodity	$x_{(i2)}^{(3)}$	-16.52	4.13	-0.00
total	$x_i^{(3)}$	-19.86	3.87	-0.81

(*a*) These are the full projected price changes from the ORANI-WINE simulation. They include, for example, a squeeze on the basic price of wine induced by the tax. Hence, the final percentage change in the purchasers price of wine (55.13 per cent) differs from the percentage change (58 per cent) generated as an impact effect of the tax increase (see section III.1).

(*b*) We have set

$$\tilde{x}_i^{(3)} = \sum_{\substack{k=1 \\ k\neq 11,12,32}}^{115} \eta_{ik}p_k^{(3)}\ , \qquad i=11,12,32.$$

To a limited extent, therefore, the *Wine and brandy* industry is able to offset the effects of the wine tax by shifting its output mix in favour of *Alcoholic beverages nec.* Note that, in the absence of any possibility for transformation, the *Wine and brandy* industry's output of *Alcoholic beverages nec* would decline along with its output of *Wine.* In that case, the specialist industry *Alcoholic beverages nec* would expand rapidly as it increased its market share.[8]

III.4 Other Structural Effects

While the primary impact of the wine tax falls on the alcoholic beverages sector, its influence also extends to other sectors of the economy in varying degrees. To illustrate the comparison, we have ranked all industries by the changes in their outputs and recorded the main gainers and losers in Table III.6.

Table III.6: Projected Effects (in Percentage Changes) of a Wine Tax on Industry Outputs — Main Gainers and Losers

Rank	Industry	Trade category (*a*)	Projection
1	Alcoholic beverages nec	IC	0.81
2	Ship and boat building	IC	0.19
3	Furniture, mattresses	IC	0.10
4	Building nec	NT	0.04
5	Cosmetics, toiletry	IC	0.03
6	Soft drinks, cordials	NT	0.03
7	Retail trade	NT	0.03
8	Ready mixed concrete	NT	0.02
9	Soap and detergents	IC	0.02
10	Concrete products	NT	0.02
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104	Prepared fibres	E	-1.88
105	Meat products	E	-2.13
106	Food products nec	E	-2.20
107	Flour and cereal products	E	-2.30
108	Agricultural machinery	IC & ER	-2.37
109	High rainfall zone	E	-2.40
110	Basic iron and steel	E	-2.55
111	Northern beef	ER	-3.07
112	Grapes	NT	-8.61
113	Wine and brandy	NT	-16.00

(*a*) The trade categories referred to in this table are export (E), export related (ER), import competing (IC) and nontraded (NT). See DPSV for a discussion of the method used to allocate the categories.

The industry that enjoys the largest increase in its output is *Alcoholic beverages nec,* a result that has already been discussed in detail. The other gainers are either nontraded or belong to a class of import competing manufacturing industries which sell to household consumption. The latter industries benefit from the shift in demand away from *Wine.*[9] Note, however, that their gains are very small.

Among the losers, the *Wine and brandy* industry and its supplier *Grapes*[10] are hardest hit. The others are either export industries themselves or sell a large part of their output to export industries. This time, the magnitude of the change in output cannot be considered trivial and, clearly, the deterioration in competitiveness of the export sector is the main effect of the wine tax outside the alcoholic beverages sector. Indeed, as discussed earlier, this effect is decisive in determining the change in aggregate employment.[11]

IV. Conclusion

We have described modifications to the data and implemented theory of ORANI which have enabled us to use the model to analyse the effects of changing indirect taxes on the products of the alcoholic beverages sector. This strategy of constructing special-purpose versions of a general-purpose multisectoral model has proved useful in a number of contexts. In each case detailed projections were required for some sector (industrial or regional) of the economy, accounting also for the interdependence of the sector with the rest of the economy. For ORANI-WINE the crucial modifications were

[8] Note that our results implicitly assume that *Alcoholic beverages nec* produced by the *Wine and brandy* industry (i.e., brandy) are perfect substitutes for the output of the specialist industry.

[9] The high ranking for *Ship and boat building* arises from the statistical treatment of the output of *Water Transport* and should be regarded as somewhat anomalous. See Meagher (1986) for a discussion of the problem.

[10] Just over 50 per cent of total sales of *Grapes* is accounted for by sales to the *Wine and brandy* industry.

[11] Despite the large fall in its output, the *Grapes* industry does not contribute significantly to the fall in employment of rural workers as it provides only a small share (1.7 per cent) of total employment in that occupation.

disaggregations of the input-output database to indentify wine production and grape growing as separate sectors, and generalization of the household demand specification to allow specific substitution effects between beer, wine and spirits within an "alcoholic beverages" nest in the utility function.

Our general equilibrium analysis of the effects of a wine tax elaborates a number of aspects of the problem which are only implicit or not handled at all in earlier Australian studies using partial-equilibrium techniques (see, for example, Tsolakis 1983). For example, our analysis accounts for the effects of the tax on the consumption of alcoholic beverage as a whole as well as on the composition of alcohol consumption; it includes cross-price elasticities between beer, wine and spirits, thus giving projections of the effects of the tax on consumption of all three alcoholic beverages; it is explicit about backward linkages from wine production to grape growing and includes full specifications of supply conditions in both these activities; finally it is able to project the effects of the tax on sectors not *directly* connected with the wine industry.

The general equilibrium results are correspondingly richer than those available from partial equilibrium studies. Within the alcoholic beverages sector they indicate (Table III.3) that, whilst spirit producers would gain from the wine tax, the measured degree of substitution between wine and beer is not sufficiently strong to present beer producers with gains in demand following the tax. As well as showing the adverse consequences for the grape growing industry (Table III.6), our projections emphasize the mild inflationary effects (Table III.2) which the tax has on the economy as a whole. These impinge most severely on the economy's export sectors (agriculture and mining, see Table III.6) which are unable to pass on cost increases in international markets.

Further work on this topic within a general equilibrium framework would benefit from two extensions of our existing specification. The first is to recognise that wine is not a homogeneous commodity. In particular bulk and premium wine should be distinguished. It is likely that the former is much more closely substitutable with beer than the latter. Storable packaging (winecasks) for bulk wine has now been available for long enough to have generated sufficient data to support econometric studies on this aspect of the wine market. The second extension is to recognise specialist dryland wine grape growing as an agricultural activity separate from grape growing in irrigated areas. The former is likely to be more vulnerable to contractions in the wine market. Growers in irrigated areas have alternative production possibilities (other fruits, etc.) lacked by dryland grape producers.

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