THE UNIVERSITY of ADELAIDE

Wine Economics Research Centre

Working Papers

Working Paper No. 2020-05 ISSN 1837-9397

Expanding the Global Bev Model to enhance analysis of trade policy, COVID impacts and other wine industry issues

Glyn Wittwer

September 2021

www.adelaide.edu.au/wine-econ

WINE ECONOMICS RESEARCH CENTRE

The Wine Economics Research Centre was established in 2010 by the School of Economics and the Wine 2030 Research Network of the University of Adelaide, having been previously a program in the University's Centre for International Economic Studies.

The Centre's purpose is to promote and foster its growing research strength in the area of wine economics research, and to complement the University's long-established strength in viticulture and oenology.

The key objectives for the Wine Economics Research Centre are to:

- publish wine economics research outputs and disseminate them to academia, industry and government
- contribute to economics journals, wine industry journals and related publications
- promote collaboration and sharing of information, statistics and analyses between industry, government agencies and research institutions
- sponsor wine economics seminars, workshops and conferences and contribute to other grape and wine events

Contact details:
Wine Economics Research Centre
School of Economics
University of Adelaide
SA 5005 AUSTRALIA
Email: wine-econ@adelaide.edu.au

Centre publications can be downloaded at: https://economics.adelaide.edu.au/wine-economics/

Expanding the Global Bev Model to enhance analysis of trade policy, COVID impacts and other wine industry issues

Glyn Wittwer

Centre of Policy Studies,
Victoria University,
Melbourne, Vic. 8001
glyn.wittwer@vu.edu.au

September 2021

The author is grateful for financial support from Wine Australia and the University of Adelaide's Faculty of the Professions and School of Agriculture, Food and Wine, under Research Project UA1803-3-1.

Expanding the Global Bev Model to enhance analysis of trade policy, COVID impacts and other wine industry issues

Abstract

The Global Bev Model is a partial equilibrium model of various wine types plus beer and spirits. This paper summarises four enhancements to the model. First, each still wine type is split into red and white. This is relevant in response to the prohibitive tariff imposed by China on Australian wine imports. Second, an on-premise sector is added to improve the depiction of wine consumption in the model. During COVID, lockdowns and social restrictions have resulted in marked reductions in hotel and restaurant activity, with a corresponding reduction in on-premise wine consumption. Now, the impacts on on-premise and off-premise can be analysed separately. Third, given the importance of interstate exports of wine from California to the rest of the nation, California is split from the rest of USA in the global model. Finally, a top-down module has been added to the model to capture sub-national impacts in Australia and sub-state impacts in California.

Key words: global wine modelling, tariff impacts, on-premise consumption

JEL codes: C68, F17, Q17

1. Introduction: expanding the Global Bev Model

The Global Bev Model (GBM) extended modelling of wine sectors in the World Wine Model of 44 countries and 7 composite regions by adding beer and spirits (Wittwer and Anderson, 2020). This paper outlines four further modifications. These are (1) a split of wine types into red and white, (2) a split of USA into California and Rest of USA, (3) a depiction of on-premise wine consumption within the Global Wine Model and (4) a top-down representation of grape & wine regions within California and Australia.

Each of the three modifications has a clear motivation. A split of red and white appeared advantageous with the imposition of China's prohibitive tariff on Australian wine. In modelling such a tariff without a split into red and white wines, substitution of domestic Australian wine for NZ imports is exaggerated in response to a fall in Australian wine prices due to the prohibitive Chinese tariff. The tariff affects mainly sales of Australian red wine, while most of New Zealand's export to Australia are white. The split diminishes the import substitution away from New Zealand wine in Australia in the tariff scenario.

The split of California and Rest of USA is motivated by occasional reports of US export campaigns.[1] Splitting California and Rest of USA shows that California's most important exports are interstate. The estimated Rest of USA share of total California interstate plus international exports is around 75%. If sales to Rest of USA are counted as exports from California, the state has a wine export base that is third in the world after France and Italy. Given the size of the domestic market, an expansion in US international wine exports will have a smaller impact on the domestic industry than in other exporting nations.

In COVID analysis, Wittwer and Anderson (2021) showed the usefulness of including different sales points in a computable general equilibrium model, TERM-Wine, of the Australian economy with grape and wine detail. Wittwer and Anderson (2021) appeared before the extent of the Delta strain of COVID-19 on hospitality sectors was apparent. Given the unexpected return and prolongation of lockdowns in Australia and overseas, there may be interest in further COVID modelling of the impacts on wine sectors with on-premise consumption separated from off-premise consumption.

2. Splitting red and white grapes and wine

The task starts with a version of the Global Wine Model database updated to 2019. The default splits are based on Anderson and Nelgen (2021), updating Anderson and Aryal (2013). Beyond these default data, sales of wine split into red and white are available for some countries.

Sales to key destinations from Australia are set to equal available data on wine by red or white and price point, available in Wine Australia data.[2] In particular, sales from New Zealand to Australia are modified to capture the dominance of white wine in sales.

The process is mechanised via programs. This will enable the rapid inclusion of additional data that become available.

[1] See https://wineinstitute.org/press-releases/us-wine-exports-total-1-36-billion-in-2019/

[2] See https://marketexplorer.wineaustralia.com/export-dashboard.

3. Splitting California from the rest of USA

California dominates grape and wine production in the USA. Although many other states include wine production, their overall output is small in comparison. Table 1 shows splitting shares by type of beverage for production, exports and consumption.

The table estimates relied in part on grape crush data.[3] These Californian data include varietal detail, crush tonnage and grape prices by Californian wine regions. These data enable us to modify the value of grape inputs into wine for the US sectors in GBM. For the California-Rest of USA split, it will be straightforward to modify any shares shown in table 1 should better data emerge.

Table 1: Splitting shares used for California-Rest of USA split from USA

		California	RoUSA		
Consumption shares	NPWine (R&W)	0.17	0.83		
	SparkWine	0.17	0.83		
	CPWine (R&W)	0.17	0.83		
	SPWine (R&W)	0.17	0.83		
	Beer	0.13	0.87		
	Spirits	0.13	0.87		
	Aggregate consumption	0.125	0.875		
Population (millions)		39.5	295.3		
Production shares	NPWine (R&W)	0.999999	0.000001		
	SparkWine	0.97	0.03		
	CPWine (R&W)	0.99	0.01		
	SPWine (R&W)	0.99	0.01		
	Beer	0.05	0.95		
	Spirits	0.05	0.95		
Export	NPWine (R&W)	0.999999	0.000001		
	SparkWine	0.17	0.83		
	CPWine (R&W)	0.17	0.83		
	SPWine (R&W)	0.17	0.83		
	Beer	0.13	0.87		
	Spirits	0.13	0.87		
US home sales split		CA origin		Rest of US origin	
	Destination	CA	RoUSA	CA	RoUSA
	NPWine (R&W) CA origin	0.18	0.82	0.000001	0.000001
	SparkWine	0.13	0.72	0.01	0.14
	CPRedWine	0.15	0.01	0.68	0.16
	CPWhiteWine	0.13	0.01	0.72	0.14
	SPWine (R&W)	0.13	0.01	0.72	0.14
	Beer	0.12	0.04	0.01	0.83
	Spirits	0.12	0.04	0.01	0.83

Two key database matrices in GBM are the USE matrix and TRADE matrix. The USE details all commodity inputs to each user. Users include the grape and beverage sectors plus households – and eventually, as outlined in section 4, on-premise consumption. For each of the 52 regions, there is a domestic source and composite import source. The TRADE matrix includes each commodity, its regional origin and its regional destination. That is, the USE excludes the regional origin of imports and the TRADE matrix excludes users.

Splitting consumption and production in the USE matrix of the GBM's database is relatively straightforward. The consumption and production shares shown in table 1 are sufficient for this task. Since the TRADE matrix includes both regional origins and destinations, splitting

[3] See https://www.cdfa.ca.gov/mkt/grapecrush.html.

USA into two requires partitioning the TRADE matrix into four segments each for the diagonal and non-diagonal elements of the matrix. The diagonal elements refer to own-country sales, equivalent to the domestic part of the USE matrix.

The first segment for both the diagonal and non-diagonal elements, comprising origins and destinations other than the US regions, remains unchanged. Second, former US sales to all destinations require splitting. Grapes, not being traded between regions (at the international level), follow the production split shown in table 1 for the diagonal elements. Beverages sales to destinations outside the US are split using the export shares shown in table 1. Third, US home sales split shares shown in table 1 assign sales for California-California, California-Rest of USA, Rest of USA-California and Rest of USA-Rest of USA. That is, a single diagonal element for each commodity is split into two diagonal and two off-diagonal elements. In the fourth matrix segment, covering foreign sales to the two US regions, the import split follows the consumption shares shown in table 1.

Although the model is partial equilibrium, market clearing identities and equations still apply for all commodities within the model. The USE matrix for a given region summed across users must equal the delivered value of commodities summed across all origins. The delivered value is equal to the TRADE matrix plus margins (retail and wholesale plus transport) and tariffs. A second market clearing and identity condition requires total costs of all endogenous industries, that is, grapes, beverages and in next section, on-premise wine consumption, to equal sales. The two sets of market-clearing identities need to be satisfied both in the pre-simulation database and post-simulation to ensure that the model is homogeneous of degree one.

Once the split database has been created, a data balancing program enforces the above identities. The database split disrupts the balance: a series of scaling equations within the balancing program bring the database back to balance.

4. Depicting on-premise wine consumption within the global model

An off-premise v. on-premise split in GBM requires data on off-premise v. on-premise wine expenditures. These are available at least for most key countries (Anderson *et al.*, 2021). The advantage of having this split in a global model is that regular national accounts data are available on hotels & restaurants household spending in OECD data and other sources.[4] For example, UK's expenditure in this category fell by more than 50% in 2020 relative to 2019 due to prolonged lockdowns. Off-premise alcohol expenditure is another item represented separately in OECD data.

[4] See https://www.oecd.org/sdd/na/gross-domestic-product-gdp-and-other-annual-national-accounts-statistics-oecd.htm

Table 2: Back-of-the-envelope impact of COVID on national sales, Australia, 2020-21 (% contribution to total sales deviation)

	NPWine (1)	CPWine (2)	SPWine (3)	NPWine (4)	CPWine (5)	SPWine (6)	AllWine (7)
	% domestic deviation from business-as-usual (BAU)			Percentage point contribution to sales deviation			
(1) HotelsCafes	-15.6	-15.6	-15.6	-0.7	-2.2	-1.8	-1.8
(2) Tourism	4.8	4.8	4.8	0.5	0.8	0.4	0.6
(3) ExpTourism	-82.7	-82.7	-82.7	-2.7	-4.3	-2.0	-3.1
(4) Households	7.4	3.1	2.3	1.3	1.1	1.0	2.6
(5) Exports	-8.1	-12.8	-10.6	-4.9	-3.0	-3.4	-3.8
(6) Other	-8.1	-8.1	-8.1	-0.2	-0.4	-0.3	-0.3
(7) BoTE sales%				-6.8	-8.0	-6.1	-5.8
(8) Modelled sales%				-6.4	-8.1	-6.0	-5.6

Source: Wittwer and Anderson (2021), table 9.

Table 2 shows an estimate of pandemic impacts on Australia sales in 2020-21 relative to business-as-usual. The relevance of being able to model on-premise wine consumption has come to the fore with social restrictions and lockdowns arising from the COVID-19 pandemic. A depiction within the GBM of an on-premise sector, consisting of intermediate wine inputs plus margins and taxes, will improve pandemic-related model scenarios.

Table 3: Off-premise volume and value % shares of total wine consumption

	Vol%	Val%		Vol%	Val%		Vol%	Val%
FRA	69	35	CRO	59	44	URU	89	73
ITA	65	42	GEO	59	40	OLAC	70	40
POR	68	40	HUN	79	67	SAF	73	50
SPN	47	30	MOLD	80	60	TURK	49	38
AUT	54	20	ROM	88	71	NAFR	62	37
BEL	75	46	RUS	96	90	OAFR	70	40
DEN	83	45	UKR	87	72	MEST	70	40
FIN	94	77	OCEF	80	60	CHINA	65	34
GER	82	45	AUS	81	53	HK	64	46
GRE	49	27	NZL	81	64	INDIA	73	38
IRL	80	56	CAN	85	71	JAP	64	36
NLD	89	60	California	83	52	KOR	65	35
SWE	92	74	RoUSA	83	52	MALAY	54	39
SWISS	85	57	ARG	84	62	PHILI	70	52
UK	83	60	BRA	74	61	SINGA	70	49
OWEN	50	30	CHILE	84	52	TAIW	64	44
BUL	81	58	MEX	65	36	THAI	66	46
						OAPA	70	50

Source: Passport *Euromonitor International*: tables 5 and table 6

Table 3 shows the volume and value shares of off-premise consumption in total consumption. We note that in all cases, the volume share of off-premise consumption is substantially greater than the value share. This reflects on-premise trade margins plus additional service taxes associated with on-premise consumption. At this stage, the on-premise sector does not include beer and spirits, or indeed any other component of restaurant and hospitality activity.

In order to harmonize the model's database with estimates of on-premise and off-premise consumption values, based on Anderson et al. (2021), we need to revisit specific wine taxes, VAT and margins. In on-premise consumption, specific wine taxes, VAT and margins account for most consumer spending on wine. At this step, UK requires particular attention because it is a large consumer of wine, a major importer of wine and has substantial wine taxes. Most wine is taxed at around US$3.20 per litre of product [5]. Given UK consumes around 1280 ML of wine per annum, this specific tax amounts to around $4 billion. Since the database contains both volumes and values of wine, we can impose volumetric tax rates directly. Specific tax rates, be they ad valorem or volumetric, are based on Anderson et al. (2021).

When calculating VAT, the appropriate base is the margins inclusive, specific wine tax inclusive value of spending. For off-premise consumption, the margin is larger for each unit of wine consumed, and therefore the VAT is higher. One assumption in calculating trade plus transport margins is that the share of off-premise sales is not less than 25% in any region.

The values in the starting database are calculated as though all wine is consumed at off-premise prices. The values are split into basic (that is, values at producer prices), margins and tax components. The on-premise and off-premise shares are split. We assume that off-premise consumption has the same specific taxes and retail margins as on-premise, plus an additional service margin and applicable VAT. Any differences in off-premise and on-premise unit expenditures by consumers reflect differences in margins and taxes, not in the composition of wine consumed: for tractability, we assume that the same volumetric shares of different wine types apply to off- and on-premise consumption. In the UK case, for example, the average off-premise price is around US$12 per litre compared with almost $24 on-premise. That is, the latter includes a service margin plus VAT on a larger base.[6]

On–premise wine consumption is diverted in the USE matrix from sales to households to sales to the new on-premise sector. Additional trade margins and VAT taxes are calculated for the on-premise sector. The database requires rebalancing.

The method does not align perfectly with target data on on- and off-premise consumption. In the case of Singapore and Hong Kong, estimates of consumption in the model are several times too high, due to re-exports not being treated as such in the trade matrices which are based on COMTRADE data. Netherlands consumption estimates are also too high, also possibly reflecting re-exports. Japan's on- and off-values are only a fraction of target values. This reflects unit value outliers: Anderson et al. (2021) report a wine consumption volume of 284 ML and consumption expenditure of US$17 billion. This implies a unit value of US$60 per litre. Given an off-premise expenditure share of 36% and volumetric share of 64%, it is difficult to reconcile available tax rate data and reasonable margins with this high target unit value. Anderson and Harada (2018) examine database issues in China, Hong Kong and Japan.

---

[5] See https://www.gov.uk/government/publications/rates-and-allowance-excise-duty-alcohol-duty/alcohol-duty-rates-from-24-march-2014. This was updated in February 2019.

[6] The UK wine quantity consumed in the database is 1566 ML. If we base retail values on Anderson et al. (2021) estimate of 1282 ML, the respective on- and off- unit values are around US$15 and US$29 per litre respectively. The model may not fully account for UK's re-exports of wine: the present database indicates UK exports of 177 ML, based on pre-Brexit data.

For the moment, it appears preferable to acknowledge puzzles in the data than attempt to match target consumption values.

Another outlier is Romania, and the problem arises again from the implied unit value. The wine consumption volume is 443 ML and target consumption value is US$660m, or $1.49 per litre. These numbers may be defensible, particularly if production and consumption occurs substantially outside of formal markets.

Finally, an expenditure elasticity of 1.7 is imposed on on-premise consumption, reflecting a "luxury" status for such consumption. All elasticities are re-calculated to ensure that marginal budget shares in all regions sum to 1.0.

5. Top-down regional grape and wine shares for Australia and California

Australian Grape and Wine Incorporated provided detailed vintage data on variety, tonnes and price by wine region. From these, we can calculate value shares for grapes by red and white for each of 65 grape and wine regions. From this point, several abstractions enable us to devise a split between red and white production in non-premium, commercial-premium and super-premium categories.

Only one red grape and white grape data are used in the calculation that follows. The key price points are $300, $800 and $2000 per tonne. In a region in which the average price of grapes is under $300 per tonne, we assume that all wine produced is non-premium. There is no such region, based on 2019 data. For regions in which the average price, red or white, is between $300 and $800 per tonne, wine production is partly non-premium red or white and partly commercial-premium red or white. Average prices between $800 and $2000 per tonne imply wine production that is partly commercial-premium and partly super-premium. Regions in which either red or white grapes exceed $2000 per tonne produce exclusively super-premium red or white wine. Mornington Peninsula is an example.

To show how share are calculated, we use the example of red grapes in the Adelaide Hills. The average price per tonne is $1239. The formula for calculating commercial -premium (s) and super-premium (1-s) shares is

$$s=(2000-p)/(2000-800) \tag{1}$$

where p is the average regional price, $800<p<2000$.

Production in the region is distributed 63.4% to commercial-premium red and 36.6% to super-premium red (i.e., 1239 = 0.634*800 +(1-0.634)*2000).

Table 4 shows the estimated shares. The methodology assumes that all grapes grown in a region are inputs into wine production in that region. This is not a good assumption, given, for example, the use of Riverland grapes in Barossa wine production. In this context, such movement of grapes implies an overestimate of Riverland's non-premium and commercial-production with a corresponding underestimate of Barossa production in these categories. There are more data concerning the Australian wine industry than this methodology reflects. For example, ABS census data indicate a larger Barossa wine industry than this methodology.

The objective of this exercise is to find a methodology suitable in a global model. To provide sub-national representation will, at least in the early stages, stretch existing data. So far, detailed grape price data by variety and region have been collected only for Australia and

California. In the case of California, similar data are available for the 17 grape pricing regions (figure 1). The same price points – in US dollars – are used to estimate sub-state wine output shares (table 5).

In Australia, sparkling wine output shares in each region set equal to regional white share of national white output. Again, better data would improve on this crude estimate. In California, sparkling wine output is set equal to 8.7% of wine output in each sub-state region.

Figure 1: California's 17 grape pricing districts

Source: https://www.cdfa.ca.gov/mkt/grapecrush.html

One objective of extending a global model to sub-national representation may be to examine climate change scenarios. Grape growing may become more widespread in regions previously considered unsuitable. In warmer climate regions, there may be a shift to varieties more able to tolerate extreme heat. Sub-national detail may improve detail on modelled shifts in production and varieties in climate change scenarios.

Table 4: Estimated regional shares of Australian output by sector

	RGrap	Wgrap	NPRedWine	CPRedWine	SPRedWine	SparkWine	NPWhiteWine	CPWhiteWine	SPWhiteWine
AdelaideHill	0.0217	0.023	0	0.0302	0.0428	0.023	0	0.029	0.044
AdelaidePlai	0.0024	0.0029	0	0.0048	0.0012	0.0029	0	0.0083	0.0007
AlpineValley	0.0026	0.0021	0.0009	0.0049	0	0.0021	0	0.0055	0.001
BarossaValle	0.0446	0.0982	0	0.036	0.1524	0.0982	0	0.0069	0.3108
Beechworth	0.0003	0.001	0	0.0005	0.0006	0.001	0	0	0.0031
Bendigo	0.0021	0.0021	0	0.0043	0.001	0.0021	0	0.0053	0.0014
BlackwoodVal	0.0012	0.0002	0	0.0025	0.0003	0.0002	0	0.0005	0.0001
CanberraDist	0.0007	0.0008	0	0.0011	0.0011	0.0008	0	0.0005	0.0021
ClareValley	0.0264	0.0143	0	0.0434	0.0358	0.0143	0	0.0185	0.027
Coonawarra	0.0773	0.0279	0	0.0883	0.1998	0.0279	0	0.0589	0.0284
Cowra	0.0013	0.0016	0.002	0.0013	0	0.0016	0.0028	0.0017	0
CurrencyCree	0.0024	0.0025	0.0009	0.0046	0	0.0025	0.0002	0.0074	0
EdenValley	0.0115	0.0076	0	0.01	0.0376	0.0076	0	0.0022	0.0223
Geelong	0.0009	0.0025	0	0.0006	0.0031	0.0025	0	0	0.0081
Geographe	0.0012	0.0011	0.0002	0.0024	0	0.0011	0	0.0031	0.0004
Gippsland	0	0.0003	0	0.0001	0	0.0003	0	0.0007	0.0001
Glenrowan	0.0011	0.0004	0	0.0024	0.0002	0.0004	0.0002	0.0009	0
GoulburnVall	0.0045	0.0042	0.0088	0.003	0	0.0042	0.005	0.0073	0
Grampians	0.001	0.0046	0	0.0018	0.0012	0.0046	0	0.0076	0.0067
GraniteBelt	0.001	0.0006	0	0.0012	0.0024	0.0006	0	0.0012	0.0008
GreatSouther	0.0093	0.0053	0	0.0085	0.0293	0.0053	0	0.0061	0.0109
Gundagai	0.0019	0.0028	0.0013	0.0032	0	0.0028	0.0018	0.0067	0
HastingsRive	0	0	0	0	0	0	0	0	0
Heathcote	0.0058	0.0154	0	0.0091	0.0091	0.0154	0	0.035	0.0131
Henty	0.0004	0.001	0	0.0007	0.0003	0.001	0	0.0011	0.0022
Hilltops	0.0016	0.0018	0	0.0032	0.001	0.0018	0	0.0048	0.0007
Hunter	0.0055	0.0067	0	0.0089	0.0079	0.0067	0	0.0114	0.0099
KangarooIsla	0.0001	0.0001	0	0.0001	0	0.0001	0	0.0001	0.0001
KingValley	0.0223	0.0078	0	0.046	0.007	0.0078	0	0.0212	0.003
LanghorneCre	0.0467	0.036	0	0.0928	0.0238	0.036	0	0.0975	0.0143
MacedonRange	0	0.0004	0	0.0001	0	0.0004	0	0	0.0012
Manjimup	0.0004	0.0001	0	0.0008	0	0.0001	0	0.0003	0
MargaretRive	0.0377	0.0168	0	0.0542	0.0704	0.0168	0	0.0289	0.0241

	RGrap	Wgrap	NPRedWine	CPRedWine	SPRedWine	SparkWine	NPWhiteWine	CPWhiteWine	SPWhiteWine
McLarenVale	0.0411	0.0634	0	0.0356	0.1341	0.0634	0	0.0569	0.1456
MorningtonPe	0.0031	0.0159	0	0	0.0166	0.0159	0	0	0.0515
MountBenson	0.0032	0.0028	0	0.0064	0.0017	0.0028	0	0.0062	0.0026
MountGambier	0.0013	0.0004	0	0.0027	0.0004	0.0004	0	0.0012	0.0001
Mudgee	0.0021	0.0024	0	0.0038	0.0022	0.0024	0	0.0051	0.0024
MurrayDarlin	0.1723	0.1352	0.3423	0.1084	0	0.1352	0.2866	0.0922	0
NewEnglandAu	0.0001	0	0	0.0001	0.0001	0	0	0.0001	0
Orange	0.006	0.0054	0	0.0098	0.0083	0.0054	0	0.0092	0.0077
Padthaway	0.0361	0.0341	0	0.0686	0.0263	0.0341	0	0.0963	0.0096
Peel	0	0	0	0	0	0	0	0	0
Pemberton	0.0025	0.0013	0	0.0051	0.0008	0.0013	0	0.0018	0.0024
Perricoota	0.0002	0	0.0002	0.0002	0	0	0	0	0
PerthHills	0	0	0	0.0001	0	0	0	0.0001	0
Pyrenees	0.0007	0.0023	0	0.0015	0.0002	0.0023	0	0.0034	0.0039
Riverina	0.1288	0.1249	0.2601	0.0778	0	0.1249	0.2551	0.0963	0
Riverland	0.1964	0.2146	0.3815	0.1305	0	0.2146	0.4467	0.1559	0
Robe	0.0014	0.0017	0.0001	0.0031	0	0.0017	0	0.0051	0.0001
Rutherglen	0.0009	0.0014	0	0.002	0.0001	0.0014	0.0001	0.0042	0
ShoalhavenCo	0	0	0	0	0	0	0	0	0
SouthBurnett	0.0001	0.0001	0	0.0002	0.0001	0.0001	0	0.0003	0.0001
SouthernFleu	0.0011	0.0007	0	0.0023	0.0003	0.0007	0	0.0011	0.0011
SouthernFlin	0.0003	0.0016	0.0002	0.0005	0	0.0016	0	0.0041	0.0007
SouthernHigh	0	0	0	0	0.0001	0	0	0	0
StrathbogieR	0.0006	0.0016	0.0001	0.0013	0	0.0016	0.0013	0.0036	0
Sunbury	0.0001	0.0002	0	0.0002	0	0.0002	0	0.0004	0.0002
SwanDistrict	0.0013	0.003	0.0014	0.0017	0	0.003	0.0002	0.0089	0
Tasmania	0.0186	0.0385	0	0	0.1002	0.0385	0	0	0.1246
ThePeninsula	0.0003	0.0004	0	0	0.0015	0.0004	0	0.0002	0.001
Tumbarumba	0.0003	0.0009	0	0.0005	0.0007	0.0009	0	0.0013	0.0017
UpperGoulbur	0.0005	0.0018	0	0.0008	0.0006	0.0018	0	0.0041	0.0016
Wrattonbully	0.0341	0.022	0	0.0577	0.0425	0.022	0	0.0502	0.0185
YarraValley	0.0102	0.0313	0	0.008	0.0351	0.0313	0	0.0132	0.0877

The methodology used to estimate Australian and California regional shares does not utilise all available data. However, Anderson and Nelgen (2021) provide quantity and variety but not price data for sub-national regions around the world. It may be possible to extend the methodology to many more countries with relatively limited additional price data.

Table 5: Estimated regional shares of Californian output by sector

	RGrap	Wgrap	NPRedWine	CPRedWine	SPRedWine	SparkWine	NPWhiteWine	CPWhiteWine	SPWhiteWine
Ca1	0.0298	0.034	0	0.0011	0.0423	0.0006	0	0.0702	0.0408
Ca2	0.0226	0.0214	0	0	0.0323	0	0	0.0518	0.0209
Ca3	0.1687	0.1881	0	0	0.2414	0	0	0	0.4793
Ca4	0.3128	0.0946	0	0	0.4476	0	0	0	0.241
Ca5	0.0056	0.006	0	0.024	0.0029	0.012	0	0.0231	0.0002
Ca6	0.0105	0.0053	0	0.0386	0.0068	0.0193	0	0.0194	0.0009
Ca7	0.0737	0.1262	0	0.1749	0.0677	0.0875	0	0.3131	0.1174
Ca8	0.1135	0.0657	0	0.0907	0.1428	0.0454	0	0.1206	0.0888
Ca9	0.0108	0.0195	0.008	0.0637	0	0.0556	0.0227	0.0449	0
Ca10	0.0112	0.0031	0	0.0226	0.0111	0.0113	0	0.0057	0.0043
Ca11	0.1184	0.1097	0.3233	0.4623	0	0.4862	0.1893	0.1685	0
Ca12	0.0241	0.0522	0.1183	0.0421	0	0.072	0.1289	0.0266	0
Ca13	0.0686	0.1769	0.4565	0	0	0.14	0.4942	0.0118	0
Ca14	0.0116	0.0298	0.0772	0	0	0	0.0848	0	0
Ca15	0.0002	0.0001	0	0.0013	0	0.0006	0	0.0002	0
Ca16	0.004	0.0029	0	0.0034	0.005	0.0017	0	0.0012	0.0065
Ca17	0.0139	0.0647	0.0167	0.0752	0	0.0679	0.0801	0.1428	0

6. Scenarios before and after model modification

6.1 China's prohibitive tariff

A red-white split is relevant in modelling China's prohibitive tariff because reds dominate wine imports. Without a red-white split, there is substantial import substitution in Australia from New Zealand super-premium wine (table 6).

Table 6: China's tariff impact on Australian exports and imports (no red-white split)

	Exports		Imports		NZ import value
	Volume	Value	Volume	Value	
NPWine	2	2	0	0	0
SparkWine	-1	-9	-1	-4	0
CPWine	-13	-278	-6	-23	0
SPWine	-13	-149	-7	-45	-35
Total	-25	-433	-15	-72	-35

When the model represents red and white wines separately, the trade pattern response differs markedly (table 7). Now, there is much smaller import substitution in the Australian market away from New Zealand wine. The diversion of Australian exports to other markets is larger with the red-white split. A collapse in exports to China (-US$607m) is partly offset by increased sales to UK (+US $14m), USA (+US $42m), Canada (+US $56m) and Hong Kong (+US $11m).

Table 7: China's tariff: revised impact on Australian exports and imports

	Exports		Imports		NZ import value
	Volume	Value	Volume	Value	
NPRedWine	2	3	0	0	0
NPWhiteWine	0	0	0	0	0
SparkWine	-2	-9	0	-3	0
CPRedWine	-11	-136	-5	-14	0
CPWhiteWine	0	-7	0	-1	0
SPRedWine	-1	-218	-5	-16	-1
SPWhiteWine	0	-16	-1	-8	-7
Total	-12	-383	-11	-43	-8

Wine Australia data indicate that in the 12 months to June 2021, exports increased to UK (AUS $90m=US $66m), Hong Kong (AUS $98m=US $73m), Korea (AUS $24m=US $18m) and Singapore (AUS $15m=US $11m) with a fall in exports to China (AUS -$490m=US -$368m).[7] Overall exports fell by AUS $279m (US -$209m). The modelled outcome aligns reasonably with observation, given that the tariff has been in effect for approximately half the observation year. The observed change in export diversion by destination differs from the modelled outcome, which may arise in part from COVID impacts in North America: sales to Canada and USA fell. The extent of trade diversion with the red and white split is stronger than the export diversion modelled without a split between the red and white segments.

Why is trade diversion stronger if we depict red and white wine types separately? The tariff's negative impact on prices for Australian red wine is larger than if there is no red-white distinction. This is because China's share of Australian red wine sales is much larger than the corresponding share of all Australian wine sales. Larger relative price movements imply more substitution, resulting in more trade diversion.

6.2 Export v. interstate sales campaign in California

The reconfigured database shows that while California's international exports have some importance, interstate sales are largest for all types of wine (table 8). A campaign to increase foreign sales may benefit the Californian industry, but maintaining or expanding markets interstate may provide larger gains. The estimated value share of sales at producer prices in the rest of USA that originates from California is 42%. The total value sold places California's interstate sales somewhere between 2nd ranked Italy's and 3rd ranked Spain's international exports.

[7] https://marketexplorer.wineaustralia.com/export-dashboard. A US-Australia exchange rate of US$0.75 used in calculations based on https://fx.sauder.
ubc.ca/.

Table 8: Sales value shares of Californian wine by destination

	California	Rest of USA	International exports
NPRedWine	0.145	0.639	0.216
NPWhiteWine	0.143	0.603	0.254
SparkWine	0.213	0.748	0.039
CPRedWine	0.233	0.567	0.201
CPWhiteWine	0.193	0.592	0.215
SPRedWine	0.235	0.586	0.179
SPWhiteWine	0.201	0.613	0.186
Total	0.201	0.607	0.180

Another reason for representing California, or indeed several regions within California separately, concerns climate change scenarios. Drought has prevailed over the past or so, presenting threats to water security for horticulture and other uses. Rising temperatures may raise the competitiveness of interstate viticulture relative to California. The regional shares estimated for the 17 grape price regions of California may enhance sub-national detail in the model in future research.

6.3 COVID-19 impacts

Wittwer and Anderson (2021) modelled COVID scenarios using the multi-regional national CGE model, TERM-Wine, plus an earlier version of the GBM. The sectoral detail in TERM-Wine meant that the model included various sales point for on-premise consumption and tourism-related wine consumption.

Translating COVID shocks, in which lockdowns and social distancing enforce a reduction in hotels and restaurant activity, in GBM was not straightforward. The shocks included a decrease in aggregate household consumption, with a strong negative expenditure effect. A positive taste swing towards super-premium wine was ascribed, on the basis that consumers confined to home drinking may raise the quality of wine consumed above usual level. A negative taste swing was imposed on sparkling wine consumption, on the basis that lockdowns forced celebratory drinking below base.

Table 9 shows GBM modelled consumption impacts relative to base, without and with representation of a separate on-premise sector. In the revised simulation, using OECD data on hotels and restaurants activity, a negative taste swing was imposed on the on-premise sector. The “WineAll” composite now refers to off-premise consumption only. Consumption impacts are slightly less negative than for the previous wine composite, which was inclusive of off- and on-premise consumption. The negative taste swing against on-premise consumption, enlarged by a relatively high expenditure elasticity, more than offsets this. That is, off-premise wine consumption depends on an expenditure effect (negative) and taste swings away from social activities (weakly positive for all commodities not under social restrictions).

Table 9: COVID impacts on consumption, without and with on-premise sector

Wittwer and Anderson (2021)	% relative to base								
	AUS	NZL	WEur	USACan	LatAmer	Saf	Asia	RoW	World
WineAll	-3	-3	-7	-3	-7	-8	-2	-5	-5
NPWine	-2	-3	-4	-2	-6	-4	-2	-3	-4
CPWine	-3	-4	-5	-3	-5	-5	-1	-3	-4
SPWine	0	-2	-4	-1	-4	-3	0	0	-2
SparkWine	-13	-15	-17	-14	-18	-17	-12	-14	-15
Beer	-3	-5	-6	-3	-6	-6	-3	-4	-4
Spirits	-3	-4	-7	-4	-6	-6	-5	-4	-5
Inclusion of on-premise sector									
	AUS	NZL	WEur	USACan	LatAmer	Saf	Asia	RoW	World
WineAll off-premise	0	-1	-5	-1	-5	-6	0	-4	-3
SparkWine	-12	-14	-16	-14	-17	-16	-11	-14	-15
CPRedWine	0	-2	-4	-1	-4	-4	1	-1	-2
SPRedWine	3	1	0	2	-2	0	4	3	1
CPWhiteWine	1	-1	-3	-1	-4	-3	1	-1	-2
SPWhiteWine	3	1	0	2	-1	0	4	3	1
NPRedWine	-1	-3	-3	-1	-5	-3	-1	-2	-3
NPWhiteWine	-1	-3	-3	-1	-5	-3	-1	-2	-3
Beer	-3	-5	-6	-3	-6	-5	-3	-4	-4
Spirits	-3	-4	-7	-4	-6	-6	-5	-4	-5
Onpremise	-17	-19	-23	-18	-23	-21	-16	-18	-20

In the revised representation of the COVID scenario, global trade volumes fall to 6% below base, compared with 4% in earlier representation without an on-premise sector (tables 10 and 11). In part, the revised scenario may benefit from hindsight, given that observations are now available in national accounts on hotels and restaurants activity.

Table 10: COVID impacts on exports, without and with on-premise sector

Wittwer and Anderson (2021)	% relative to base								
	AUS	NZL	WEur	USACan	LatAmer	Saf	Asia	RoW	World
WineAll	-3	-2	-3	-2	-7	-2	0	-4	-4
NPWine	-4	-3	-1	-2	-6	-3	1	-3	-2
CPWine	-3	-1	-1	0	-8	-1	0	-3	-2
SPWine	-3	-1	0	-3	-6	-1	5	-1	0
SparkWine	-17	-12	-15	-15	-29	-11	-4	-24	-15
Beer	-3	1	1	-7	3	-2	0	0	1
Spirits	-2	-1	-2	-3	0	-4	1	-2	-2
Inclusion of on-premise sector									
	AUS	NZL	WEur	USACan	LatAmer	Saf	Asia	RoW	World
WineAll off-premise	-8	-2	-5	-5	-12	-4	-3	-6	-6
SparkWine	-21	-13	-17	-14	-29	-11	-2	-23	-17
CPRedWine	-7	-1	-3	-6	-11	-3	-5	-4	-5
SPRedWine	-11	1	-1	-4	-13	-4	11	-2	-3
CPWhiteWine	-2	-2	-3	-6	-11	-4	4	-6	-4
SPWhiteWine	-10	-2	-2	-4	-13	-4	42	-2	-3
NPRedWine	-8	-2	-2	-5	-9	-5	2	-4	-5
NPWhiteWine	-9	-2	-3	-5	-9	-6	7	-5	-4
Beer	-3	1	1	-7	4	-1	0	1	1
Spirits	-2	-1	-2	-2	0	-4	2	-2	-1

Table 11: COVID impacts on imports, without and with on-premise sector

Wittwer and Anderson (2021)	% relative to base								
	AUS	NZL	WEur	USACan	LatAmer	Saf	Asia	RoW	World
WineAll	-3	-5	-5	-2	-7	-5	-1	-4	-4
NPWine	-2	0	-2	-1	-2	0	-1	-2	-2
CPWine	1	-3	-3	-1	-6	-1	1	-2	-2
SPWine	2	0	-1	0	-6	-1	0	1	0
SparkWine	-13	-11	-15	-12	-15	-10	-11	-13	-15
Beer	5	0	-2	2	-3	-4	7	1	1
Spirits	0	-1	-3	-1	-3	-1	-1	-1	-2
Inclusion of on-premise sector									
	AUS	NZL	WEur	USACan	LatAmer	Saf	Asia	RoW	World
WineAll off-premise	-3	-7	-6	-4	-9	-4	-4	-5	-6
SparkWine	-13	-11	-17	-15	-15	-8	-12	-13	-17
CPRedWine	-1	-8	-6	-4	-8	0	-2	-3	-5
SPRedWine	7	-1	-3	-1	-9	-1	-4	-4	-3
CPWhiteWine	-2	-4	-5	-3	-5	0	-2	-3	-4
SPWhiteWine	3	-1	-3	-1	-8	-1	-5	-3	-3
NPRedWine	-2	-4	-4	-3	-2	0	-3	-3	-5
NPWhiteWine	-3	-3	-4	-3	-1	0	-3	-3	-4
Beer	6	2	-1	1	-3	-4	8	1	1
Spirits	1	-1	-2	-1	-3	-2	0	-1	-1

The response to COVID does not follow the usual economy theory of price adjustments, because lockdowns and social distancing imply quantitative restrictions and reduced utilisation of capital and labour in restricted sectors.

The household demand equation in GBM follows the form

$$x_c - q = \varepsilon_c.(C - q) + \sum_d \eta_{cd}.p_c + a_c - \sum_d S_d.a_d \,, \qquad (2)$$

where in percentage changes x_c is the quantity, p_c the price and a_c the taste switch for commodity c, q is population and C aggregate nominal consumption. The expenditure elasticity is ε_c and the matrix of price elasticities η_{cd}. S_d is the budget share of commodity d.

A scenario to revisit COVID impacts is outlined in the next section. The taste terms in (2) are important drivers in a COVID scenario.

7. Additional potential applications

A split into red and wine grape and wine types has improved modelling of China's prohibitive tariff by depicting in more detail the characteristics of wine-producing and consuming nations. China's wine consumption is mainly of red varieties, as reflected in its import base. New Zealand is mainly a white wine producer, so that import substitution in Australia in the wake of the Chinese tariff away from New Zealand wine is unlikely.

Are more detailed varietal splits possible in a global model? Anderson and Nelgen (2021) have compiled varietal data on a global scale. The anticipated response of the global wine industry to climate change will in part be through varietal shifts. This is already happening to some extent in Australia with some warm climate inland grape-growers switching from varieties such as Shiraz and Sauvignon Blanc to Mediterranean varieties more suitable for warm regions. Cooler climate regions in turn are switching in part to varieties such as Shiraz that previously have struggled in such regions.

Climate change scenarios modelled in a GBM may benefit from more disaggregation in the sub-national and varietal dimensions. But to estimate impacts, we also need to anticipate how accepting consumers will be of varietal change and shifts in regions of origin.

Detailed grape variety, region and price data available for Australia and California may provide a next step for disaggregation in the varietal and regional dimensions. The top-down module prepared as part of this study is a start. A bottom-up approach to further disaggregation would require some theoretical enhancements to the existing model. These would follow in part a methodology devised by Horridge (2011). To make such a model workable, aggregation programs would enable the user to concentrate on regions of particular interest for a study.

The California – Rest of USA split provides a start on sub-national representation. There are difficulties in extending the split to more regions, such as the grape-growing regions of Australia. One is that grape regions for which data are available require mapping to regions for which official economic statistics are collected. In developing TERM-Wine, for example, Australia's wine regions were mapped to SA3 regions for which Australian Bureau of Statistics data are available.

As OECD and other agencies release more national accounts data for 2020 and 2021 relative to previous years, it will improve the detail used to estimate underlying taste shocks in GBM. Restaurants and hotels have a larger expenditure weight than the on-premise (wine) component modelled in GBM. Other service sectors have also suffered downturns during the pandemic. One way of improving the modelling with virtually no theoretical enhancements to the model would be to divide the "rest of commodities" spending in the household vector of commodities into several, aligning more closely with COVID-affected national accounts sectors. Given initial expenditure shares and observed pandemic-induced downturns (x_c in equation (2)), combined with aggregate consumption observations (C), estimates of a_c could be inferred for a larger share of total expenditure. Within the budget constraint, the share-weighted taste changes a_c sum to zero. Therefore, the larger the expenditure share for which observations are available, the more accurate the taste shocks will be on remaining commodities, in this case, wine. This would be helpful in showing the marginal contribution of the pandemic to the grape and wine sectors, and estimating how the industry will fare during a global economic recovery phase.

References

Anderson, K. and Harada, K. (2018), "How much wine is really produced and consumed in China, Hong Kong and Japan?" *Journal of Wine Economics*, 13(2):199-220. doi:10.1017/jwe.2018.13

Anderson, K. and Nelgen, S. (2021), *Which Winegrape Varieties are Grown Where?* https://www.adelaide.edu.au/press/titles/winegrapes. Update of Anderson and Aryal (2013).

Anderson, K. and V. Pinilla (with the assistance of A.J. Holmes) (2021), Annual Database of Global Wine Markets, 1835 to 2019, freely available in Excel at the University of Adelaide's Wine Economics Research Centre, August.

Horridge, M. (2011), "The TERM model and its data base," Centre of Policy Studies/ Working Papers G-219, Victoria University, Centre of Policy Studies.

Wittwer, G. and Anderson, K. (2020), "A Model of Global Beverages Markets", *Journal of Wine Economics*, 15(3):330-354, doi: 10.1017/jwe.2020.17

Wittwer, G. and Anderson, K. (2021), "COVID's impact on Australian wine markets and regions", *Australian Journal of Agricultural and Resource Economics*, doi.org/10.1111/1467-8489.12447