Who Gains from Australian Generic Wine R&D and Promotion?*

Xueyan Zhao, Kym Anderson and Glyn Wittwer**

February 2002

* Paper prepared for the AARES Annual Conference, Canberra, 13-15 February 2002. The authors are grateful for financial support from the Grape and Wine Research and Development Corporation, the Rural Industries Research and Development Corporation, and the Australian Research Council. Thanks are due also to Julian Alston and other discussants on an earlier draft presented at an international workshop on Understanding Developments in the World's Wine Markets, Adelaide, 11-12 October 2001.

** The authors were all at Adelaide University's School of Economics and Centre for International Economic Studies at the time this paper was first drafted. Since late 2001, Zhao has been with the Department of Econometrics and Wittwer with the Centre of Policy Studies, both of Monash University, Clayton, Vic.

Abstract

A multi-sectoral partial equilibrium model of the markets for two types of Australian grapes and wine (premium and non-premium) is developed to study the aggregate returns from different types of research and promotion investments by the industry and their distribution across actors in the market (grapegrowers, winemakers, wholesalers/retailers, domestic consumers, the tax office and foreign consumers). The distinction is made between premium and non-premium, since half the market is non-premium and yet virtually all the R&D and marketing efforts are focused on just premium products in an attempt to raise quality as consumers continue to move up-market. The results show that in the short run four-fifths (and in the longer run three-fifths) of the gains from cost-reducing R&D go to producers, with wineries faring better than grapegrowers; that producers get a far larger share of the benefit from promotion when it is targeted abroad than when it focuses on domestic consumers; and that foreign consumers of Australian wine enjoy one-tenth of the benefits of cost-reducing R&D and one-fifth of the benefits (in a willingness-to-pay sense) from promotion of 'Brand Australia' abroad in the short run, and even larger shares in the long run. Each producer is benefiting more per dollar of levy as the industry's aggregate output and export orientation rise.

Keywords: Economics of R&D, promotion, wine, equilibrium displacement modelling

JEL codes: C69, O33, Q13, Q16

Contact author:
Kym Anderson
Professor, School of Economics and
Executive Director
Centre for International Economic Studies
Adelaide University
Adelaide SA 5005
Phone (+61 8) 8303 4712
Fax (+61 8) 8223 1460
kym.anderson@adelaide.edu.au

Who Gains from Australian Generic Wine R&D and Promotion?

Xueyan Zhao, Kym Anderson and Glyn Wittwer

During the latter half of the 20th century the wine industry in many parts of the world has gradually become more professional in its approach to investing both in research and development (R&D) and in promotion. This has been particularly pronounced in the New World as the industry has corporatized and large firms have emerged,[1] and as export-oriented output has expanded.[2] Brand-level promotion can be and is undertaken by large firms, but since the vast majority of firms are tiny, even in the United States and Australia, many cannot afford mass media promotion campaigns. They therefore depend on generic promotion of their nation and region of origin. With respect to R&D, even large firms, let alone small ones, cannot on their own justify undertaking much large-scale research. As well, the public-good nature of both research and generic promotion is such that they are underinvested in unless done collectively. Hence grapegrowers and winemakers in countries such as Australia agree to pay a production-based annual levy to fund both of those activities. The Australian Government supplements those funds, matching them in the case of R&D on a dollar-for-dollar basis up to 0.5 per cent of the value of production (Brennan and Mullen 2002).

Who benefits from the investment of those funds? Does the distribution of benefits from R&D differ from that for promotion? To what extent do premium producers benefit relative to producers of lower-quality product? How do these outcomes change as the industry become more export-oriented? This paper outlines a methodology for addressing those questions. It then applies the model to Australian grape and wine industry data. The Australian case study is particularly timely at the moment for two reasons: because producers are contemplating raising the R&D levy they pay so as to at least reach the Federal Government's 0.5% matching funding

[1] The shares of national wine production held by the top five firms in 2000 are as follows: Australia 68%, New Zealand 80%, United States 73%, Argentina 50%, and Chile 47%. By contrast, they are much lower in the Old World where small cooperatives still dominate: 13% in France (excluding Champagne), 10% in Spain and 5% in Italy (Anderson, Norman and Wittwer 2001).

threshold; and because the industry has recently launched a major new marketing drive (WFA and AWBC 2000). As recent modelling results demonstrate (Anderson 2001; Anderson, Norman and Wittwer 2001), the latter is going to be essential if producer prices are not to decline over the next few years as the recent boom in plantings translates into ever-greater supplies of premium wines on the international market.

Specifically, R&D via Australia's Grape and Wine Research and Development Corporation (GWRDC) is currently funded by a levy of $5 per tonne of grapes ($2 per tonne from grapegrowers on grapes received by wineries, and $3 per tonne from wineries on the weight of grapes crushed for wine), which is matched by a similar grant from the Federal Government. As can be seen from Figure 1, there has been a significant increase in real dollar terms in the grape and wine R&D expenditure since early eighties as a result of industry expansion and increases in the levy rate. The annual R&D expenditure for 2000-01 reached $11.3 million in nominal terms. However, the producer proportion of that represents only about 0.3% of the value of production, well below the 0.5% limit to which matching government funding applies. Proposals are currently being considered by producers to raise the industry R&D levy and possibly to move to an ad valorem levy system so as to ensure funding moves with the product price as quality rises over time. The support for such a rise has been boosted by a recent benefit-cost study suggesting that the current portfolio of GWRDC research projects is expected to yield a 9:1 benefit/cost ratio and that a sample of past projects yielded ratios ranging from 7:1 to 76:1 (McLeod 2002).

Generic national promotion abroad is funded by a Federal Government grant plus a compulsory wine export levy based on the f.o.b. value of wine exported (0.2% of an exporter's first $10 million of sales, 0.1% for the next $40 million, and 0.05% for sales beyond $50 million per year). The manager of those funds is the Australian Wine and Brandy Corporation (AWBC). Generic regional promotion is funded by voluntary membership of regional associations. State governments have supplemented

[2] Between 1988 and 1999 wine production grew at 5.3 % per year in Australia, 2.8% in the United States, 2.4% in Chile and Uruguay, and 2.0% in New Zealand; and the share of global wine production that is exported rose from 15% to 25% (Anderson and Norman 2001, Tables 11 and 32).

the federal contributions from time to time (GWRDC 2001; AWBC 2001; Brennan and Mullen 2001).

The two producer groups and the government (on behalf of taxpayers and domestic consumers) are interested in maximizing the pay-offs from the investment for those funds. The government is also concerned about any spillovers to other producer groups, and any additional environmental and/or social outcomes generated from the expenditure of those public funds. There is also the issue of how much of the research outcome benefits wine consumers and producers in other countries, both gross and net of benefits to Australia from similar activities abroad.

Issues of interest include, among others, the returns from research investments versus those from promotion, the returns from grape R&D versus those from wine R&D versus those from marketing research, and returns from domestic promotion versus those from export promotion. Both the aggregate benefit/cost ratios of these broad types of investments, and the distribution of total returns among groups such as premium and non-premium grape growers, premium and non-premium winemakers, domestic retailers, taxpayers, and domestic and overseas consumers are of interest. The distributional issue relates to the question of who should pay for what types of investments: not only as between consumers (including as taxpayers) and producers, but also as between grape growers and wineries (given that much of the quality of a wine is determined in the vineyard prior to crushing). In addition, the impact on the government treasury via both the wholesale sales tax and the Goods and Services Tax (GST) will also be informative.

The returns from the various parts of this investment portfolio need to be analysed within a comprehensive, internally consistent framework. Just measuring the direct effect of, say, a new cost-reducing viticultural technology on grape growers' costs per tonne is insufficient, for it does not take into account the indirect flow-on effects to those further down the supply chain and the associated changes in prices and quantities. Determining the net economic welfare benefits for growers, winemakers and consumers requires an economic model that identifies explicitly the multi-stage

production process involved.[3] Even that leaves unmeasured any economic spillovers to other industries, and any social and environmental spillovers (both positive and negative).

There is a rapidly growing literature on the economic evaluation of research and promotion expenditures (see Alston, Norton and Pardey 1995). A common approach has been the use of a partial equilibrium, comparative static framework to measure effects on economic welfare within an industry or sector (Freebairn, Davis and Edwards 1982; Wohlgenant 1993; Alston and Chalfant (1999); Zhao *et al.* 2000). A set of demand and supply equations with general functional form are used to describe the relationships among various industry links in the supply chain and consumer groups (see, for example, Alston and Wohgenant 1990; Zhao, Mullen and Griffith 1997). The impacts of alternative R&D and promotion investments are modelled as exogenous variables that shift the relevant supply or demand curves, and the changes in prices and quantities resulting from new technologies or promotion are then obtained to estimate the welfare implications for various industry groups.

In this paper, we use a multi-sectoral partial equilibrium model of the markets for two types of Australian grapes and wine (premium and non-premium) to study the aggregate returns and their distributions from different types of research and promotion investments in the industry. The distinction between premium and non-premium is crucial, since half the market is non-premium and yet virtually all the R&D and marketing efforts are focused on just premium products in an attempt to raise quality as consumers continue to move up-market. The model is presented first, and the data and market parameters are described next. Results are then presented, before drawing out their implication in the final section of the paper.

The model

The structure of the model of the Australian wine industry is provided in Figure 1, where each rectangle represents a production function and each arrowed straight line

[3] The global average cost of a bottle of wine is shared roughly as follows: 10% to the grapegrower, 30% to the winery, 37% to transporters, wholesalers and retailers, and 23% to tax collectors (Wittwer, Berger and Anderson 2002).

the market for a product, with the arrowed end being the demand and the non-arrowed end being the supply of the product. Each oval represents a supply or demand schedule where an exogenous shift may occur.

Horizontally, the industry is disaggregated into premium and non-premium wine sectors. Vertically, the industry is separated into the following sectors: grape production, wine making, wine marketing and final consumption. This enables us to study implications of R&D and promotion investments in individual parts of the wine production and marketing chain.

We assume that participants in all sectors are profit-maximizers and the technologies are characterised by constant returns to scale. The economic equilibrium among sectors of the Australian wine industry can be modelled with general functional forms by Equations (1)-(36). Fifteen exogenous shifter variables are incorporated in the model. Variable notation is also shown in Figure 2.

Input supply to the premium and non-premium wine sectors:

(1) $X_p = X_p(w_p, w_{mp}, T_{Xp})$ *Supply of premium grapes*

(2) $X_p = X_{p1} + X_{np1}$ *Destinations for premium grapes*

(3) $X_{p2} = X_{p2}(w_{p2}, T_{Xp2})$ *Supply of premium wine specific inputs*

(4) $X_{p3} = X_{p3}(w_{p3}, T_{Xp3})$ *Supply of other premium winemaking inputs*

Equation (1) is the supply function for premium wine grapes, relating total quantity supplied X_p to own price w_p and the price of multi-purpose grapes w_{mp}. In other words, it is assumed that the premium grape growers can shift some of the production to multi-purpose grapes, through grafting for example, in response to changes in the relative prices of the two types of grapes. T_{Xp} is the supply shifter representing the impact of new technologies that reduce the costs of producing X_p. The identity given in Equation (2) shows that the premium grapes can be used for producing either premium wine (X_{p1}) or non-premium wine (X_{np1}). Less than 5% of premium grapes are used for non-premium wine production. Equations (3) and (4) are supply functions for two other aggregated inputs to premium wine production. X_{p2} represents fixed capital, human capital and other inputs that are specific to premium wine making.

These are relatively inelasticly supplied. X_{p3} represents mobile factors such as labour, chemical and other factor inputs that are non-specific to premium wine making. Supplies of these inputs are elastic. T_{Xp2} and T_{Xp3} are supply shifters for X_{p2} and X_{p3} respectively. X_{p2} can be used to represent technical changes in the premium wine making sector.

(5) $X_{mp} = X_{mp}(w_{mp}, w_p, T_{Xmp})$ *Supply of multipurpose grapes*

(6) $X_{mp} = X_{np2} + X_{dtd} + X_{dte}$ *Destinations for multipurpose grapes*

(7) $X_{np3} = X_{np3}(w_{np3}, T_{Xnp3})$ *Supply of non-premium wine specific inputs*

(8) $X_{np4} = X_{np4}(w_{np4}, T_{Xnp4})$ *Supply of other non-premium wine making inputs*

Equation (5) is the supply of multi-purpose grapes relating the quantity supplied to own price and the price of premium grapes, with T_{mp} as the supply shifter. Equation (6) shows that multi-purpose grapes can be used either for non-premium wine production (32%) or as dried and table grapes for domestic or export market. Equations (7) and (8) are supply functions for capital inputs (X_{np3}) and mobile inputs (X_{np4}) respectively into non-premium wine production, with T_{Xnp3} and T_{Xnp4} as supply shifters.

Demand for table grapes

(9) $X_{dtd} = X_{dtd}(w_{mp}, N_{Xdtd})$ *domestic demand for drying/table grapes*

(10) $X_{dte} = X_{dte}(w_{mp}, N_{Xdte})$ *overseas demand for drying table grapes*

Equations (9) and (10) are demand schedules for dried and table grapes for domestic (X_{dtd}) and export (X_{dte}) markets respectively. N_{Xdtd} and N_{Xdte} are the respective demand shifters.

Output-constrained input demand of the premium wine sector

(11) $X_{p1} = Y_p^* \, c'_{Yp,1}(w_p, w_{p2}, w_{p3})$ *demand for premium grapes*

(12) $X_{p2} = Y_p^* \, c'_{Yp,2}(w_p, w_{p2}, w_{p3})$ *demand for specific inputs*

(13) $X_{p3} = Y_p^* \, c'_{Yp,3}(w_p, w_{p2}, w_{p3})$ *demand for other inputs*

The above three equations are the output-constrained input demand for X_{p1}, X_{p2} and X_{p3}, derived using Shephard's Lemma. $c'_{Yp,i}(w_p, w_{p2}, w_{p3})$ (i=1, 2, 3) are partial derivatives of the unit cost functions $c_{Yp}(w_p, w_{p2}, w_{p3})$ (i=1, 2, 3).

Output-constrained input demand of the non-premium wine sector

(14) $X_{np1} = Y_{np} * c'_{Ynp,1}(w_p, w_{mp}, w_{np3}, w_{np4})$ *demand for premium grapes*

(15) $X_{np2} = Y_{np} * c'_{Ynp,2}(w_p, w_{mp}, w_{np3}, w_{np4})$ *demand for non- premium grapes*

(16) $X_{np3} = Y_{np} * c'_{Ynp,3}(w_p, w_{mp}, w_{np3}, w_{np4})$ *demand for specific inputs*

(17) $X_{np4} = Y_{np} * c'_{Ynp,4}(w_p, w_{mp}, w_{np3}, w_{np4})$ *demand for other inputs*

Equations (14)-(17) are the output-constrained input demand for non-premium wine production, also derived using Shephard's Lemma. $c'_{Ynp,i}(w_p, w_{mp}, w_{np3}, w_{np4})$ (i=1, …, 4) are partial derivatives of the unit cost functions $c_{Ynp}(w_p, w_{mp}, w_{np3}, w_{np4})$ (i=1, …, 4).

Market-clearing condition/supply of premium and non-premium wholesale wine:

(18) $v_p = c_{Yp}(w_p, w_{p2}, w_{p3})$ *supply of premium wine*

(19) $v_{np} = c_{Ynp}(w_p, w_{mp}, w_{np3}, w_{np4})$ *supply of non- premium wine*

The above market-clearing conditions specify that unit price for the output equals the unit cost of the production.

Destination of wine at the cellar door:

(20) $Y_p = Y_{pd1} + Y_{pe1}$ *premium wine destinations*

(21) $Y_{np} = Y_{npd1} + Y_{npe}$ *non-premium wine destinations*

Equations (20) and (21) show that both premium and non-premium producer wines are destined for either domestic and export markets.

Supply of wine marketing inputs:

(22) $Y_{pd2} = Y_{pd2}(v_{pd2}, T_{Ypd2})$ *supply of domestic premium wine marketing inputs*

(23) $Y_{pe2} = Y_{pe2}(v_{pe2}, T_{Ype2})$ *supply of export premium wine marketing inputs*

(24) $Y_{npd2} = Y_{npd2}(v_{npd2}, T_{Ynpd2})$ *supply of domestic non-premium wine marketing inputs*

Equations (22)-(24) show that the supplies of marketing inputs (Y_{pd2}, Y_{pe2} and Y_{npd2}) relate to own prices (v_{pd2}, v_{pe2} and v_{npd2}), with impacts of marketing R&D represented by the shifters (T_{Ypd2}, T_{Ype2} and T_{Ynpd2}).

Output-constrained input demand of the wine marketing sectors:

(25) $Y_{pd1} = Q_{pd} * c'_{Qpd,1}(v_p, v_{pd2})$ *for premium wine -- domestic*

(26) $Y_{pd2} = Q_{pd} * c'_{Qpd,2}(v_p, v_{pd2})$ *for premium wine marketing inputs – domestic*

(27) $Y_{pe1} = Q_{pe} * c'_{Qpe,1}(v_p, v_{pe2})$ *for premium wine -- export*

(28) $Y_{pe2} = Q_{pe} * c'_{Qpe,2}(v_p, v_{pe2})$ *for premium wine marketing inputs – export*

(29) $Y_{npd1} = Q_{npd} * c'_{Qnpd,1}(v_{np}, v_{npd2})$ *for non-premium wine -- domestic*

(30) $Y_{npd2} = Q_{npd} * c'_{Qnpd,2}(v_{np}, v_{npd2})$ *for non-premium wine marketing inputs -- domestic*

These are the output-constrained input demand for the three marketing sectors from Shephard's Lemma.

Market-clearing condition for the marketing sectors:

(31) $p_{pd} = c(v_p, v_{pd2})$ *premium wine domestic marketing*

(32) $p_{pe} = c(v_p, v_{pe2})$ *premium wine export marketing*

(33) $p_{npd} = c(v_{np}, v_{npd2})$ *non-premium wine domestic marketing*

These specify that unit output price for each of the three marketing sectors is equal to the unit cost function.

Final demand for wine:

(34) $Y_{npe} = Y_{npe}(v_{np}, N_{Ynpe})$ *overseas demand for non-premium wine*

(35) $Q_{pd} = Q_{pd}(p_{pd}, p_{npd}, N_{Qpd}, N_{Qnpd})$ *domestic demand for premium wine*

(36) $Q_{pe} = Q_{pe}(p_{pe}, N_{Qpe})$ *overseas demand for premium wine*

(37) $Q_{npd} = Q_{npd}(p_{pd}, p_{npd}, N_{Qpd}, N_{Qnpd})$ *domestic demand for non-premium wine*

These are the demand functions for the four final wine products/markets. The N's are demand shifters representing impacts of promotion or increase in product quality in individual markets. As can be seen from Equations (35) and (37), the premium and non-premium wines are assumed substitutes in the domestic market.

The above structural model defines an equilibrium status in all markets involved. When a new technology or promotion disturbs the system through an exogenous shock, a displacement from the base equilibrium results. By totally differentiating the system of equations at the initial equilibrium points, the displacement model that relates changes of endogenous variables to changes in exogenous shifters can be derived as follows, where $E(.)=\Delta(.)/(.)$ represents a small relative change of a variable (.). Definitions of all market parameters are given in Table 1. They refer to values at the initial equilibrium points. Integrability conditions such as symmetry and homogeneity conditions are imposed implicitly.

The model in equilibrium displacement format

Input supply to premium wine and non-premium wine sectors:

(1)' $EX_p = \varepsilon_{(Xp,\ wp)}(Ew_p - t_{Xp})$ *Supply of premium grapes*

(2)' $EX_p = \rho_{Xp1}EX_{p1} + \rho_{Xnp1}EX_{np1}$ *Destinations for premium grapes*

where $\rho_{Xp1}=X_{p1}/(X_{p1}+X_{np1})$ and $\rho_{Xnp1}=X_{p1}/(X_{p1}+X_{np1})$ are quantity shares.

(3)' $EX_{p2} = \varepsilon_{(Xp2,\ wp2)}(Ew_{p2} - t_{Xp2})$ *Supply of premium wine specific inputs*

(4)' $EX_{p3} = \varepsilon_{(Xp3,\ wp3)}(Ew_{p3} - t_{Xp3})$ *Supply of other premium wine making inputs*

(5)' $EX_{mp} = \varepsilon_{(Xmp,\ wmp)}(Ew_{mp} - t_{Xmp})$ *Supply of multipurpose grapes*

(6)' $EX_{mp} = \rho_{np2}E\ X_{np2} + \rho_{Xdtd}EX_{dtd} + \rho_{Xdte}EX_{dte}$ *Destinations for multipurpose grapes*

where $\rho_{Xnp2}=X_{np2}/(X_{np2}+X_{dt})$ and $\rho_{Xdt}=X_{dt}/(X_{np2}+X_{dt})$ are quantity shares.

(7)' $EX_{np3} = \varepsilon_{(Xnp3,\ wnp3)}(Ew_{np3} - t_{Xnp3})$ *Supply of non-premium wine specific inputs*

(8)' $EX_{np4} = \varepsilon_{(Xnp4,\ wnp4)}(Ew_{np4} - t_{Xnp4})$ *Supply of other non-premium wine making inputs*

Demand for drying and table grapes:

(9)' $EX_{dtd} = \eta_{(Xdtd,\ wmp)}(Ew_{mp} - n_{Xdtd})$ *domestic demand for drying/table grapes*

(10)' $EX_{dte} = \eta_{(Xdte,\ wdte)}(Ew_{mp} - n_{Xdte})$ *overseas demand for drying/table grapes*

Output-constrained input demand of the premium wine sector:

(11)' $EX_{p1} = -(\kappa_{p2}\sigma_{(Xp1,\ Xp2)} + \kappa_{p3}\sigma_{(Xp1,\ Xp3)})\ Ew_p + \kappa_{p2}\sigma_{(Xp1,\ Xp2)}Ew_{p2} + \kappa_{p3}\sigma_{(Xp1,\ Xp3)}Ew_{p3} + EY_p$ *demand for premium grapes*

(12)' $EX_{p2} = \kappa_{p1}\sigma_{(Xp1,\ Xp2)}Ew_p - (\kappa_{p1}\sigma_{(Xp1,\ Xp2)} + \kappa_{p3}\sigma_{(Xp2,\ Xp3)})\ Ew_{p2} + \kappa_{p3}\sigma_{(Xp2,\ Xp3)}Ew_{p3} + EY_p$ *demand for specific inputs*

(13)' $EX_{p3} = \kappa_{p1}\sigma_{(Xp1,\ Xp3)}Ew_p + \kappa_{p2}\sigma_{(Xp2,\ Xp3)}Ew_{p2} - (\kappa_{p1}\sigma_{(Xp1,\ Xp3)} + \kappa_{p2}\sigma_{(Xp2,\ Xp3)})Ew_{p3} + EY_p$ *demand for other inputs*

Output-constrained input demand of the non-premium wine sector:

(14)' $EX_{np1} = -(\kappa_{np2}\sigma_{(Xnp1,\ Xnp2)}+\kappa_{np3}\sigma_{(Xnp1,\ Xnp3)}+\kappa_{np4}\sigma_{(Xnp1,\ Xnp4)})Ew_p + \kappa_{np2}\sigma_{(Xnp1,\ Xnp2)}w_{mp} + \kappa_{np3}\sigma_{(Xnp1,\ Xnp3)}Ew_{np3} + \kappa_{np4}\sigma_{(Xnp1,\ Xnp4)}Ew_{np4} + EY_{np}$ *demand for premium grapes*

(15)' $EX_{np2} = -(\kappa_{np1}\sigma_{(Xnp1,\ Xnp2)}+\kappa_{np3}\sigma_{(Xnp2,\ Xnp3)}+\kappa_{np4}\sigma_{(Xnp2,\ Xnp4)})Ew_{mp} + \kappa_{np1}\sigma_{(Xnp1,\ Xnp2)}w_p + \kappa_{np3}\sigma_{(Xnp2,\ Xnp3)}Ew_{np3} + \kappa_{np4}\sigma_{(Xnp2,\ Xnp4)}Ew_{np4} + EY_{np}$ *demand for non- premium grapes*

(16)' $EX_{np3} = -(\kappa_{np1}\sigma_{(Xnp1,\ Xnp3)}+\kappa_{np2}\sigma_{(Xnp2,\ Xnp3)}+\kappa_{np4}\sigma_{(Xnp3,\ Xnp4)})Ew_{np3} + \kappa_{np1}\sigma_{(Xnp1,\ Xnp3)}w_p + \kappa_{np2}\sigma_{(Xnp2,\ Xnp3)}Ew_{mp} + \kappa_{np4}\sigma_{(Xnp3,\ Xnp4)}Ew_{np4} + EY_{np}$ *demand for specific inputs*

(17)' $EX_{np4} = -(\kappa_{np1}\sigma_{(Xnp1,\ Xnp4)}+\kappa_{np2}\sigma_{(Xnp2,\ Xnp4)}+\kappa_{np3}\sigma_{(Xnp3,\ Xnp4)})Ew_{np4} + \kappa_{np1}\sigma_{(Xnp1,\ Xnp4)}w_p + \kappa_{np2}\sigma_{(Xnp2,\ Xnp4)}Ew_{mp} + \kappa_{np3}\sigma_{(Xnp3,\ Xnp4)}Ew_{np3} + EY_{np}$ *demand for other inputs*

Market-clearing condition/supply of premium and non-premium wholesale wine:

(18)' $Ev_p = \kappa_{p1}Ew_p + \kappa_{p2}Ew_{p2} + \kappa_{p3}Ew_{p3}$ *supply of premium wine*

(19)' $Ev_{np} = \kappa_{np1}Ew_p + \kappa_{np2}Ew_{mp} + \kappa_{np3}Ew_{np3} + \kappa_{np4}Ew_{np4}$ *supply of non- premium wine*

Destination of wine at the cellar door:

(20)' $EY_p = \theta_{pd}EY_{pd1} + \theta_{pe}EY_{pe1}$ *premium wine destinations*

(21)' $EY_{np} = \theta_{npd}EY_{npd1} + \theta_{npe}EY_{npe}$ *non-premium wine destinations*

Supply of wine marketing inputs:

(22)' $EY_{pd2} = \varepsilon_{(Ypd2,\ vpd2)}(Ev_{pd2} - t_{Ypd2})$ *supply of domestic premium wine marketing inputs*

(23)' $EY_{pe2} = \varepsilon_{(Ype2,\ vpe2)}(Ev_{pe2} - t_{Ype2})$ *supply of export premium wine marketing inputs*

(24)' $EY_{npd2} = \varepsilon_{(Ynpd2,\ vnpd2)}(Ev_{npd2} - t_{Ynpd2})$
supply of domestic non-premium wine marketing inputs

Output-constrained input demand of the wine marketing sectors:

(25)' $EY_{pd1} = -\lambda_{pd2}\sigma_{(Ypd1,\ Ypd2)}Ev_p + \lambda_{pd2}\sigma_{(Ypd1,\ Ypd2)}Ev_{pd2} + EQ_{pd}$
for premium wine -- domestic

(26)' $EY_{pd2} = \lambda_{pd1}\sigma_{(Ypd1,\ Ypd2)}Ev_p - \lambda_{pd1}\sigma_{(Ypd1,\ Ypd2)}Ev_{pd2} + EQ_{pd}$
for premium wine marketing inputs – domestic

(27)' $EY_{pe1} = -\lambda_{pe2}\sigma_{(Ype1,\ Ype2)}Ev_p + \lambda_{pe2}\sigma_{(Ype1,\ Ype2)}Ev_{pe2} + EQ_{pe}$
for premium wine -- export

(28)' $EY_{pe2} = \lambda_{pe1}\sigma_{(Ype1,\ Ype2)}Ev_p - \lambda_{pe1}\sigma_{(Ype1,\ Ype2)}Ev_{pe2} + EQ_{pe}$
for premium wine marketing inputs – export

(29)' $EY_{npd1} = -\lambda_{npd2}\sigma_{(Ynpd1,\ Ynpd2)}Ev_{np} + \lambda_{npd2}\sigma_{(Ynpd1,\ Ynpd2)}Ev_{npd2} + EQ_{npd}$
for non-premium wine -- domestic

(30)' $EY_{npd2} = \lambda_{npd1}\sigma_{(Ynpd1,\ Ynpd2)}Ev_{np} - \lambda_{npd1}\sigma_{(Ynpd1,\ Ynpd2)}Ev_{npd2} + EQ_{npd}$
for non-premium wine marketing inputs -- domestic

Market-clearing condition for the marketing sectors:

(31)' $Ep_{pd} = \lambda_{pd1}Ev_p + \lambda_{pd2}Ev_{pd2}$ *premium wine domestic marketing*

(32)' $Ep_{pe} = \lambda_{pe1}Ev_p + \lambda_{pe2}Ev_{pe2}$ *premium wine export marketing*

(33)' $Ep_{npd} = \lambda_{npd1}Ev_{np} + \lambda_{npd2}Ev_{npd2}$ *non-premium wine domestic marketing*

Final demand for wine:

(34)' $EY_{npe} = \eta_{(Ynpe,\ vnpe)}(Ev_{np} - n_{Ynpe})$ *overseas demand for non-premium wine*

(35)' $EQ_{pd} = \eta_{(Qpd,\ ppd)}(Ep_{pd} - n_{Qpd}) + \eta_{(Qpd,\ pnpd)}(Ep_{npd} - n_{Qnpd})$ *domestic demand for premium wine*

(36)' $EQ_{pe} = \eta_{(Qpe,\ ppe)}(Ep_{pe} - n_{Qpe})$ *overseas demand for premium wine*

(37)' $EQ_{npd} = \eta_{(Qnpd,\ ppd)}(Ep_{pd} - n_{Qpd}) + \eta_{(Qnpd,\ pnpd)}(Ep_{npd} - n_{Qnpd})$
domestic demand for non-premium wine

The data

The inputs required for the model in Equations (1)'-(36)' are in three parts: (i) base equilibrium values for all sectors and markets that summarize the industry prior to the shocks to be considered; (ii) market parameters that describe producer and consumer responsiveness to any price changes, and (iii) the values of exogenous variables that quantify the effects of R&D and promotion.

The database used for the base equilibrium for 1996 and 2005 is adapted from the model of global wine markets outlined in Anderson, Norman and Wittwer (2001) and Wittwer, Berger and Anderson (2002), which describe the sectoral disaggregation of the Australian wine industry as projected to 2005. As it often takes up to seven years before newly planted vines are fully bearing, the projection of production to 2005 based on planting areas up to 1999 is likely to be reasonably robust. The disaggregation between premium and non-premium wines is based on containers, with premium wines referring to those in bottles of 1.5 litres or less and non-premium otherwise.

The input cost structures for industry sectors are adapted and reconstructed from the database in Wittwer, Berger and Anderson (2002). Inputs other than grapes to the two winemaking sectors are grouped into two aggregated inputs: capital inputs and mobile factors. The capital inputs refer to fixed capital, human capital and other inputs that are specific to wine making and that have relatively inelastic supplies. The mobile factor inputs include all other factors such as labour, chemicals and other mobile factors that are non-specific to the wine industry and that are more mobile. These therefore have relatively elastic supplies. The inputs to wine marketing sectors are grouped into wholesale wine inputs and other marketing inputs. The cost structures for marketing sectors are based in part on the margin information in Wittwer, Berger and Anderson (2002), as are the splits among domestic and export destinations for both premium and non-premium wines. The base values and the resulting cost shares are summarized in Table 1. We show them for both 2005 and, for comparative purposes, for 1996 before the recent dramatic increase in vine plantings.

The market elasticity values used are given in Table 2. On the supply side these relate to both a short-term (say two-year) and a longer-term (say seven-year) adjustment period, and are specified according to limited empirical studies and subjective judgement. On the demand side, in addition to including input substitution and own-price elasticities, we include a cross-price elasticity of final demand between premium and non-premium wine for the domestic market. Sensitivity analysis to changes of these parameter values is helpful in determining the relative importance of improving on those estimates.

There are fifteen exogenous variables in the model that can be used to shift the various demand and supply schedules and thus to model the impacts of various R&D and promotion investments on various industry sectors. In this study, we concentrate on estimating the impacts of five R&D and promotion scenarios:

(1) R&D in premium grape production;
(2) R&D in premium wine making;
(3) R&D in the domestic marketing sector for premium wine;
(4) premium wine promotion or quality change in the domestic market; and
(5) premium wine promotion or quality change in the export market.

In each case, a one per cent vertical parallel shift of the relevant supply or demand curve is assumed. In other words, we examine the impacts of a 1% cost reduction in the relevant sector in the case of R&D and a 1% increase in consumers' willingness to pay due to promotion or product quality improvement.

Results of the impacts of alternative R&D and promotion investments

With specified values for the base equilibrium, market elasticities and exogenous shifters, the equilibrium displacement model in Equations (1)'-(37)' can be solved to obtain the percentage changes in all price and quantity variables for each policy scenario. Changes in economic surpluses are then calculated for each of the industry groups involved.

The economic welfare results for the five scenarios are summarised in Table 3 for the short run and in Table 4 for the longer run. For each case, total non-government

economic welfare gains and wine tax revenue changes are shown in 2001 AUD (converted from 1999 $US millions, the unit of measurement in the model from which the data are drawn, simply by multiplying by 2). Table 3 and 4 provide the proportional distribution of the welfare effects of each shock among grapegrowers, wineries, retailers, domestic and overseas consumers. They also show the effects on the two types of tax revenues collected from industry (the recently introduced Wine Equalization Tax and the Goods and Services Tax – see Wittwer and Anderson (2002) for an analysis of those tax changes). In the interest of brevity the price and quantity changes for each scenario are not presented, but they are available from the authors.

What do the results reveal, focusing on the 2005 projections (with the 1996 results being left until the end)? Consider the first column of Table 3. It shows how a 1% shift downwards in the premium grape supply curve because of productivity enhancing R&D would, in the short run, benefit mostly but not only premium producers: 40% of the non-government economic welfare gain would go to the grapegrowers and 36% to the makers of premium wine. Most of the rest is shared with domestic and overseas consumers (8% and 10% respectively). The reason that some of the benefit goes to consumers is because, given the partial equilibrium setting, the consumers enjoy lower price and higher quantity as a result of lower production costs. The total gain is $13.8 million per year, less a 0.2 million loss in tax. This is roughly the budget of the Grape and Wine Research and Development Corporation for 2002-03. The ad valorem tax revenue is reduced because the increased quantity cannot compensate the reduced price, due in part to the assumed inelastic demand, so the wholesale and retail values for wine are both reduced as a result of cost reduction. In the longer term, as grapegrowers expand their plantings in response to the new cost-reducing technologies, the net welfare gain is only slightly greater but a larger share of that benefit (almost one-third) goes to consumers at the expense of grapegrowers whose share falls from 40% to 25% -- yet the share to winemakers falls very little (compare column 1 in Tables 3 and 4).

If instead the R&D is directed toward premium wine (rather than grape) production, the majority of the short-run welfare gains (57%) go to premium wineries and only 24% goes to ~~premium~~ grapegrowers, with 15% going to consumers. The net benefit of

that shock would be $21 million per year, of which 9% goes to consumers abroad.[4] This gain is greater than the short-run gain in the grape R&D scenario ($14 million pa), even though it involved a similar 1% shock, because of the large additional value added in the supply chain by the winery. That 57% share of the gain to wineries is diminished over time and in the longer run scenario of Table 4 is only 45%, with the consumers' share rising from 15% to 24%, equalling the grapegrowers' share which hardly changes over that adjustment period.

If there were to be productivity gains in domestic marketing, only one-eighth of the gains from that would accrue to the marketers themselves, due to the highly elastic and non-specialised nature of the supply of wine marketing/retailing inputs. Most (86%) would go to domestic consumers, with a total of only 6% also going to grapegrowers and winemakers. This holds in the longer term too. A similar distribution would result from domestic promotion of premium wine (or an improvement in quality of premium wine – see the 4th set of columns of Tables 3 and 4). In that scenario, notice the effect on tax revenue is considerably more sizeable than for the other scenarios (bottom rows of Tables 3 and 4). This is because a 1% shift in the retail market would result in a larger increase in the total industry values than that from a same 1% shift in the markets earlier in the chain.

The final set of columns is of particular interest to those engaged in the industry's efforts to boost marketing abroad of Australian premium wine (WFA and AWBC 2001). It shows the distributional effects of such an initiative (or equivalently in this model, of an increase in the quality of such wine, for example via R&D). They are very different from the effects of cost-reducing R&D. Specifically, in the short run ~~premium~~ grapegrowers gain half the benefits and premium winemakers gain half as much again. Non-premium producers, on the other hand, enjoy almost no benefits from such promotion. Certainly overseas consumers benefit in the sense that they are paying much lower than what they are willing to pay after the promotion.[5] They get 20% of the total measured welfare gain in the short run. These percentages add to more than 100 because domestic consumers lose substantially from the price-raising

[4] For simplicity we assume throughout that, in the time frame considered here, there are no beneficial spillovers to producers abroad in terms of the new technologies lowering their costs of production.

effect of the promotion abroad, due to the reduced supply to domestic market as more wine is going overseas. In the longer run (Table 4) the effects are similar but with somewhat more benefit/less loss to consumers and somewhat less benefit to both grapegrowers and winemakers.

How do the above results for 2005 compare with what they would have been in 1996? The differences are minor in terms of the distributional shares, despite the fact that in 2005, 70% of Australian premium wine is expected to be sold abroad whereas in 1996 that share was only 49% (see the data in Table 1). The biggest difference is with premium grape R&D: the share to grape producers is lower in 1996; for example, in the long term, the proportional loss to producers of multipurpose (i.e., non-premium wine) grapes would have been greater back in 1996 than it would be in 2005.

However, when expressed in terms of dollars, the differences between 1996 and 2005 are huge, thanks to the dramatic growth of the industry's plantings in the latter 1990s. For example, the aggregate estimated benefit from the same extent of cost reduction in either grape or wine R&D in 1996 is only two-fifths that of 2005, while the difference in the aggregate benefit from the same promotional effort in export markets is even greater. Table 5 summarizes these numbers, drawn from the first and final sets of columns in Table 4.

It is interesting to compare our results for the wine industry to that of a similar study for the beef industry (Zhao 1999), not least because it indicates how sensitive the welfare distribution results are to assumed values of market elasticities and model specification. Both industries involve a vertical chain of farm production, post-farm processing, marketing, and domestic and export consumption; are significant exporters; and have differentiated products. Details of the comparison are in the Appendix. Post-farm processors and marketers in the case of beef are found to benefit little from R&D and promotion because that study assumed highly elastic supply for those sectors. As a result, most of the welfare gains go to domestic consumers. In addition, due to the assumption also of joint processing (a feature not in the wine industry), domestic consumers gain most of the welfare from overseas promotion.

[5] Although see the important comments by Alston and Chalfant (1999) on the difficulties of inferring

Implications and conclusions

Numerous qualifications need to be kept in mind in interpreting the above results. Obviously the numbers depend heavily on the elasticities assumed (see Table 2). The comparison of the results in Table 3 with those in Table 4 provide a form of sensitivity analysis with respect to grape and wine supply elasticities. Systematic account for uncertainty in market parameters, as undertaken in Zhao *et. al.* (2000) and Griffiths and Zhao (2000), would add further insights.

It also should be kept in mind that this model only captures partial equilibrium effects within the Australian industry and for overseas consumers, leaving unmeasured any economic spillovers to other industries (including the grape and wine industry abroad) and any social and environmental spillovers (both positive and negative).

As well, the economic surplus measure of consumer welfare is not without problems (see Just, Heuth and Schmitz 1982), particularly when used to measure gains from promotion (Alston and Chalfant 1999). The only sense in which it is used here is as a 'willingness-to-pay' measure.

It would seem, though, that the major direct gainers within the grape and wine industry from R&D will be the producers, and more so as the industry becomes more and more export focused over the next decade. In the case of promotion abroad, the gains are even more concentrated on producers, with domestic consumers losing because of the price-raising effect such promotion has on the home market. In that case, the justification for government subsidization depends on spillovers in the form of in-bound tourism and the like.

Finally, with the industry re-considering the R&D levy in the light of the apparently high rewards from research to date (McLeod 2002) and the fact that the current levy is well below the 0.5% threshold that attracts maximum government matching funds, now is the time to question the method of levying in addition to raising its level. To

benefits to consumers from advertising.

date it has been a weight-based measure, and so has declined as a percent of the gross value of production over the past decade as the price of wine has risen with quality improvements and with increased demand in export markets. An easy way to prevent that continuing is to switch to an ad valorem levy rate. That would have the additional effect of ensuring that higher-quality producers pay more per tonne. Since most of the promotion and much of the R&D is focused on premium rather than non-premium products, that would also seem a more equitable way to levy producers.

References

Alston, J.M. and J.A. Chalfant (1999), "Advertising and Consumer Welfare", CIES Discussion Paper 99/09, Adelaide University, June.

Alston, J.M., G.W. Norton and P.G. Pardey (1995), *Science Under Scarcity: Principles and Practice for Agricultural Research Evaluation and Priority Setting*, Ithaca and London: Cornell University Press.

Alston, J.M. and J.A. Chalfant (1999), "Advertising and Consumer Welfare", CIES Discussion Paper 99/09, Adelaide University, June.

Alston, J.M. and M.K. Wohlgenant (1990), "Measuring Research Benefits Using Linear Elasticity Equilibrium Displacement Models", Appendix 2 in *Mullen J.D. and J.M. Alston, Returns to the Australian Wool Industry from Investment in R&D*, Rural & Resource Economics Report No. 10, New South Wales Agriculture and Fisheries, Sydney.

Anderson, K. (2001), 'The Internationalization of Australia's Wine industry', Paper presented at the CIES-sponsored AWITC Post-Conference Workshop on Understanding Developments in the World's Wine Markets, Stamford Plaza Hotel, Adelaide, 11-12 October.

Anderson, K., D. Norman and G. Wittwer (2001), 'Globalization and the World's Wine Markets: Overview', Opening paper at the CIES-sponsored AWITC Post-Conference Workshop on Understanding Developments in the World's Wine Markets, Stamford Plaza Hotel, Adelaide, 11-12 October.

AWBC (2001), *Annual Report 2000-01*, Adelaide: Australian Wine and Brandy Corporation.

Brennan, J.P. and J.D. Mullen (2002), 'Australia's Research Levy System', in *Tomorrow's Agriculture: Incentives, Institutions, Infrastructure and*

Innovations, edited by G.H. Peters and P. Pingali, Aldershot: Ashgate for the IAAE (forthcoming).

Freebairn, J.W., J.S. Davis and G.W. Edwards (1982), "Distribution of Research Gains in Multistage Production Systems", *American Journal of Agricultural Economics*, 64(1): 39-46, February.

Griffiths, W. and X. Zhao (2000), "A Unified Approach to Sensitivity Analysis in Equilibrium Displacement Models: Comment", *American Journal of Agricultural Economics*, 82(1)(February): 236-240.

GWRDC (2001), *Annual Operational Plan 2000/2001*, Adelaide: Grape and Wine Research and Development Corporation.

Just, R.E., D.L. Hueth and A. Schmitz (1982), *Applied Welfare Economics and Public Policy*, Englewood Cliffs: Prentice-Hall.

McLeod, R. (2002), *Ex Ante and Ex Post Cost Benefit Analysis of the GWRDC's Project Portfolio*, Adelaide: Grape and Wine R&D Corporation, February.

WFA (Winemakers' Federation of Australia) and AWBC (Australian Wine and Brandy Corporation) (2000), *The Marketing Decade: Setting the Australian Wine Marketing Agenda 2000- 2010*, Adelaide: WFA.

Wittwer, G. and K. Anderson (2002), 'Impact of the GST and Wine Tax Reform on Australia's Wine Industry: A CGE Analysis', *Australian Economic Papers* 41(1), March (forthcoming).

Wittwer, G., N. Berger and K. Anderson (2002), 'A Model of the World's Wine Markets', *Economic Modelling* Volume 19 (forthcoming, but an earlier version is downloadable at www.adelaide.edu.au/CIES/wine.htm#other).

Wohlgenant, M.K. (1993), "Distribution of Gains from Research and Promotion in Multi-Stage Production Systems: The Case of the U.S. Beef and Pork Industries", *American Journal of Agricultural Economics* 75(3): 642-51, August.

Zhao, X. (1999), The Economic Impacts of New Technologies and Promotions on the Australian Beef Industry, PhD thesis, University of New England, Armidale.

Zhao, X., G. Griffith and J. Mullen (2001), "Returns to New Technologies in the Australian Beef Industry: On-farm Research versus Off-farm Research", *Australasian Agribusiness Review* 9: 1-18.

Zhao, X., J.D. Mullen and G.R. Griffith (1997), "Functional Forms, Exogenous Shifts, and Economic Surplus Changes", *American Journal of Agricultural Economics*, 79(4): 1243-51, November.

Zhao, X., W.Griffiths, G.Griffith and J.Mullen (2000), "Probability Distributions for Economic Surplus Changes: The Case of Technical Change in the Australian Wool Industry", *Australian Journal of Agricultural and Resource Economics* 44(1): 83-106, March.

Table 1(a): Base equilibrium values projected for 2005 (in 1999 $US million)

Grapes	**Premium Grapes** *Total value:* TV_{Xp} = 675 *Destinations:* ρ_{Xp1}=0.96 (prem. wine), ρ_{Xnp1}=0.04 (non-prem. wine) **Multi-purpose Grapes** *Total value:* TV_{Xmp} = 245 *Destinations:* ρ_{Xdtd}=0.26 (domestic fruit) ρ_{Xdte}=0.42 (export fruit) ρ_{Xnp2}=0.32 (non-prem. wine making)
Wine Production	**Premium Wine** *Total value:* TV_{Yp} = 2,392 *Cost Shares:* κ_{p1}=0.27 (prem. grapes) κ_{p2}=0.43 (fixed capitals) κ_{p3}=0.30 (other mobile) **Non-premium Wine** *Total value:* TV_{Ynp} = 326 *Cost Shares:* κ_{np1}=0.09 (prem. grapes) κ_{np2}=0.24 (multi-purpose grapes) κ_{np3}=0.43 (fixed capitals) κ_{np4}=0.24 (other mobile)
Marketing Sectors and Final Wines	**Premium Wine** *Domestic:* *producer value before WET (tax):* TV_{Ypd1} = 718 *final wine value after GST:* TV_{Qpd}^{*} = 1,726 *cost shares for marketing:* λ_{pd1}=0.59 (wine) λ_{pd2}=0.41 (retail marketing inputs) *Export:* *producer value:* TV_{Ype1}= 1,674 *f.o.b. value:* TV_{Qpe} = 1,840 *cost shares for marketing:* λ_{pe1}=0.91 (wine) λ_{pe2}=0.09 (marketing inputs) **Non-premium Wine** *Domestic:* *producer value before WET (tax):* TV_{Ynpd1} = 280 *final wine value after GST:* TV_{Qnpd}^{*} = 652 *cost shares for marketing:* λ_{npd1}=0.61 (wine) λ_{pd2}=0.39 (retail marketing inputs) *Export:* *producer/ f.o.b. value:* TV_{Ynpe}= 46

Table 1(b): Base equilibrium values for 1996 (in 1999 $US million)

Grapes	**Premium Grapes** *Total value:* TV_{Xp} = 272 *Destinations:* ρ_{Xp1}=0.86 (prem. wine), ρ_{Xnp1}=0.14 (non-prem. wine) **Multi-purpose Grapes** *Total value:* TV_{Xmp} = 174 *Destinations:* ρ_{Xdtd}=0.21 (domestic fruit) ρ_{Xdte}=0.29 (export fruit) ρ_{Xnp2}=0.50 (non-prem. wine making)
Wine Production	**Premium Wine** *Total value:* TV_{Yp} = 870 *Cost Shares:* κ_{p1}=0.27 (prem. grapes) κ_{p2}=0.48 (fixed capitals) κ_{p3}=0.25 (other mobile) **Non-premium Wine** *Total value:* TV_{Ynp} = 414 *Cost Shares:* κ_{np1}=0.09 (prem. grapes) κ_{np2}=0.21 (multi-purpose grapes) κ_{np3}=0.47 (fixed capitals) κ_{np4}=0.23 (other mobile)
Marketing Sectors and Final Wines	**Premium Wine** *Domestic:* *producer value before WST:* TV_{Ypd1}= 427 *retail value:* TV_{Qpd} = 790 *cost shares for marketing:* λ_{pd1}=0.54 (wine) λ_{pd2}=0.46 (retail marketing inputs) *Export:* *producer value:* TV_{Ype1}= 444 *f.o.b. value:* TV_{Qpe} = 488 *cost shares for marketing:* λ_{pe1}=0.91 (wine) λ_{pe2}=0.09 (export marketing inputs) **Non-premium Wine** *Domestic:* *producer value before WST:* TV_{Ynpd1} = 331 *retail value:* TV_{Qnpd} = 495 *cost shares for marketing:* λ_{npd1}=0.67 (wine) λ_{pd2}=0.33 (retail marketing inputs) *Export:* *producer/ f.o.b. value:* TV_{Ynpe}= 50

Table 2: Market elasticity values assumed

Grape supply

Short-Run: $\varepsilon_{(Xp,\ wp)}=0.4$ $\varepsilon_{(Xmp,\ wmp)}=0.5$ $\varepsilon_{(Xmp,\ wp)}=-0.2$

Long-Run: $\varepsilon_{(Xp,\ wp)}=0.8$ $\varepsilon_{(Xmp,\ wmp)}=1.0$ $\varepsilon_{(Xmp,\ wp)}=-0.6$

Other wine-making input supply

Short-Run:

Premium: $\varepsilon_{(Xp2,\ wp2)}=0.4$ $\varepsilon_{(Xp3,\ wp3)}=5$

Non-Premium: $\varepsilon_{(Xnp3,\ wnp3)}=0.5$ $\varepsilon_{(Xp3,\ wp3)}=5$

Long-Run:

Premium: $\varepsilon_{(Xp2,\ wp2)}=0.8$ $\varepsilon_{(Xp3,\ wp3)}=5$

Non-Premium: $\varepsilon_{(Xnp3,\ wnp3)}=1.0$ $\varepsilon_{(Xp3,\ wp3)}=5$

Table grape demand

$\eta_{(Xdtd,\ wdtd)} = -0.6$, $\eta_{(Xdte,\ wdte)} = -5$,

Input substitution for winemaking

Premium: $\sigma_{(Xpi,\ Xpj)} = 0.1$ (i, j = 1, 2 and 3; i<j)

Non-Premium: $\sigma_{(Xnpi,\ Xnpj)} = 0.1$ (i, j = 1, 2, 3 and 4; i<j)

Wine marketing input supply

Premium: $\varepsilon_{(Ypd2,\ vpd2)}=2$ $\varepsilon_{(Ype2,\ vpe2)}=2$

Non-Premium: $\varepsilon_{(Ynpd2,\ vnpd2)}=2$

Input substitution for marketing

Premium: $\sigma_{(Ypd1,\ Ypd2)} = 0.1$ $\sigma_{(Ype1,\ Ype2)} = 0.1$

Non-Premium: $\sigma_{(Ynpd1,\ Ynpd2)} = 0.1$

Final wine demand

Premium: $\eta_{(Qpd,\ ppd)} = -0.8$ $\eta_{(Qpe,\ ppe)} = -5$

Non-Premium: $\eta_{(Qnpd,\ pnpd)} = -0.9$ $\eta_{(Ynpe,\ vnpe)} = -7.0$

Cross-price : $\eta_{(Qnpd,\ ppd)} = 0.3$

Table 3: Economic welfare changes (in 2001 AUD million) and shares of total welfare changes (in %) to various groups, and tax revenue changes, from alternative investment scenarios: 2005 vs 1996 – short run

Non-Gov't Welfare Gains (% shares)	**Scenario 1 (t_{Xp}=-1%) Prem. Grape Cost R&D**		**Scenario 2 (t_{Xp2}=-1%) Prem. Wine Cost R&D**		**Scenario 3 (t_{Ypd2}=-1%) Dom. Marketing Cost R&D**		**Scenario 4 (n_{Qpd}=1%) Prem. Dom. Prom or Quality**		**Scenario 5 (n_{Qpe}=1%) Prem. Exp. Prom or Quality**	
	2005	**1996**	**2005**	**1996**	**2005**	**1996**	**2005**	**1996**	**2005**	**1996**
ΔPS_{Xp} ~~Prem.Grapes producers~~	41.7	39.0	23.5	21.9	2.5	2.6	2.5	4.2	48.8	50.8
ΔPS_{Xmp} ~~Multi-P Grape producers~~	-1.3	-3.2	0.5	1.1	-0.1	-0.9	-0.2	-0.2	1.2	2.9
$\Delta PS_{Xp}+\Delta PS_{Xmp}$ Grape producers Subtotal	**40.4**	**35.8**	**24.0**	**23.0**	**2.4**	**1.7**	**2.3**	**4.0**	**50.0**	**53.7**
ΔPS_{Xp2} Prem. Wineries	35.6	33.8	57.0	59.1	4.5	6.1	3.7	9.2	77.2	89.1
ΔPS_{Xnp3} Non-prem. Wineries	1.3	4.4	-0.7	-2.0	-1.3	-5.5	-1.8	-3.7	-0.5	-1.4
$\Delta PS_{Xp2}+\Delta PS_{Xnp3}$ Wineries Subtotal	**36.9**	**38.2**	**56.3**	**57.1**	**3.2**	**0.6**	**1.9**	**5.5**	**76.7**	**87.7**
$\Delta PS_{Xp3}+\Delta PS_{Xnp4}$ Mobile Factors Gains	**2.5**	**2.0**	**2.5**	**1.9**	**0.2**	**-0.3**	**-0.1**	**0.3**	**5.2**	**4.5**
ΔPS_{Ypd2}	0.6	0.9	0.8	1.3	14.5	17.3	12.5	14.1	-5.8	-8.6
ΔPS_{Ynpd2}	0.1	0.3	-0.2	-0.3	-1.2	-2.5	-1.5	-1.8	0.5	0.9
ΔPS_{Ype2}	1.9	1.5	2.0	1.7	-0.9	-1.0	-1.3	-1.2	4.9	5.4
Marketing Sector Subtotal	**2.6**	**2.7**	**2.6**	**2.7**	**12.4**	**13.8**	**9.7**	**11.1**	**-0.4**	**-2.3**
ΔCS_{Xdtd}	0.3	0.7	-0.1	-0.2	0.02	0.2	0.1	0.1	-0.3	-0.6
ΔCS_{Qpd}	5.9	7.7	6.0	8.4	82.8	84.3	88.9	79.6	-48.3	-58.6
ΔCS_{Qnpd}	1.7	4.0	-0.3	-0.8	2.9	3.5	2.8	4.5	-3.0	-6.5
Domestic Consumers Subtotal	**7.9**	**12.4**	**5.6**	**7.4**	**85.7**	**88.0**	**91.8**	**84.2**	**-51.6**	**-65.7**
ΔCS_{Xdte}	0.6	0.9	-0.2	-0.3	0.04	0.3	0.1	0.1	-0.5	-0.8
ΔCS_{Qpe}	8.9	7.4	9.3	8.4	-4.1	-4.5	-5.9	-5.6	20.9	23.6
ΔCS_{Ynpe}	0.2	0.6	-0.1	-0.2	0.2	0.5	0.2	0.4	-0.3	-0.8
Overseas Consumers Subtotal	**9.7**	**8.9**	**9.0**	**7.9**	**-3.9**	**-3.7**	**-5.6**	**-5.1**	**20.1**	**22.0**
Total, %	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**
Total, AUD million	**13.8**	**5.4**	**21.0**	**8.4**	**13.9**	**6.9**	**32.6**	**15.8**	**31.8**	**9.9**
Tax revenue changes (AUD million)										
Wholesale sales tax	-0.14	-0.12	-0.16	-0.20	0.88	0.56	2.52	1.98	2.20	1.94
GST	-0.04		-0.04		-0.34		2.24		0.46	
Total	**-0.2**	**-0.1**	**-0.2**	**-0.2**	**0.5**	**0.6**	**4.8**	**2.0**	**2.7**	**1.9**

Table 4: Economic welfare changes (in 2001 AUD million) and shares of total welfare changes (in %) to various groups, and tax revenue changes, from alternative investment scenarios: 2005 vs 1996 – long run

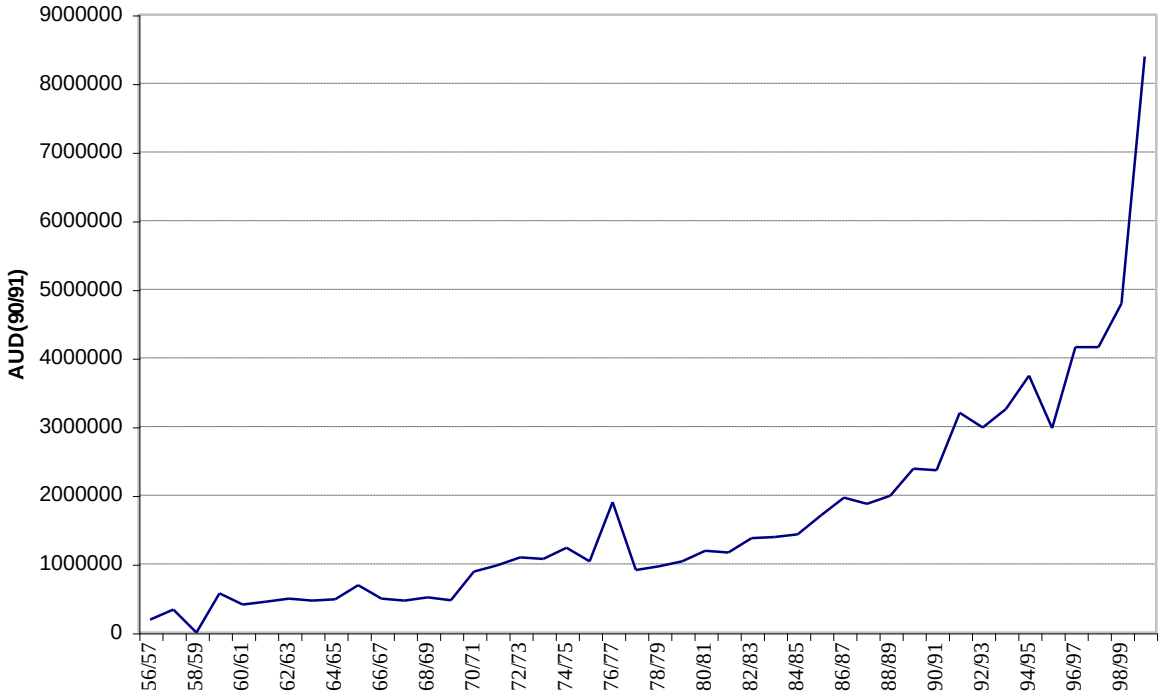
Non-Gov't Welfare Gains (% shares)	**Scenario 1 (t_{Xp}=-1%) Prem. Grape Cost R&D**		**Scenario 2 (t_{Xp2}=-1%) Prem. Wine Cost R&D**		**Scenario 3 (t_{Ypd2}=-1%) Dom. Marketing Cost R&D**		**Scenario 4 (n_{Qpd}=1%) Prem. Dom. Prom or Quality**		**Scenario 5 (n_{Qpe}=1%) Prem. Exp. Prom or Quality**	
	2005	**1996**	**2005**	**1996**	**2005**	**1996**	**2005**	**1996**	**2005**	**1996**
ΔPS_{Xp} ~~Prem.Grapes producers~~	29.2	23.9	22.2	21.1	2.1	2.9	2.6	3.4	41.2	44.2
ΔPS_{Xmp} ~~Multi-P Grape producers~~	-4.2	-10.4	1.4	2.8	-0.03	-0.1	-0.003	-0.3	2.6	6.1
$\Delta PS_{Xp}+\Delta PS_{Xmp}$ Grape producers Subtotal	**25.0**	**13.5**	**23.6**	**23.9**	**2.1**	**2.8**	**2.6**	**3.1**	**43.8**	**50.3**
ΔPS_{Xp2} Prem. Wineries	33.4	32.8	45.0	46.2	3.7	6.2	4.4	7.3	63.0	72.0
ΔPS_{Xnp3} Non-prem. Wineries	1.3	4.7	-0.5	-1.8	-0.9	-2.5	-0.9	-3.9	-0.4	-1.5
$\Delta PS_{Xp2}+\Delta PS_{Xnp3}$ Wineries Subtotal	**34.7**	**37.5**	**44.5**	**44.4**	**2.8**	**3.7**	**3.5**	**3.4**	**62.6**	**70.5**
$\Delta PS_{Xp3}+\Delta PS_{Xnp4}$ Mobile Factors Gains	**4.3**	**3.5**	**4.1**	**3.0**	**0.4**	**0.3**	**0.4**	**0.1**	**7.7**	**6.5**
ΔPS_{Ypd2}	1.1	1.6	1.3	2.2	14.6	16.6	12.3	14.4	-5.0	-7.2
ΔPS_{Ynpd2}	0.2	0.6	-0.3	-0.6	-1.2	-1.8	-1.3	-2.3	0.4	0.6
ΔPS_{Ype2}	3.2	2.7	3.2	2.9	-0.8	-0.8	-0.9	-1.0	6.8	7.2
Marketing Sector Subtotal	**4.5**	**4.9**	**4.2**	**4.5**	**12.6**	**14.0**	**10.1**	**11.1**	**2.2**	**0.6**
ΔCS_{Xdtd}	1.1	2.2	-0.4	-0.6	0.01	0.01	0.001	0.1	-0.7	-1.3
ΔCS_{Qpd}	10.0	13.4	9.9	13.6	83.1	79.0	85.1	83.3	-41.2	-49.7
ΔCS_{Qnpd}	3.1	7.8	-0.6	-1.3	2.5	3.8	2.5	3.3	-3.0	-6.6
Domestic Consumers Subtotal	**14.2**	**23.4**	**8.9**	**11.7**	**85.6**	**82.8**	**87.6**	**86.7**	**-44.9**	**-57.6**
ΔCS_{Xdte}	1.8	3.0	-0.6	-0.8	0.01	0.01	0.001	0.1	-1.1	-1.8
ΔCS_{Qpe}	15.1	12.9	15.4	13.6	-3.6	-3.9	-4.3	-4.9	30.0	32.4
ΔCS_{Ynpe}	0.4	1.3	-0.1	-0.3	0.1	0.3	0.1	0.4	-0.3	-0.9
Overseas Consumers Subtotal	**17.3**	**17.2**	**14.7**	**12.5**	**-3.5**	**-3.6**	**-4.2**	**-4.4**	**28.6**	**29.7**
Total	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**
Total (AUD million)	**14.1**	**5.4**	**21.2**	**8.4**	**13.9**	**7.3**	**34.0**	**15.3**	**32.4**	**9.9**
Tax revenue changes (AUD million)										
Wholesale sales tax	-0.26	-0.32	-0.16	-0.32	0.88	0.70	2.62	1.78	1.94	1.68
GST	-0.06		-0.04		-0.34		2.28		0.42	
Total	**-0.3**	**-0.3**	**-0.2**	**-0.3**	**0.5**	**0.7**	**4.9**	**1.8**	**2.5**	**1.7**

Table 5: Changes in economic welfare to various groups and tax revenue changes (in 2001 AUD million), from premium grape R&D and premium wine promotion abroad: 2005 vs 1996 – long run

	Premium grape cost-reducing R&D		Premium wine promotion abroad or quality-raising R&D	
	2005	**1996**	**2005**	**1996**
Global total	**13.8**	**5.1**	**34.9**	**11.6**
of which				
Overseas consumers	2.4	0.9	9.3	2.9
Australian total	**11.4**	**4.2**	**25.6**	**9.7**
of which				
Tax office	-0.3	-0.3	2.5	1.7
Premium consumers	1.4	0.7	-13.3	-4.9
Domestic wineries	4.9	2.0	20.3	7.0
Premium grapegrowers	4.1	1.3	13.3	4.4
Non-premium grapegrowers	-0.6	-0.6	0.8	0.6

Source: Estimates in first and final set of columns of Table 4.

Figure 1: Real expenditure on grape and wine research and development, 1956-57 to 1999-2000 (in 1990-91 Australian dollars)



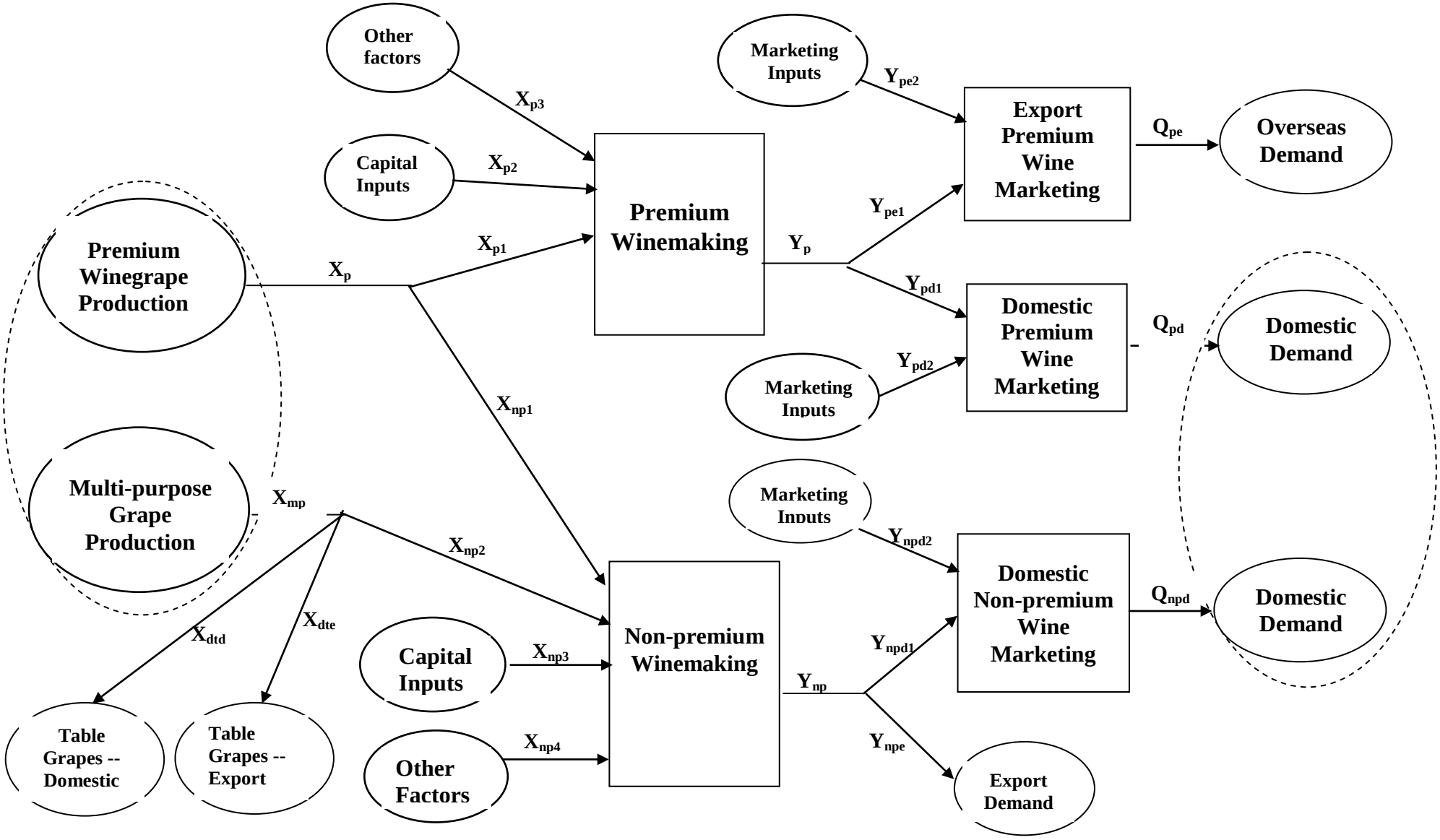


Figure 2: Structure of the Model

Appendix: Comparison of results for Australia's wine and beef industries

It is informative to compare the above wine industry study with a similar study for the beef industry in Zhao (1999) and Zhao, Griffith and Mullen (2001), since those industries share a number of common. Both industries export a significant share of their output (around 50% for wine and 60% for beef), and both have quality differentiated products (grain-fed and grass-fed beef, and premium and non-premium wine). In each case products are quality differentiated early in the production chain.

There are also the following differences between the two industries and the assumptions used in the two studies. First, all four products in the beef study, whether grain- or grass-fed and whether destined for the export or domestic market, are processed through a joint processing sector at the abattoirs, which is captured in the study by a joint production function. Marketing sectors are separate for export and domestic destinations but joint for each quality of grain- and grass-fed beef. The wineries, on the other hand, are more closely linked with the farm sector and thus the post-farm processing and marketing are separated by qualities and destinations.

Second, export and domestic beef are differentiated products early on in the production chain, unlike for wine where premium wine for both export and domestic consumption are assumed to be of the same quality up to the point of cellar door (Yp).

And third, supply in the post-farm sectors for beef (feedlots, abattoirs, retailers, etc.) is assumed to be highly elastic (ε=5), while in the wine model some winery inputs are assumed to be specialised and so inelastic in supply (ε=0.4 to 1.0 for human and fixed capital and ε=5 for labour, etc.). Marketers also are assumed to be less elastically supplied to the wine industry than that for beef (ε=2 for wine compared with 5 for beef).

The differences in the distribution of welfare results for the two industries are summarised in the Table A.1. Due particularly to the difference explained in point (3) above, post-farm sectors in the beef industries are unable to benefit greatly, leaving the welfare gains from R&D or promotion accruing to either farmers or consumers. In contrast, due to the assumed inelastic supply for wine-specific inputs, wineries are able to collect sizeable welfare gains from grape and wine R&D, and even to gain reasonably from marketing R&D and domestic promotion.

Another significant difference in the two sets of results relates to the case of export promotion, where domestic consumers gain significantly in the beef case and lose in the case of wine. This is due to the differences listed in the above points (2) and (3). Premium wine for export and domestic is assumed to be the same product at cellar door (Yp). Export promotion shifts the supply of premium wine away from the domestic market, so the premium price for domestic sales increases, leaving domestic consumers worse off (with a lower quantity and higher price). For beef, export and domestic products are differentiated all the way back in the production chain (made possible via contracts through vertical integration, as exported beef has unique genetic and nutritional specifications even before feedlot entry, so they are then linked with joint production functions in processing and marketing). Due to this assumption of

jointness, an increase in demand for one product will result in an increased supply of the joint inputs and thus increased supply of other products. As a result of an overall supply expansion, domestic consumers enjoy a price fall, and thus a gain in welfare.

Table A.1: Comparison of welfare shares (%) from R&D and promotion for Australia's beef and wine industries

	Farmers	**Processors+Marketers** *(beef: feedlot+abattoir+ retailer wine: wineries+retailers+others)*	**Consumer** Domestic	Export
Farm R&D:				
Beef	32	9	51	8
Wine(s/l run)	40/25	42/44	8/14	10/17
Processing R&D:				
Beef	26	10	55	9
Wine(s/l run)	24/24	61/52	6/9	9/15
Marketing R&D:				
Beef	20	9	66	5
Wine(s/l run)	2/2	16/16	86/86	-4/-4
Domestic Prom'n:				
Beef	23	9	62	6
Wine(s/l run)	2/3	12/13	92/88	-6/-4
Export Prom'n:				
Beef	31	10	50	9
Wine(s/l run)	50/44	82/72	-52/-45	20/29