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Two Decades of Grape Variety Trends in Australia's Wine Regions

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Over the past two decades, Australia's vignerons have both produced and exported around 180 winegrape varieties from 70+ regions and sub-regions, but the main varieties have changed little. This is despite the industry being on a huge roller-coaster ride since the turn of the century.

Having more than trebled its vine bearing area in the previous decade, Australia's average winegrape price peaked in 2001 before halving over the next decade. The expansion in bearing area continued until 2008, making that 22-year boom in area nearly twice as long as the average of Australia's four previous booms of 12 years (Anderson 2015).

The global financial crisis of 2008 followed six years of rapid appreciation of the AUD, and since then there have been numerous extreme weather events possibly associated with climate change (drought, floods, and heat waves that led to huge bushfires), plus disruptions to supply chains thanks to COVID-19 and Russia's invasion of Ukraine, China's decline in wine consumption since 2017 and imposition of prohibitive tariffs on Australian wine since late 2020, and a new era of higher inflation, interest rates and global economic and policy uncertainty.

Particularly with the loss of sales to China plus high yields in 2021, Australia's wine stocks-to-annual-sales ratio rose above two in 2022, which is one-third above the average of the past four decades. More than two-thirds of those stocks are red varieties, an historic record (Wine Australia 2022c and earlier).

Each of Australia's four previous booms was followed by a longer plateau period, averaging 21 vintages. This begs the question as to how long it might be before the next boom, it now being 15 years since the 2008 peak in the nation's vine bearing area.

The present article does not address that unanswerable question, but it does provide a brief summary of Australia's winegrape developments over the past two decades by drawing on a comprehensive new data set that includes, for the first time, estimates of the bearing area of winegrapes in each of Australia's wine regions outside of South Australia for the numerous years when surveys were not conducted.

Fortunately South Australia, which accounts for almost half the national vineyard area, is well served with data because of the required annual reporting by SA growers to Vinehealth Australia (previously the Phylloxera and Grape Industry Board of South Australia). Those data, which are now published annually by Wine Australia (2022a and earlier), were analysed in a recent *WVJ* article by Anderson and Puga (2022a).

For the rest of Australia, there have been no data on the bearing area of winegrapes by variety and region since 2015. That was when the Australian Bureau of Statistics stopped collecting data on national, state and regional vine areas. Neither did it collect them in 2009, 2011, 2013 and 2014 (see ABS 2015 and earlier). So it has not been possible to trace changes in that basic statistic outside of South Australia since then to see how growers have been altering their area of each variety in different wine regions in response to the above-mentioned macro shocks plus changes in demand for various varieties and in the expected climate of each region.

To compile a database for wine regions outside South Australia and thus also for each of the other States and for the nation as a whole, Anderson and Puga (2022b) have brought together available annual data from various sources for winegrape crush volumes and prices by variety and region, and then made a series of assumptions (detailed in the Appendix to this article) to estimate the missing bearing area data. This new data set also includes some national varietal data back to 1956, building from and updating the historic varietal data reported in Anderson (2015).[1]

In total there are 72 regions in the database, a little more than the 65 legally defined Geographic Indicators (GIs) because of changes in definitions of GIs over time including the emergence of some sub-regions, and despite needing to aggregate some small new regions. Area, crush and price data are available for 118 'prime' varieties (prime as defined by Anderson and Nelgen 2020b based on Robinson, Harding and Vouillamoz 2012 or otherwise www.vivc.de). There are also another 64 more-minor prime varieties whose data are aggregated into 'other red' or 'other white' for confidentiality reasons. Of that total of 183 varieties, 178 of them have been exported at some time in the past 22 years (but just five accounted for around four-fifths of the total volume of Australia's wine exports in the past five years).

This article first summarizes what this new data set – enhanced by our new estimates of bearing area data that used to be provided annually by the ABS – suggests has been happening at the national and state levels leading up to and during the 21st century. It then focuses in more detail on varietal developments at the regional level from 2001.

National and State data

While interest in expanding Australia's winegrape area began shortly after the mid-1980s' subsidized vine-pull, the bearing area began to grow most rapidly from the mid-1990s, in a delayed reaction to rising prices of winegrapes which in turn shadowed rising wine export prices (Figure 1). That expansion was stimulated also by the industry's long-term strategy that was laid out in 1995 (WFA 1995). The plan had targets of exporting $1 billion worth of wine by the turn of the century (up from $470 million in 1995-96 and less than $100 million a decade prior) and of trebling the real value of wine production within 30 years. As it turned out, exports reached $1.4 billion by 2000, and the trebling of wine production target was met in one rather than three decades.

[insert Figure 1 around here]

However, wineries struggled to expand export markets fast enough to dispose of that rapidly expanding supply, and export prices began to fall also because of a dramatic appreciation of the AUD over the first decade of this century thanks to rapid growth in mineral sales to China. A belated and modest decline in vine bearing area started after 2008 and continued to 2015 before appearing to plateau as prices started to rise again before abruptly declining (especially for red varieties) when China imposed prohibitive tariffs on Australian wine from late 2020. In short, there is no end in sight yet to the downturn part of the industry's current boom/slump cycle, which has involved the real prices of winegrapes and exported wine falling by more than 60% this century.

Turning to the varietal mix of that national vine area, it too has cycled. Red varieties rose in importance in the 1960s and 1970s before being taken over by whites in the 1980s –

[1] To validate the assumptions used to estimate the missing non-SA area data, we applied the same assumptions to the SA data and compared them with the actual SA area data by region and variety for those same vintages. As reported in the Appendix, there is a close match, which gives us confidence in our estimates for non-SA regions.

and then regaining their dominance in the 1990s and holding on to it since then (Figure 2). This mirrors changes since 1990 in the rest of the world, where red's share rose from 46% to 49% by 2000 and to 56% by 2016 (Anderson and Nelgen 2020b, 2021). If China's obsession with reds is an important part of the reason for this century's swing, one might expect red's share to fall over the 2020s given that, according to OIV (2022), China's wine imports have halved since 2017 – and almost completely stopped from Australia which is why the share of reds in its exports is now dipping.

[insert Figure 2 around here]

The main varieties are shown in Figure 3, which reveals the drift away from the varieties commonly used for fortified wines toward the key varieties that produce premium still and sparkling wines, most of which have their origin in France. Again that change mirrors what is happening in the rest of the world, with key French varieties becoming more popular everywhere (Anderson and Nelgen 2020a, 2021).

[insert Figure 3 around here]

The extent of swing toward French varieties in Australia leading up to the turn of the century is extreme, as shown in Figure 4. In the 1950s/early 1960s, the share originating from Spain was more than 40% while the French share was no more than that of Greece at just under 20%, with Turkey next at around 10% (because of Sultana). By the early 1980s the shares of Spanish and French varieties had reversed, and by the turn of the century Spanish shares were less than 4% (because of Grenache's share falling from 20% in the late 1950s to 1% today).

[insert Figure 4 around here]

The extent of Australia's convergence on that changing global mix is measured by our Varietal Similarity Index (VSI), which is like a correlation coefficient that ranges from zero to one: it indicates how close the varietal mix of one region is to another region or to the national or world average mix, based on varietal shares of total bearing area (see Appendix). In 2001 that index for Australia vis-à-vis the world mix was 0.47, but in 2022 it was 0.66.

Associated with that increasing similarity across the world of national winegrape varietal mixes is a greater concentration on fewer varieties in most countries (Puga and Anderson 2022). In Australia's case, the top ten varieties by area have accounted recently for 87% of the national area, whereas the share of the top ten in 2001 was 83%. True, many vignerons are exploring 'alternative' or 'emerging' varieties (see, e.g., Higgs 2019), but as yet those listed in Table 1 (ones with bearing area between -5 and 1000 hectares and export volumes between 10 and 3600 kl) make up just 3.0% of the nation's vineyard area and 1.5% of its volume of exports, up from 0.9% and 0.3%, respectively, in 2007.

[insert Table 1 around here]

An advantage of us having assembled a full time series of winegrape bearing area data is that it allows us to estimate of grape yields per hectare and gross revenue per hectare, since tonnes of winegrapes crushed and their average prices are available by variety and region in the *National Vintage Report* (Wine Australia 2022b and earlier) and from ABS and Vinehealth. Yields per hectare vary most in Tasmania but on average during 2001-22 were estimated to be lowest in Western Australia at 5 t/ha, compared with 6 in Tasmania, 11 in South Australia, 12 in Victoria, and 14 in New South Wales. Prices over those two decades were highest by far in Tasmania though, at an average $2650 per tonne over those 22 vintages, compared with just half that in Western Australia, one-quarter that in Victoria and less than one-fifth that in New South Wales. Thus gross revenue per hectare covers a much narrower range on the mainland (between $6340 and $8850) while Tasmania is again an outlier at over $14,000 (Table 2). Furthermore, the time series for gross revenue per hectare is trending slightly upward for Tasmania even though its winegrape bearing area has trebled and spread geographically over the island during those two decades. By contrast, gross revenue per

hectare trended downwards in all the mainland states in the 2000s, before recovering in the 2010s but turning down again in 2022 (Figure 5).

[insert Table 2 and Figure 5 around here]

There is also a large range in the average gross revenue per hectare across varieties. That is true even among the top dozen varieties by bearing area, and even when averaged over 22 years: the range is from $6800 to $10,500 per hectare (Figure 6). Since this indicator is the product of the variety's price and its yield per hectare, its ranking by variety is not obvious given that those two variables often have a negative correlation. Nor is there a close ranking between the Varietal Quality Index (VQI, the average price of a particular variety divided by that for all varieties) and the Varietal Productivity Index (VPI, the average gross revenue per hectare of a particular variety divided by that for all varieties), as shown in Table 3. While there is a four-fold range in the VQI (from Pinot Noir at 1.8 to Colombard at 0.4), the VPI range is much smaller because yield per hectare and price are negatively correlated.

[insert Figure 6 and Table 3 around here]

It is also not easy to guess how average gross revenue per hectare differs as between red and white varieties, since the average price of reds has been much higher than that of whites this century while the average yield per hectare has favoured whites (bottom rows of Table 3). The price difference across the two colours holds in most years, yet the gross revenue per hectare has been almost identical each vintage for the two colours during the past two decades – but with a big divergence in 2022 thanks to the current glut of red wine (Figure 7).

[insert Figure 7 around here]

Regional data

The regions have been classified by Jones et al. (2012), according to average growing season temperature (GST), into four groups: Cool (<15^{o}C), Temperate (from 15^{o} but <17^{o}), Warm (from 17^{o} but <19^{o}) and Hot (≥19^{o}). For present purposes we use the average GST for the period 1989-2019. Over that period, no Australian regions meet the Cool criterion and, apart from Tasmania, the only other regions meeting the Temperate criterion are Coonawarra in SA and the small Victorian regions of Grampians, Henty, Macedon Ranges and Strathbogie Ranges (which together account for less than 10% of the Australian wine industry). However, because their grapes are attracting ever-higher prices than warmer regions, their share of the nation's crush *value* has doubled over that period (Figure 8).

[insert Figure 8 around here]

The gross revenue per hectare range is wider of course at the regional level. While no region except Tasmania has an average above $11,000 over the 2001-22 period, three South Australian regions (two Warm, one Hot) have averages just over $10,000: Adelaide Hills, McLaren Vale and Wrattonbully. Regions that have among the lowest average gross revenues per hectare also include a mixture of Warm and Hot climates. Of particular note is that average gross revenues per hectare range very widely in the Hot regions, from $9700 in the Riverland, and $8900 in the Murray Darling of NSW, to $7300 in the Murray Darling of Vic, $6000 in the Riverina and $3900 in the Hunter Valley (Table 4). No doubt costs of production per hectare also very greatly across regions (and across vineyard sizes), but unfortunately there are no comparably comprehensive data available to quantify that.

[insert Table 4 around here]

This heterogeneity across regions in average prices and gross revenues per hectare is reflected in the two indexes reported in Table 4, namely the Regional Quality Index and Regional Productivity Index (RQI and RPI). The RQI is the ratio of regional to national

average price per tonne of all varieties, while the RPI is the ratio of regional to national average gross value of production per hectare of all varieties. Both have more than a four-fold range, with Tasmania the highest of each.

The varietal mixes of most major regions of Australia have converged a lot on the global mix. There are only eight regions whose Varietal Similarity Index vis-à-vis the world has moved by less than one-fifth (left half of Table 5). They are Adelaide Hills (0.48 to 0.55), Barossa Valley (0.39 to 0.41) and McLaren Vale (0.45 to 0.47) in South Australia, Grampians (0.35 to 0.37), Mornington Peninsula (0.30 to 0.31) and Yarra Valley (0.44 to 0.46) in Victoria, WA's Swan District (0.37 to 0.40), and Tasmania (0.34 to 0.34).

[insert Table 5 around here]

To get a clearer idea of the contribution of different varieties to those rising VSIs, it is helpful to generate the varietal intensity index (VII), defined as a variety's share of the bearing area in Australia relative to its share in the world. Shown in Table 6 are the top dozen varieties. Apart from Grenache and Pinot Gris, all had VIIs well above one in 2001 but they have declined substantially this century, indicating that their shares in the country's bearing area have grown (or shrunk) less rapidly than in the rest of the world.

[insert Table 6 around here]

The VSIs of regions relative to Australia, by contrast, suggest many smaller regions are differentiating themselves from the large hottest regions along the Murray River. Indeed more than half of the regions listed in Table 5 have seen their VSI relative to Australia fall this century, and for four of the cooler regions their VSI relative to Australia has fallen by around one-quarter since 2001 (Adelaide Hills, Mornington Peninsula, Tasmania and Yarra Valley) while the varietal mix of the big hot irrigated regions have become more similar to the national average according to VSI changes (right half of Table 5).

How similar are changes in the varietal mix of exports?

Changes in the shares of the dozen top varieties in vine bearing area, winegrape crush and wine export volumes over the past two decades are shown in Table 7. Those dozen varieties account for all but one-ninth of the industry, but their relative importance has changed considerably in that time and most so for volume of exports. Note that for two of these dozen varieties (Chardonnay and Merlot) the export shares have moved in the opposite direction to the area and crush shares, while for Shiraz the area and crush shares have risen a lot while the export share has hardly changed. It remains to be seen whether the recent decline in exports of premium reds (thanks to the high tariffs by China from late 2020) reverses the past two decades' growth in red varietal plantings.

[insert Table 7 around here]

Final word

The above numbers are but a tiny fraction of the data and indicators compiled by and reported in the 150 tables in Anderson and Puga (2022b). For readers interested in the smaller regions, or the many varieties beyond the top dozen, or the combination of those two (a particular variety in a particular region), the full dataset is freely available in Excel to access at any time at https://economics.adelaide.edu.au/wine-economics/databases#australian-winegrape-vine-area-production-and-price-database-by-region-and-variety-1956-to-2022

Appendix: Winegrape data considerations and methodology for estimating missing bearing area data

Concordance between regions:
Since the data for this database come from different sources (listed below), we created a concordance between regions. This concordance uses as its basis the definitions of Australian Geographical Indications (GIs), which are available in the Wine Australia website (https://www.wineaustralia.com/labelling/register-of-protected-gis-and-other-terms/geographical-indications).

Some region names begin with the word 'Other'. These residual regions are often not constant over time (e.g., they may vary across years in their vine area or winegrape production coverage). 'Canberra', listed here as a region of NSW, includes data that are part of the (not included) Canberra ACT region. The Northern Territory is excluded from this database, because it is so minor.

Concordance between varieties and their colours:
The names of the varieties are based on the prime names as in Anderson and Nelgen (2020b), which are based mostly on Robinson, Harding and Vouillamoz (2012). Just three of Australia's prime varieties in the area data are listed as 'grey', namely Flora, Pinot Gris and Schönburger. Since they are typically thought of as white wines in Australia, we have classified them as such in this national database. There are three additional minor grey varieties in the wine export data that we classified as white, namely Barbaroux, Perle and Roter Veltliner.

Years:
The years shown refer to fiscal years ending 30 June except for export data, which refer to fiscal years beginning 1 July since almost no wine from a particular vintage is exported before 1 July of that year. Vintage is always in the latter half of the fiscal year, mostly during February-April.

Winegrape bearing area:
For the wine regions of South Australia, we used area data from Vinehealth for 2001 to 2022, see Wine Australia (2022a and earlier) and Vinehealth Australia (2014 and earlier). For wine regions in other states, we used winegrape bearing data from Anderson (2015) for 2001-08, 2010, 2012, which were based on ABS (2015 and earlier), as are our data for 2015.To estimate the winegrape bearing area by variety for missing years in regions outside South Australia, we first use a five-step methodology to estimate the 2019 areas based on the total vineyard area for 2019 as revealed in a satellite scan by Wine Australia (2019). The first step consists of estimating the bearing area from that total vine area of each non-SA region, which we assumed was lower to the same extent as the bearing to total area for South Australia in that year (0.97). The second step consists of calculating the average yield by variety in each non-SA region, for the 11 years for which there are area, crush and yield data available from ABS (2015 and earlier): 2001-08, 2010, 2012, and 2015. We assume this gives us the 'expected yield' for each variety by region combination. The third step consists of estimating the average production by variety for each non-SA region, for the three years 2018, 2019, and 2020, from Wine Australia (2022b and earlier). We refer to these values as the 'average production' for each variety-by-region combination. The fourth step consists of estimating the area by variety and region, for each non-SA region, as: 'area without any adjustment' = 'average production' / 'expected yield'. The fifth step consist of adjusting the

'area without any adjustment' estimate by multiplying each variety-by-region estimate by a 'region-specific index' which is set so that the sum of the area for all varieties in a given region equals the total bearing area in that region as per the 2019 National Vineyard Scan (Wine Australia 2019) after deflating it as in step 1 above to account for non-bearing areas.

Having so estimated non-SA regional bearing areas by variety for 2019, we then estimated the total area of each region for the years without area data as follows: for 2009, the average of 2008 and 2010; for 2011, the average of 2010 and 2012; for 2013 and 2014, a linear trend from 2012 to 2015; for 2016, 2017 and 2018, a linear trend from 2015 to 2019; and for 2020, 2021 and 2022, we set them equal to 2019 – since the total (including non-bearing) area in SA in 2022 (73226 ha) is very similar to this State's total area in 2019 (73135 ha). Some regions, most of whose names start with the word 'Other', are not reported in the 2019 National Vineyard Scan. For those regions, we assumed their area by variety after 2015 is the same as in 2015.

Data for the region Murray Darling – Swan Hill, which spreads across the state border between NSW and Vic (which is the River Murray), are combined for some years. In order to have state-specific area statistics, we divided this region into two: Murray Darling – Swan Hill (NSW) and Murray Darling – Swan Hill (Vic). We assumed that 45% is planted in NSW and 55% in Vic.

The ABS area data for Queensland prior to 2010 included grapes for non-wine purposes, In the subsequent years to 2015 the area was only 32.65% of the 2001-09 average, so we multiplied the Queensland total area by 0.3265 in 2001-09.

For Tasmania we used Wine Tasmania area data for 2011-21 (personal communication from Wine Tasmania).

In a preliminary article that examined trends just in South Australia (Anderson and Puga 2022), total winegrape area were used rather than just bearing area.

Winegrape production:

For SA regions, we used production data from Vinehealth as published by Wine Australia (2022a and earlier) from 2015 and Vinehealth Australia (2014 and earlier) for previous years. For non-SA regions, the following process applies. First, we used production data from Anderson (2015) for non-SA regions in 2001-08, 2010, and 2012 and ABS (2015) production data for 2015.

For the other years, we relied on production and price data from Wine Australia (Wine Australia 2022b and earlier) for 2008-22, as follows. Since the 2008-14 data only refer to purchased grapes, we generated a regional index for 2015-21 = (production purchased + production own grown) / production purchased. In cases when this index is higher than 10 or when it cannot be calculated, we set it to 10. Then we calculated production as production purchased times that index. As with the area data, Murray Darling – Swan Hill, which spreads across the border between NSW and Vic, appears combined for some years. In order to have state-specific production statistics, we divided this region into two: Murray Darling – Swan Hill (NSW) and Murray Darling – Swan Hill (Vic). We assumed that 45% was produced in NSW and 55% in Vic in those years.

For Qld, we interpolated production for 2009, 2011, and 2013-14 using surrounding year data.

Winegrape prices:

Price is a weighted average for the receival prices paid per tonne by wineries to growers. It does not include end-use bonuses or quality adjustments determined post-receival. There is a wide range of different pricing/contractual arrangements, including per hectare pricing, fair market value, achievement of specifications, and adjustments for regional average. Wineries

do not supply pricing information for own-grown grapes, so they are valued at the same average value as purchased grapes in order to determine a total value of grapes for each region.

For SA regions, we used price data from Vinehealth as reported by Wine Australia (2022a and earlier) for recent years. For non-SA regions, we used data from Anderson (2015) for 2001-08, 2010, and 2012, and from Wine Australia (2022b and earlier) for 2009, 2011, and 2013-22.

Weighted averages:
Across the database, the variables are weighted averages when appropriate. For example, when applicable, yield per ha and revenue per ha are area-weighted averages, and price is a production-weighted average.

Underestimation of winegrape gross revenues:
For calculating regional, state, and national gross revenues, we used only those region-by-variety combinations for which there are data on both production and price. There are some region-by-variety combinations for which there are data only for production or price that are not included in the calculation. As a result, some regional, state, and national revenues are underestimated.

Wine sales and inventory volumes:
Sourced from Wine Australia (2022c and earlier).

Wine export volumes:
The volume of exports of each variety are compiled by Wine Australia and made available at https://marketexplorer.wineaustralia.com/export-dashboard

Varietal similarity index (VSI):
When there are M varieties, this measure is defined as:

$$\omega_{ij} = \frac{\sum_{m=1}^{M} f_{im} f_{jm}}{\left(\sum_{m=1}^{M} f_{im}^2\right)^{1/2} \left(\sum_{m=1}^{M} f_{jm}^2\right)^{1/2}},$$

where f_{im} is the area of plantings of grape variety m as a proportion of the total grape plantings in country i, and f_{jm} is the area of plantings of grape variety m as a proportion of the total grape plantings in the world, such that these proportions fall between zero and one and sum to one where f_{im} is the area of plantings of grape variety m as a proportion of the total grape plantings in country i, and f_{jm} is the area of plantings of grape variety m as a proportion of the total grape plantings in the world, such that these proportions fall between zero and one and sum to one.

For the VSIs for 2001 and 2019 we used world data for 2000 and 2016, respectively, from Anderson and Nelgen (2020b).

Climatic classifications:
Based on TerraClimate's high-resolution (1/24º, 4-km) monthly data, Gregory Jones averaged them over the period 1989-2019. Jones and many others have found that growing season temperature (GST) is the most representative single indicator of climate insofar as it affects viticulture, so that is used to summarize regional climates by classifying regions as

either cool, temperate, warm or hot. In Australia no regions were classified as cool over that period. Anderson and Nelgen (2020) similarly classified all regions of the world but used TerraClimate's data over the longer period 1958-2019, which was cooler than the more-recent period 1989-2019. Remenyi et al. (2019) have since estimated the GST for Australia's wine regions for the two decades to 2060 and found they average 1.4^0 C above the average for the two decades to 2017. That suggests the shares of winegrape regions in Australia (as elsewhere in the world) that are warm and hot are rising over time as the temperate area shrinks. Puga, Anderson and Doko Tchatoka (2022) estimate that this could reduce Australian winegrape prices by 12% by mid-century, assuming no adaptation by vignerons.

Reliability of our estimates of bearing area by variety for non-SA regions in 2019:

The area by variety is available for South Australian regions, hence allowing us to compare the estimates of area by region and variety outlined above with the actual South Australian data by region and variety as reported by Vinehealth. Table A1 below reports the mean and standard deviation of the percentage difference between our estimates and the Vinehealth data for 2019, across regions. This is shown for all varieties combined, as well as for the five most-planted varieties. Positive mean values indicate an overestimated mean area while negative values point to an underestimated mean area. The first two columns show the unweighted values, and the last two columns show the area-weighted mean and standard deviation.

Table A1: Mean and standard deviation (SD) of the percentage difference between our estimates and the Vinehealth data, across SA regions, 2019

	Unweighted		Area-weighted	
	Mean	SD	Mean	SD
Shiraz	-1.2	8.6	-0.8	6.4
Cabernet Sauvignon	-5.0	15.2	-0.6	14.9
Merlot	0.6	24.4	7.2	19.6
Chardonnay	-3.4	9.3	1.9	7.6
Sauvignon Blanc	4.4	36.5	14.6	23.5
All varieties	**3.4**	**53.7**	**0.3**	**20.0**

While the mean area across all varieties is overestimated by 3.4% across regions in SA, the area-weighted mean area is overestimated by just 0.3%. Similarly, the standard deviation across all varieties in SA is quite high at 54%, but the area-weighted standard deviation is much lower at 20%. This suggest that our estimates of area by variety may be most reliable in the largest regions. The standard deviations are also lower for the top five varieties by area (except for the area-weighted standard deviation of Sauvignon Blanc), indicating that our estimates are most reliable for the most-planted varieties.

Another way of testing the reliability of our estimates involves using the varietal similarity index (VSI). This index takes values between 0 and 1, and is higher the more similar the mix of winegrape varieties between two regions (in terms of shares planted to each variety). An index of 0 means that the mix of varieties of the two regions is totally different, while an index of 1 means that their mix of varieties is identical.

Table A2 below shows the VSI between each region using our area estimates for 2019 and the same region using the area data from Vinehealth. The last row of this table shows all the SA regions combined. The average VSI across regions in SA is 0.99, and 1.00 for the

State as a whole. These values are close to perfect alignment, providing confidence in our estimates for non-SA regions.

Table A2: VSI between each region using our area estimates and the same region using the area data from Vinehealth, 2019

	VSI
Adelaide Hills	1.00
Adelaide Plains	0.98
Barossa Valley	1.00
Clare Valley	0.99
Coonawarra	1.00
Eden Valley	1.00
Langhorne Creek	1.00
McLaren Vale	1.00
Padthaway	1.00
Riverland	1.00
Wrattonbully	0.98
All South Australia	**1.00**

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Table 1: Australian emerging (and declining) varieties' bearing area of between 5 and 1000 hectares as of 2022, 2007 and 2022, and also an export volume of between 10 and 3600 kl as of 2019-21, 2006-08 and 2019-21

	Bearing area (ha)		Export volume (kl)	
Emerging:	**2007**	**2022**	**2006-08**	**2019-21**
Aglianico		5	0	48
Alicante Henri Bourschet	2	15	2	21
Arneis	1	38	4	16
Barbera	114	118	174	37
Canada Muscat		326	2	1658
Cinsaut		9	3	14
Côt (Malbec)	359	672	694	2390
Dolcetto	15	126	62	128
Durif	412	847	1213	3521
Fiano		380	0	264
Graciano		13	1	27
Grüner Veltliner		20	0	38
Lagrain	1	10	7	28
Montepulciano		96	0	101
Nebbiolo	120	122	31	24
Nero d'Avelo		87	0	290
Prosecco		320	1	550
Rousanne	36	45	40	147
Saperavi		11	0	10
Tempranillo	314	844	335	1074
Touriga National	21	71	32	38
Vermentino		110	1	332
TOTAL of above emerging	**1395**	**4285**	**2602**	**10756**
% of national bearing area or export volume	**0.9%**	**3.0%**	**0.3%**	**1.5%**
Declining:				
Cabernet Franc	503	313	543	133
Chenin Blanc	666	415	2142	306
Grouchen	91	33	38	9
Marsanne	177	137	241	180
Sangiovese	464	433	1118	576
Tribidrag (Zinfandel)	99	80	34	54
Viognier	1040	692	1941	1707
TOTAL of above declining	**3040**	**2103**	**6057**	**2965**
% of national bearing area or export volume	**1.9%**	**1.5%**	**0.8%**	**0.4%**

Source: Authors' compilation from Anderson and Puga (2022b).

Table 2: Average yields (t/ha), prices ($/t) and gross revenue per hectare ($), Australian States, 2001-22 (nominal AUD)

	Yield (t/ha)	Price ($/t)	Gross revenue ($/ha)
SA	11.2	770	8850
NSW	13.8	470	6340
Vic	12.0	610	7060
WA	4.9	1330	6520
Tas	6.0	2650	14280
AUSTRALIA	**11.3**	**670**	**7710**

Source: Authors' compilation from Anderson and Puga (2022b).

Table 3: Average yields (t/ha), prices ($/t) and gross revenue per hectare ($) of the dozen most-planted varieties, Australia, 2001-22 (nominal AUD)

	Yield (t/ha)	**Price ($/t)**	**Gross revenue ($/ha)**	**VQI[a]**	**VPI[b]**
Cabernet Sauvignon	9.2	790	7410	1.18	0.98
Chardonnay	14.7	580	8570	0.84	1.10
Colombard	29.3	290	8390	0.42	1.17
Grenache	8.3	880	7180	1.32	0.96
Merlot	12.4	610	7540	0.89	0.96
Muscat of Alexandria	23.9	330	7690	0.50	1.12
Pinot Gris	14.2	730	10530	1.35	1.45
Pinot Noir	8.5	1190	10200	1.79	1.25
Riesling	7.6	920	6970	1.37	0.88
Sauvignon Blanc	12.6	810	9990	1.20	1.27
Sémillon	13.9	480	6800	0.72	0.90
Shiraz	9.8	830	8310	1.24	1.11
All reds	*9.8*	*790*	*7860*		
All whites	*14.1*	*540*	*7610*		
All varieties	***11.3***	***670***	***7710***	***1.00***	***1.00***

[a] *Varietal quality index* (VQI) is the **r**atio of national average price of each variety to that of all varieties in that vintage.

[b] *Varietal productivity index* (VPI) is the ratio of varietal to national average gross value of production per hectare in that vintage.

[c] In calculating the average price and gross revenue per ha of Pinot Gris, the years 2001-05 are ignored as that variety's bearing area and annual production were well under 400 ha and 2500 tonnes.

Source: Authors' compilation from Anderson and Puga (2022b).

Table 4: Climate classification, and average yields (t/ha), prices ($/t) and gross revenue per hectare ($) of winegrapes, Australian wine regions, 2001-22 (nominal AUD)

	Climate[c]	Yield (t/ha)	Price ($/t)	Gross rev/ha($)	RQI[a]	RPI[b]
Adelaide Hills	Warm	7.3	1461	10777	2.19	1.51
Barossa Valley	Warm	5.9	1532	8674	2.31	1.24
Bendigo	Warm	3.5	1133	4113	1.70	0.51
Canberra District	Warm	3.0	1674	4715	2.54	0.49
Clare Valley	Hot	4.8	1253	6037	1.87	0.82
Coonawarra	Temp	6.3	1290	8194	1.93	1.13
Cowra	Hot	6.3	742	5099	1.09	0.62
Eden Valley	Warm	4.9	1538	7334	2.31	1.05
Geographe	Hot	4.5	1038	4977	1.54	0.63
Goulburn Valley	Hot	6.9	788	5998	1.29	0.59
Grampians	Temp	3.7	1418	5363	2.31	0.67
Great Southern	Warm	3.4	1375	5126	2.07	0.66
Heathcote	Warm	4.8	1155	6675	1.82	0.85
Hilltops	Hot	4.3	822	3907	1.54	0.49
Hunter Valley	Hot	3.6	1126	3863	1.69	0.50
Langhorne Creek	Hot	9.0	955	9029	1.41	1.23
Margaret River	Hot	4.9	1429	7371	2.20	1.08
McLaren Vale	Hot	6.7	1509	10034	2.27	1.38
Mornington Peninsula	Warm	3.9	2394	8620	3.67	1.15
Mudgee	Hot	4.5	916	4126	1.33	0.49
Murray Darling/Swan Hill (NSW)	Hot	21.4	434	8905	0.64	1.24
Murray Darling/Swan Hill (Vic)	Hot	17.3	431	7310	0.63	1.02
Orange	Warm	5.2	1103	5819	1.62	0.71
Padthaway	Warm	9.3	996	9366	1.47	1.24
Pyrenees	Warm	1.9	1757	3153	2.84	0.30
Riverina	Hot	14.9	396	5961	0.59	0.84
Riverland	Hot	22.2	427	9689	0.62	1.34
Rutherglen	Hot	5.0	1106	5403	1.68	0.56
Swan District	Hot	7.1	597	6099	1.29	0.60
Tasmania	Temp	6.0	2647	15717	4.15	2.28
Tumbarumba	Warm	4.6	1456	6403	2.39	0.91
Wrattonbully	Warm	8.6	1167	10252	1.73	1.39
Yarra Valley	Warm	4.8	1735	8259	2.63	1.17
All regions		**11.3**	**670**	**70**	**1.00**	**1.00**

[a] *Regional quality index (RQI)* is the ratio of regional to national average price per tonne of all varieties in that vintage.

[b] *Regional productivity index (RPI)* is the ratio of regional to national average gross value of production per hectare of all varieties in that vintage.

[c] Average growing season temperature for the period 1989-2019 in Temperate (from 15^{o} but <17^{o}C), in Warm (from 17^{o} but <19^{o}) and in Hot (≥19^{o}).

Source: Authors' compilation from Anderson and Puga (2022b).

Table 5: Varietal Similarity Indexes (VSIs), national, state and regional,[a] 2001 and 2022

	VSI relative to world			VSI relative to Australia		
	2001	2022	% of 2022 above 2001	2001	2022	% of 2022 above 2001
AUSTRALIA	0.47	0.66	42	1.00	1.00	0
South Australia	0.46	0.62	34	0.96	0.98	2
New South Wales	0.44	0.66	50	0.97	0.95	-2
Victoria	0.37	0.66	79	0.85	0.96	13
Western Australia	0.50	0.68	35	0.94	0.88	-7
Tasmania	0.34	0.34	0	0.48	0.32	-33
Queensland	0.40	0.58	43	0.94	0.94	1
Adelaide Hills	0.48	0.55	14	0.78	0.63	-19
Barossa Valley	0.39	0.41	6	0.87	0.86	-1
Bendigo	0.33	0.56	70	0.85	0.91	7
Canberra District	0.47	0.61	29	0.90	0.92	3
Clare Valley	0.43	0.52	21	0.90	0.86	-5
Coonawarra	0.43	0.59	36	0.79	0.72	-9
Cowra	0.40	0.56	40	0.83	0.71	-14
Eden Valley	0.33	0.51	52	0.74	0.86	16
Geographe	0.48	0.66	37	0.95	0.86	-9
Goulburn Valley	0.44	0.64	45	0.94	0.96	2
Grampians	0.35	0.37	5	0.92	0.84	-9
Great Southern	0.48	0.62	31	0.94	0.97	2
Hilltops	0.43	0.59	37	0.94	0.93	0
Hunter Valley	0.33	0.44	32	0.76	0.79	4
Langhorne Creek	0.45	0.62	38	0.87	0.94	9
Margaret River	0.49	0.67	35	0.88	0.81	-9
McLaren Vale	0.45	0.47	3	0.94	0.89	-5
Mornington Peninsula	0.30	0.31	4	0.46	0.33	-29
Mudgee	0.44	0.69	58	0.95	0.96	1
Murray Darling/Swan Hill(NSW)	0.37	0.69	87	0.85	0.93	9
Murray Darling/Swan Hill(Vic)	0.26	0.66	156	0.68	0.96	41
Orange	0.45	0.71	58	0.93	0.95	2
Padthaway	0.45	0.65	45	0.90	0.98	9
Pyrenees	0.39	0.61	55	0.89	0.97	9
Riverina	0.41	0.64	56	0.88	0.93	6
Riverland	0.47	0.65	40	0.96	0.97	2
Rutherglen	0.29	0.37	25	0.78	0.74	-5
Swan District	0.37	0.40	7	0.69	0.52	-25
Tasmania	0.34	0.34	0	0.48	0.32	-33
Tumbarumba	0.31	0.39	24	0.51	0.45	-11
Wrattonbully	0.43	0.64	47	0.80	0.85	6
Yarra Valley	0.44	0.46	3	0.69	0.52	-25

[a] The world's winegrape bearing area's varietal mix refers to 2000 and 2016 (the most-recent year available), from Anderson and Nelgen (2020b). See Appendix for the VSI's definition.
Source: Authors' compilation from Anderson and Puga (2022b).

Table 6: Varietal intensity index[a] of the dozen most-planted varieties in Australia, relative to the world, 2001 and 2021

	2001	**2021**
Cabernet Sauvignon	4.2	2.7
Chardonnay	4.9	3.4
Colombard	1.7	1.5
Grenache	0.4	0.4
Merlot	1.3	1.0
Muscat of Alexandria	3.8	1.7
Pinot Gris	0.0	3.2
Pinot Noir	1.9	1.8
Riesling	3.1	1.9
Sauvignon Blanc	1.6	1.6
Sémillon	10.2	6.5
Shiraz	11.3	7.5

[a] *Varietal intensity index* (VII) is defined as a variety's share of the bearing area in Australia relative to its share in the global bearing area of winegrapes in years 2000 and 2016 (the most-recent year available), from Anderson and Nelgen (2020b).

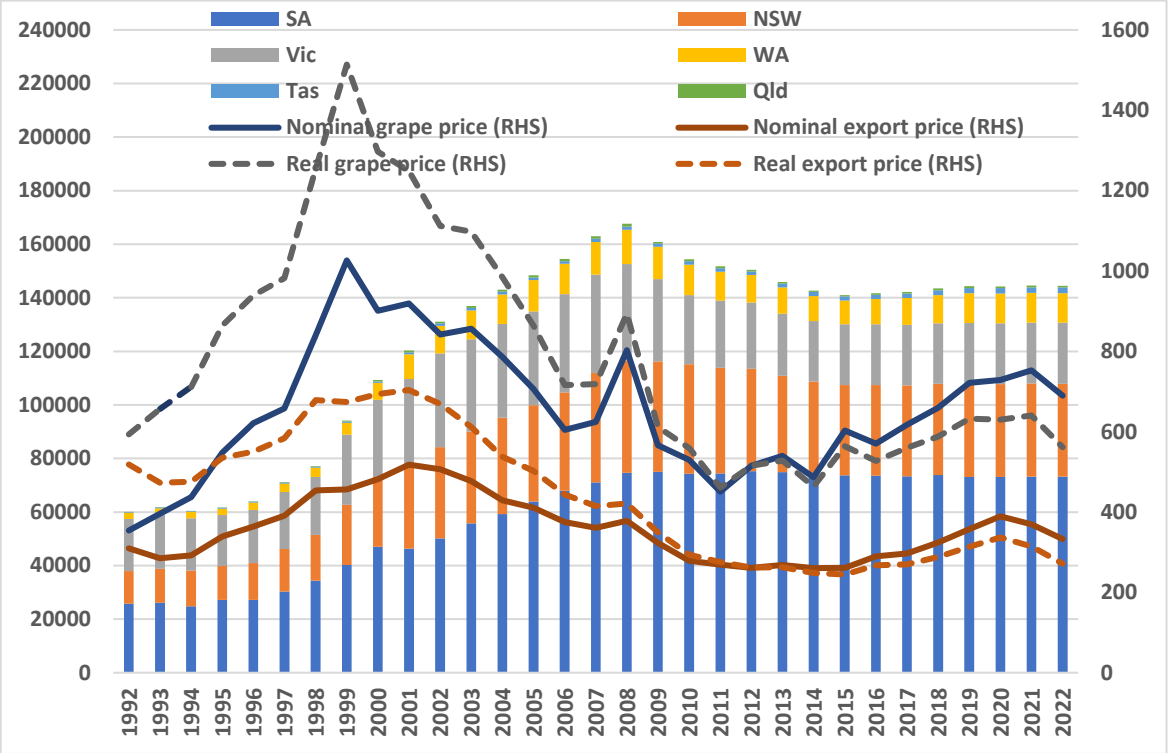
Source: Authors' compilation from Anderson and Puga (2022b).

Table 7: Shares of the dozen most-planted varieties (and all reds) in Australia's winegrape bearing area, crush and wine export volume, 2001-03 and 2020-22 (%)

	Bearing area		Crush volume		Wine export volume	
	2001-03	2020-22	2001-03	2020-22	2001-03	2019-21
Cabernet Sauvignon	18.7	18.3	17.8	15.1	16.8	14.8
Chardonnay	13.7	14.9	17.5	19.8	24.6	22.8
Colombard	1.4	1.0	3.8	3.0	2.8	1.1
Grenache	1.5	1.2	1.6	0.8	1.4	0.4
Merlot	6.1	5.7	6.6	6.1	6.1	6.9
Muscat of Alexandria	2.0	1.3	3.1	3.3	0.8	1.4
Pinot Gris	0.0	3.4	0.0	4.5	0.0	5.7
Pinot Noir	2.7	4.1	1.5	2.5	0.8	1.2
Riesling	2.5	2.2	1.9	1.0	1.0	0.6
Sauvignon Blanc	2.1	4.5	1.7	5.4	1.3	4.2
Sémillon	4.8	2.6	6.3	3.2	6.4	1.0
Shiraz	23.0	29.8	23.4	26.1	27.3	27.6
SUM of ABOVE	**78.5**	**89.0**	**85.2**	**90.6**	**89.4**	**87.7**
Next 10 varieties in area in 2020-22	5.1	5.9	6.2	6.6	2.6	3.7
Remaining varieties	16.4	5.2	8.6	2.8	8.0	8.6
TOTAL	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**
% red varieties	***59***	***65***	***57***	***56***	59	58

Source: Authors' compilation from Anderson and Puga (2022b).

Figure 1: Winegrape bearing area by State (left axis in hectares), and prices of winegrapes and of exported wine (right axis in $/tonne and cents/litre), Australia, 1992 to 2022[a] (nominal and real AUD)[b]

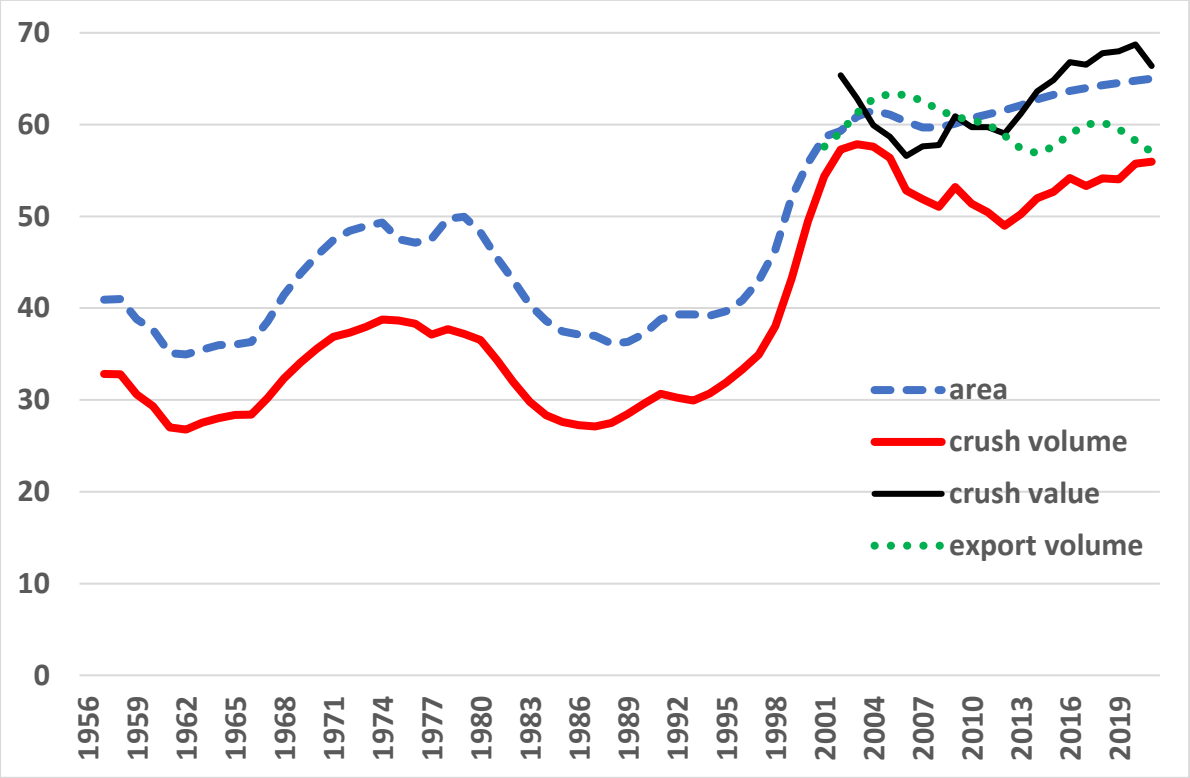


[a] Export prices are for fiscal years beginning 1 July.

[b] Real prices are nominal prices deflated by the CPI which is set at 2011-12 = 1.00.

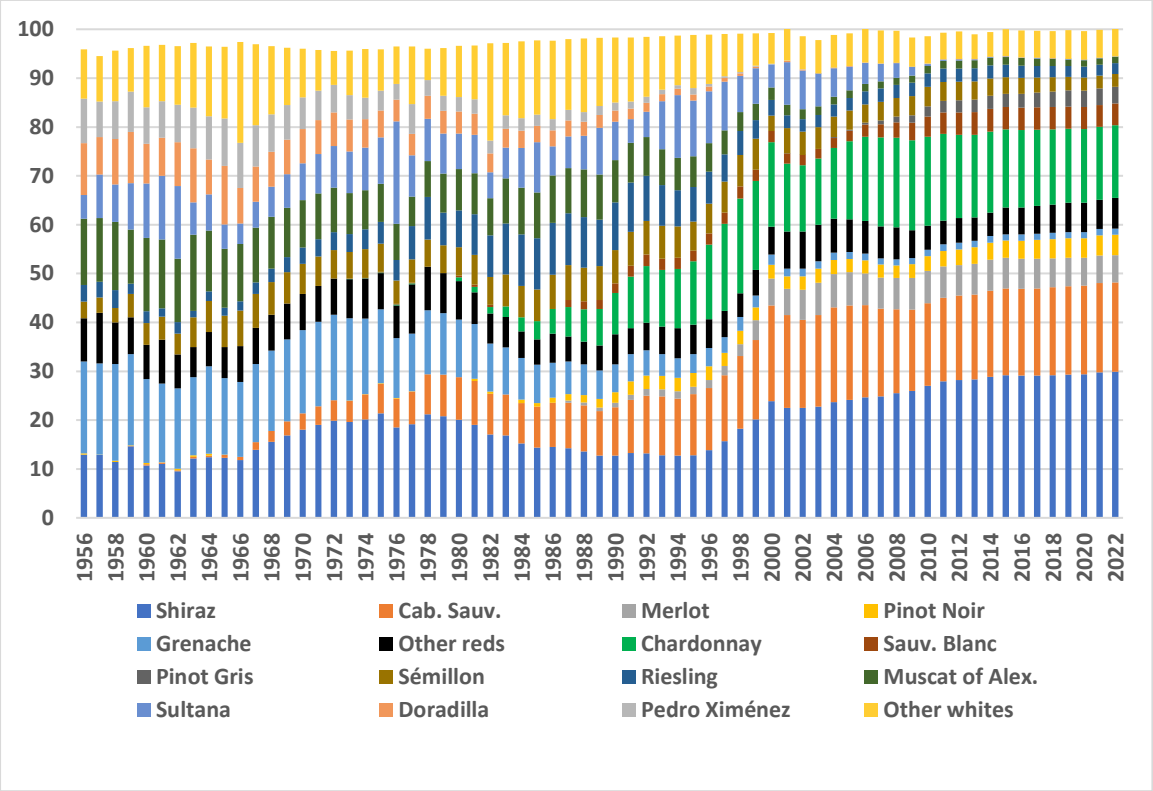
Source: Authors' compilation from Anderson and Puga (2022b).

Figure 2: Red shares of Australia's vine bearing area, crush volume, export volume and crush value, 1956 to 2022 (%, 3-year averages around year shown)



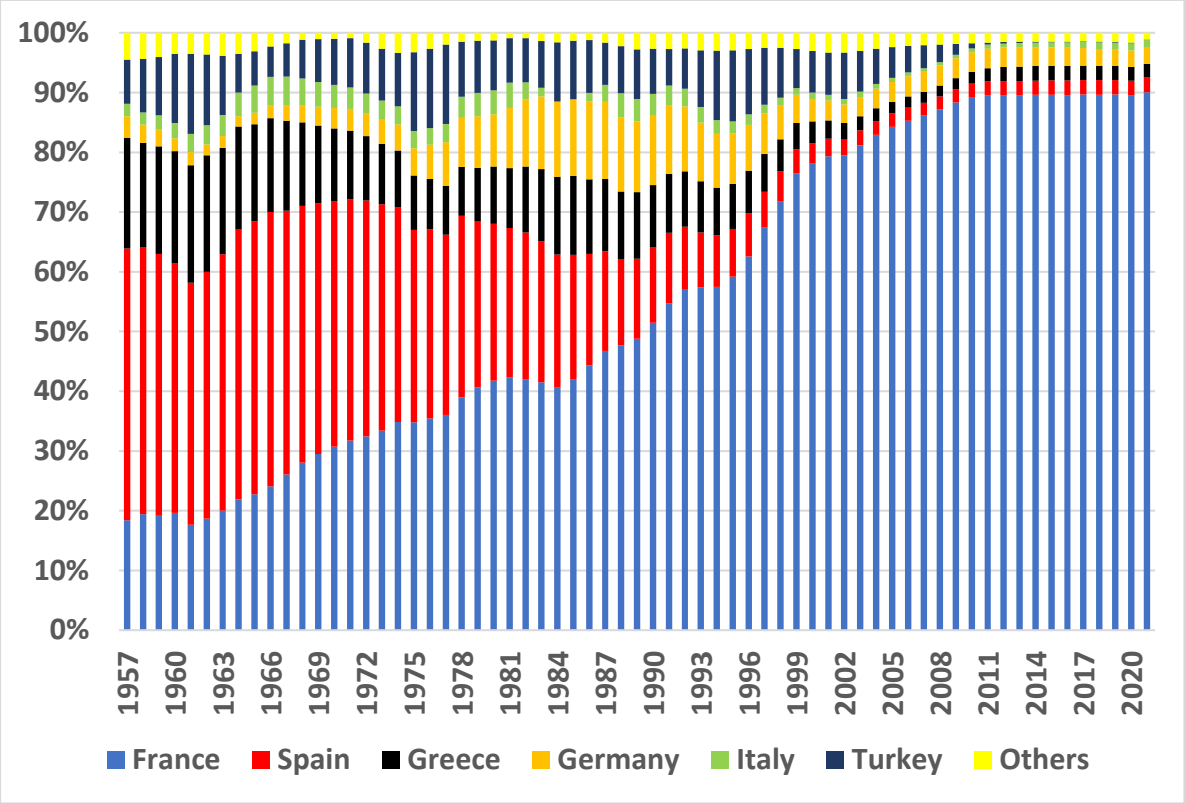
Source: Authors' compilation from Anderson and Puga (2022b).

Figure 3: Shares of main varieties in the total Australian winegrape bearing area, 1956 to 2022 (%)



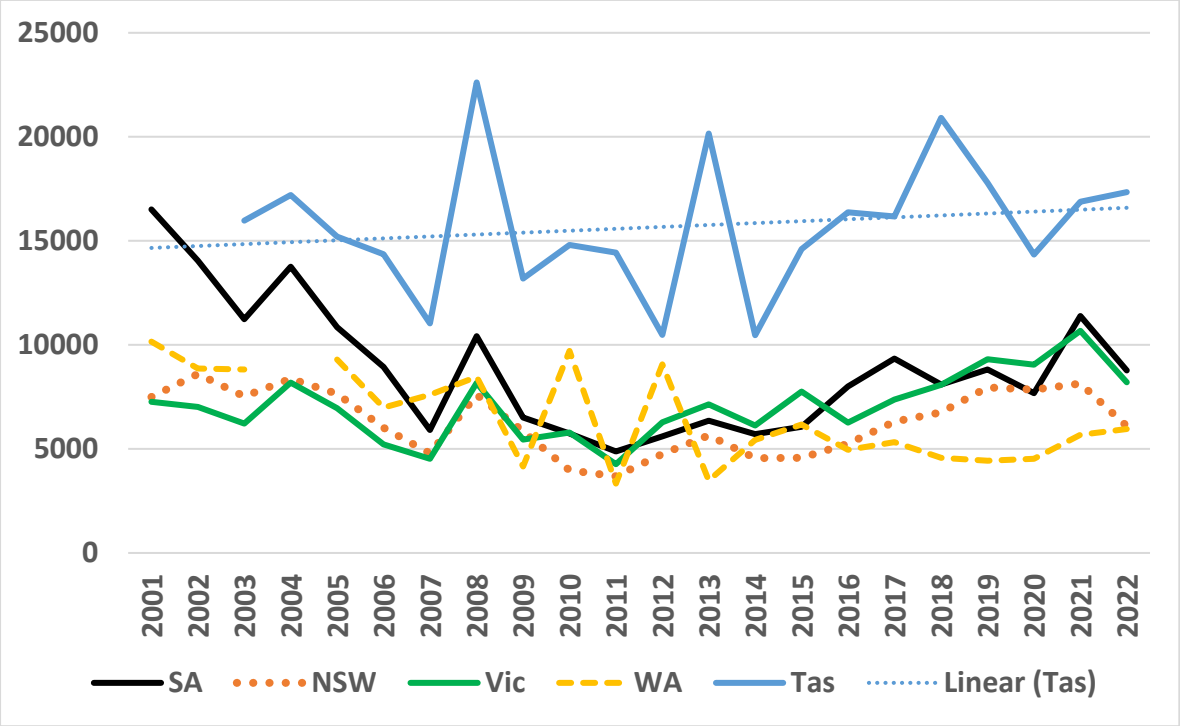
Source: Authors' compilation from Anderson and Puga (2022b).

Figure 4: Shares of varietal country of origin in Australia's winegrape bearing area, 1956 to 2022 (%, 3-year average around year shown)



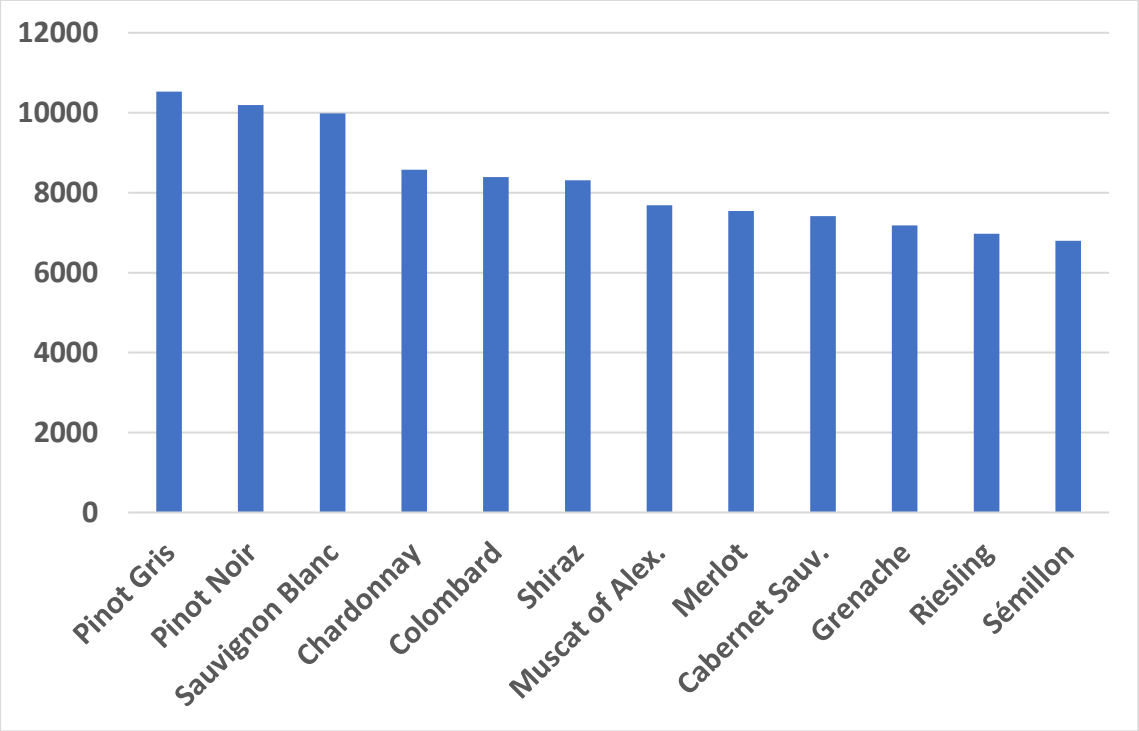
Source: Authors' compilation from Anderson and Puga (2022b).

Figure 5: Gross revenue per hectare of winegrapes, Australian States, 2001 to 2022 (nominal A$)



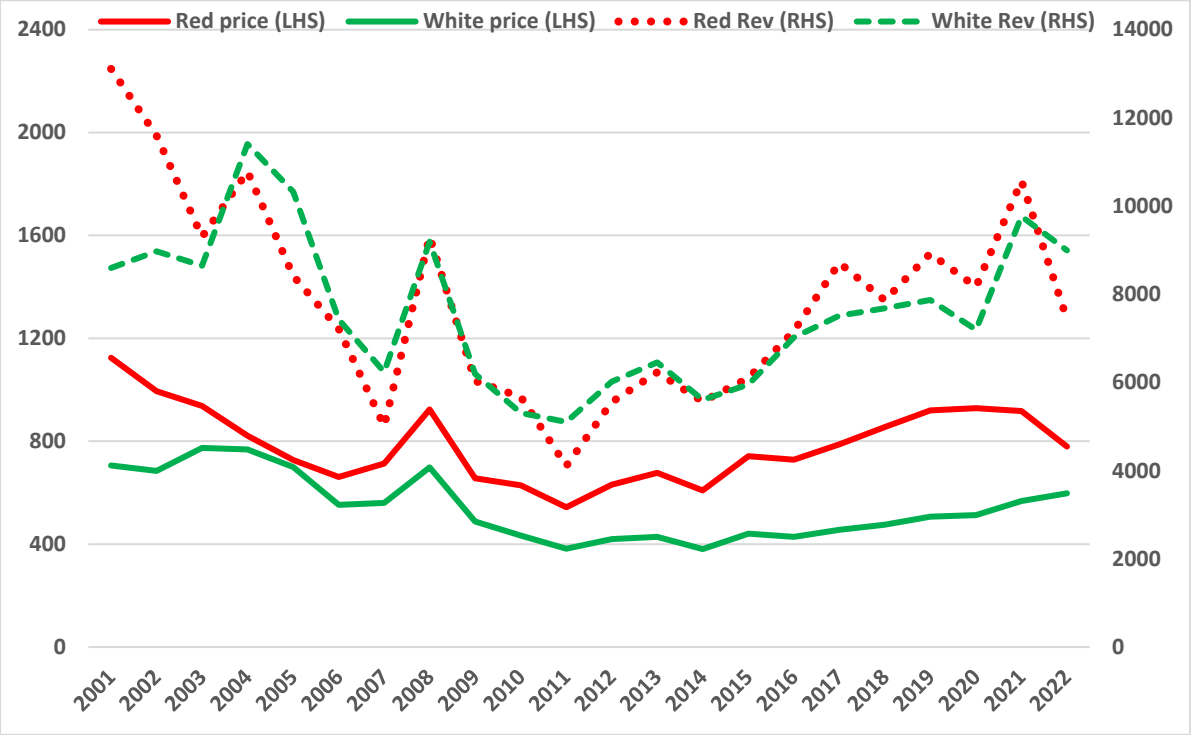
Source: Authors' compilation from Anderson and Puga (2022b).

Figure 6: Gross revenue per hectare of Australian winegrapes, dozen most-planted varieties, average for 2001-22 (nominal AUD)



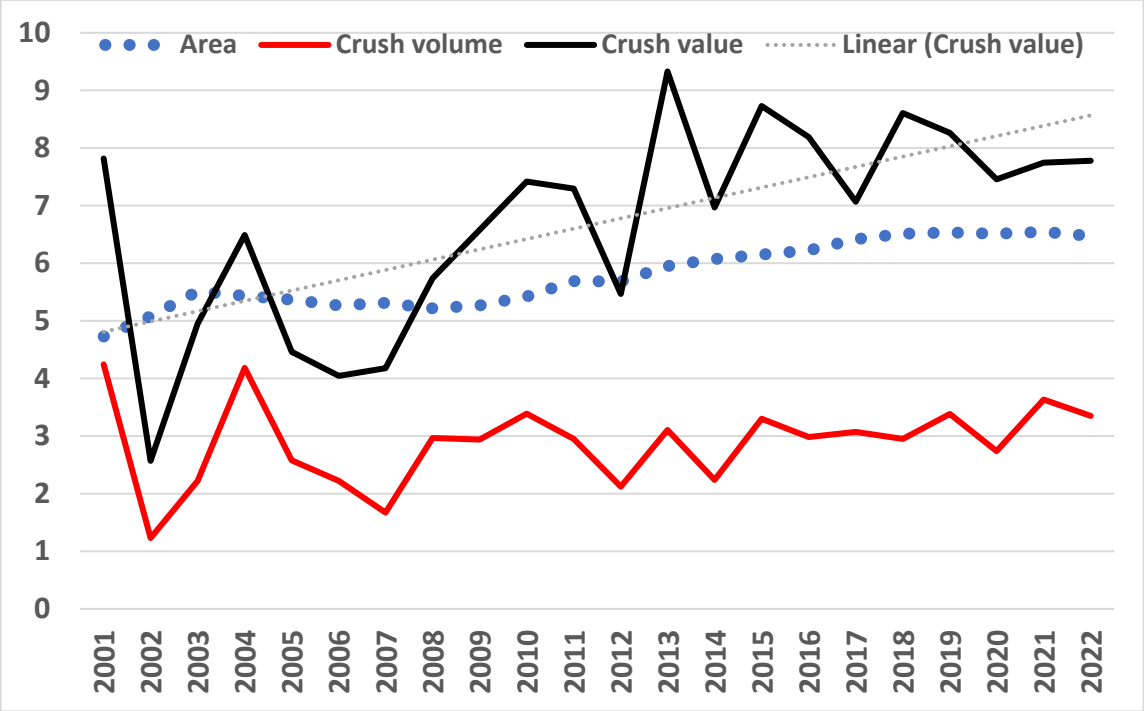
Source: Authors' compilation from Anderson and Puga (2022b).

Figure 7: Price per tonne (LH axis) and gross revenue per hectare (RH axis) of red and white winegrapes, Australia, 2001 to 2022 (nominal AUD)



Source: Authors' compilation from Anderson and Puga (2022b).

Figure 8: Share of Temperate regions[a] in Australia's winegrape area, crush volume and crush value, 2001 to 2022 (%)



[a] They are the coolest regions in Australia in terms of average growing season temperature during 1989-2019: Coonawarra, Grampians, Henty, Macedon Ranges, Strathbogie Ranges, and Tasmania.

Source: Authors' compilation from Anderson and Puga (2022b).