Journal of Wine Economics (2024), **19**, 201–231
doi:10.1017/jwe.2024.19

CAMBRIDGE UNIVERSITY PRESS

ARTICLE

Wine prices and weather: Are cult wines different?

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Abstract

In this article, we examine how weather variables affect markets for U.S. high-end wines, both luxury wines and wines from the same region that are still high-end but not in the very limited highest category. Specifically, we compare so-called "cult wines" with "non-cult wines" from the same subregions that are known for their high-quality wines. We investigate associations between weather conditions and prices, price gaps (the difference between the secondary market price and release price), the number of cases produced, and wine scores assigned for both cult and non-cult wines. We further examine whether associations with weather differ across wine regions. Implementing a fixed-effects methodology, cult and non-cult wines from three U.S. regions were studied: both Napa and Sonoma in California, and Walla Walla on the border of Washington State and Oregon. Overall, the analysis suggests that weather is associated with various characteristics of wine markets, including prices, price gaps for cult wines, wine scores, and cases produced. The nature of the associations depends on the type of wine (cult or non-cult, red or white) and timing of weather conditions throughout the year and growing region.

Keywords: luxury wines; cult wines; weather

JEL classifications: L66; Q13

I. Introduction

Ashenfelter and Storchmann (2016) find that weather can affect the quantity, quality, and longevity of wine. Therefore, because climate change results in increased weather variability, one should expect wine markets to be impacted by climate change. In considering effects on wine markets, a factor to consider is that consumers value the same wine attributes differently across categories of wines (Costanigro et al., 2007). Specifically, the quantity (number of cases produced), expert rating scores, and aging have greater impacts on prices in the "fine wine" category than in lower-priced categories. Thus, it seems reasonable to hypothesize that the impacts of weather on wine prices including the effects of quantity and quality will be heterogeneous across different segments of the wine market.

In this article, we examine how weather variables affect markets for U.S. high-end wines, both luxury wines and wines from the same region that are still high-end but not in the very limited highest category. Specifically, we compare so-called “cult wines” with “non-cult wines” from the same subregions that are known for their high-quality wines. Cult wines are wines that are characterized by high quality, limited production, restricted market availability, and high prices (Taplin, 2016). Since these wines are generally sold exclusively to members on an allocation list, many cult wines have waiting lists that span several years. Consequently, consumers who are not on allocation lists can only purchase these wines on the secondary market.

The main objectives of this research are to (1) analyze how weather affects both the primary and secondary markets for U.S. cult wines and (2) assess whether effects are different for non-cult wines that are located in close proximity. We further consider whether the impact of weather differs across the U.S. regions we study in California and Washington state.

Several researchers have examined how wine prices are affected by weather. The first econometric analysis is Ashenfelter (1986), who estimates the effect of weather on *Grand Cru* (high quality) wine prices from the Bordeaux region in France. The Bordeaux region has been the focus of several studies using linear model specifications with the general finding that warmer average temperatures during the growing season have significant positive impacts on prices (Ashenfelter, 2008; Ashenfelter et al., 1995; Chevet et al., 2011; Jones and Storchmann, 2001). Ashenfelter (2010) finds that excess precipitation at the end of the growing season has a negative impact on the price of Bordeaux wines.

Researchers have also analyzed how weather impacts new world wines. Byron and Ashenfelter (1995) use a quadratic functional form for temperature in their analysis of how weather affects prices of Grange variety wines in Australia. They find that the first derivative of price with respect to temperature is positive, and the second derivative is negative, indicating a relationship that is increasing at a decreasing rate, with a maximal price achieved at an optimal level of temperature, *ceteris paribus*. In an analysis of Australian premium wines, Oczkowski (2016) finds that if temperature increases by 1°C, the prices for Cabernet Sauvignon and Sauvignon Blanc decrease by less than 1% and by more than 3% for Chardonnay and Pinot Noir. Furthermore, he finds a positive relationship between price and the average rainfall during the harvest period. He argues that climate change will have differential impacts across wine regions.

Regarding U.S. wines, Haeger and Storchmann (2006) examine the impact of weather on Pinot Noir wines. They find that general temperature increases are not beneficial—the optimal average temperature is 22.2°C, which is lower than average temperatures in many top U.S. wine regions. Using data on Cabernet Sauvignon wines from the Napa Valley, Ramirez (2008) examines the relationship between price and weather. He finds that weather explains nearly 92% of the variation in wine prices. Furthermore, his results suggest cool, wet winters with dry, warm summers tend to result in higher wine prices.

https://doi.org/10.1017/jwe.2024.19

Since our analysis includes cult wines, we consider the difference between their secondary market prices and release prices.[1] Other studies analyze the relationship between these prices. Masset et al. (2023) estimate efficient release prices on the Bordeaux *en primeur* (primary) market. Using information from the secondary market, they find that most chateaux released their wines at prices that were too high. They discuss that one possible explanation for this overpricing is the tendency of chateaux with similar status to release their wines at similar price levels. In contrast, Okhunjanov et al. (2024) find that U.S. cult wine release prices are below their corresponding secondary market prices. They posit that the underpricing is consistent with a strategy to intentionally create a perception of scarcity in order to increase demand in future periods.

The current paper contributes to the existing literature in a number of ways. We examine the impact of weather on the markets for U.S. cult wines. We analyze not only how weather impacts wine prices but also how the differences between primary and secondary market prices are affected. Moreover, in conducting the analysis, we utilize a panel data set that implements a fixed-effects (FE) methodology that yields differing results, depending on the explanatory variable partitions applied. These varying results include differing coefficient signs, differences with respect to statistical significance, or both, which to some degree then imply different conclusions in comparison to past studies with respect to weather effects. However, some of the observed differences may be attributable to the types of wines and regions analyzed, as well as the set of explanatory factors that are conditioned on, as opposed to the methodology *per se*. In addition, we assess whether there are differences between effects on cult and non-cult wines from the same local region.

This study also considers how the impact of weather may differ across regions that produce cult wines. Ashenfelter and Storchmann (2016) discuss that some regions will be better off, and some will be worse off from the effects of climate change. The cult wines in this study emanate from the famous regions of Napa and Sonoma in California and Walla Walla in Washington/Oregon. Walla Walla has a more northern latitude compared to Napa and Sonoma, and it is farther from the Pacific coast, on the eastern side of the Cascade mountain range. As a result, differences in weather include Walla Walla receiving much less rain as well as having higher summer temperatures and lower winter temperatures relative to the California coastal locations.

The article proceeds as follows: Section II provides a description of the data used in the analysis and presents summary statistics. Section III presents the econometric models used to conduct the analyses, the results of which are provided in Section IV. Finally, Section V provides conclusions and implications of the estimation results.

II. Data

A longitudinal dataset was created containing statistics relating to annual releases of cult and non-cult wines. The panel data spans a 5-year period from 2016 through 2020.

[1] A related but different topic is price-cost markups in wine. Back et al. (2019) analyze markups for Fair Trade (FT) wines sold in the United States to investigate how the increased costs of FT affects pricing strategies in the supply chain.

We define the "cult wine" market to be wines for which vintners require their customers to be on an allocation list in order to purchase wines directly from them and there is a waiting list to be on the allocation list. Yeung and Thach's (2019) book on luxury wine marketing provides a list of 162 luxury winemakers across the world. Their list indicates that the locations of U.S. luxury winemakers are limited to California, Oregon, and Washington. No other states are known for luxury wines at the "cult" level, and thus our analysis of cult wines is focused on these states.

To be included in our data on "cult" wines, the following criteria had to be met: (1) Wines could only be purchased directly from the wineries by members who are on the allocation list. (2) The allocation list must be full during the years 2016–2020, and thus, new customers must place themselves on a waiting list. (3) Release prices must be published for the years 2016–2020. (4) Secondary market prices must be available for the years 2016–2020. The vintages for cult wines range from 2013 to 2018. The cult wine data includes variables from fifteen winemakers, including eight from the Napa region of California, four from the Sonoma region of California, and three from the Walla Walla region which straddles the border of Washington and Oregon. For some wineries, there is only one cult wine variety, while for others there are several varieties produced and sold.

We also compiled data on a comparison group of non-cult wines from winemakers whose vineyards are located close to the same weather stations as the cult wines in our dataset. The non-cult wine data are from eighteen winemakers, including ten from Napa, three from Sonoma, and five from Walla Walla. A major difference between the two groups is that the non-cult wines do not have fully subscribed allocation lists. Thus, consumers can buy directly from the winemaker without the delay of a waiting list. Appendix Tables A1 and A2 provide lists of all companies and the wine products that are analyzed in this study for cult and non-cult wines, respectively.

The wine data are from *Wine-Searcher, Wine Spectator*, and from each winemaker's official website. The average U.S. retail price for each cult wine is obtained from *Wine-Searcher* and reflects the average price of a bottle of wine in the year in which it was released to customers.[2] For example, if a particular vintage of wine was released in 2017, then the average retail price listed would be for that specific year. Data on release prices of wines (i.e., prices for wines obtained directly from winemakers), the number of cases produced, and wine scores are from *Wine Spectator*. Prices of all wines used in this analysis reflect the average retail price per 750 ml in U.S. dollars and exclude sales tax. For non-cult wines, the release prices are generally the same as the market prices since there is no waiting list or scarcity of non-cult wines.

We note that *Wine Spectator* wine score ratings are the result of a blind tasting process and no information about price is available to the reviewers at the time of tasting. Moreover, all labels and identifying branding are removed from wine bottles as well. Experts who provide the scores pour wine samples into fresh, neutral, and clear glasses to taste at their pace.

[2]Regarding the calculation of the average retail price, according to *Wine-Searcher*, "Auction prices are excluded, all units and prices are converted to a 750 ml equivalent, and average prices are calculated from a 'topped and tailed' data set, which means that the highest and lowest 20% are removed to prevent the average being skewed by pricing errors. When only a small number of prices are available the median is used."

https://doi.org/10.1017/jwe.2024.19

Monthly weather variables, including the average temperature and precipitation, are from the National Centers for Environmental Information. The data represents conditions at the weather station closest to each vineyard where grapes are grown for use in producing a particular wine. The average temperature for each month is measured in degrees Fahrenheit. For measuring precipitation, total rainfall for a given month is used, measured in inches. We follow Ashenfelter (2008, 2010) and Ramirez (2008), who use averages rather than maximum temperatures.

Summary statistics for the key variables are presented in Table 1 (overall and separated by region) and Table 2 (separated by cult and non-cult). Comparing across regions, in our sample, Napa has the highest average prices and scores while winemakers in Sonoma, on average, produce the highest number of cases of wine. In terms of weather, the vineyards in Napa start out the warmest, on average, in the spring and early summer, but Walla Walla is warmer, on average, over the summer. In terms of rain, the vineyards in Sonoma receive the most rain early in the year, and Walla Walla, on average, receives the most rain in the summer and early fall. Comparing across cult versus non-cult wines, as expected, the average prices and scores are higher for cult wines. The mean number of cases produced is lower for cult wines than for non-cult wines.

III. Econometric model

Based on the panel data structure of the dataset, models are implemented that control for year, or year and firm FE in the analysis of the number of cases produced, which will be discussed further ahead. Robust standard errors are calculated and used in hypothesis testing to account for possible heteroskedasticity of unknown form using the well-known methodology that was originally devised by White (1980) and implemented in the R econometric computer software package that is used to calculate the estimates below.

To analyze weather effects on open market prices for wines the following equation, expressed in general form, is estimated for both cult and non-cult wines:

$$\begin{aligned}\ln\left(Market\ Price_{i,j,t}\right) = \alpha + \boldsymbol{\beta}'\mathbf{Weather}_{i,j,t\text{-}k} + \boldsymbol{\gamma}'\left(\mathbf{Region}_i \times \mathbf{Weather}_{i,j,t\text{-}k}\right) \\ + \delta'\mathbf{X}_{i,j,t} + \lambda_t + \varepsilon_{i,j,t}\end{aligned} \tag{1}$$

where i denotes a winemaker; j denotes a type of wine produced by wine maker i; t is the year when the wine is released for sale; k is years of aging; $(t-k)$ represents the wine vintage; $\mathbf{Weather}_{i,j,t-k}$ represents a vector of weather variables, Region_{i} is an indicator for the region in which winemaker i is located; $\boldsymbol{X}$ is a vector of other explanatory variables; λ_t is a fixed time effect; and ε_{ijt} is an error term.

In equation (1), we initially focus on linear functional forms for weather, which have been most prominent in the literature. We then also examine quadratic functions as a robustness check, which allows for nonlinear, and concave or convex relationships with temperature and rain as well as the possibility of peak temperature and rain levels within the range of observed data. For non-cult wines, the market price should equal the release price, whereas for cult wines the market price is the price established on the secondary market, which is generally higher than the release price.

Table 1. Summary statistics by region

	Overall		Napa		Sonoma		Walla Walla	
Variable	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Vintage	2,015.15	1.41	2,014.98	1.36	2,015.62	1.36	2,014.91	1.44
Market Price	211.25	317.88	364.86	446.17	113.81	53.35	89.63	57.22
Price Gap*	61.77	35.58	51.60	43.73	70.93	25.11	63.64	30.73
Cases Produced	1,835.74	4,166.92	2,006.66	4,590.52	2,496.28	5,320.64	971.82	911.32
Wine Score	91.74	2.65	92.56	2.63	91.12	2.55	91.07	2.43
White Wines**	0.21	0.41	0.03	0.18	0.55	0.50	0.12	0.32
Temp. APR–MAY	60.62	2.36	62.62	1.97	59.74	1.27	58.62	1.23
Temp. JUN–JUL	71.16	2.81	71.64	1.31	67.82	1.10	74.01	1.91
Temp. AUG–SEP	70.37	2.26	71.24	1.87	68.00	1.69	71.62	1.07
Rain JAN–FEB	5.35	5.33	5.99	4.75	8.16	6.35	1.42	0.39
Rain APR–MAY	1.14	0.62	0.85	0.35	1.45	0.89	1.21	0.33
Rain JUN–JUL	0.26	0.31	0.12	0.19	0.14	0.19	0.58	0.33
Rain AUG/SEP	0.25	0.24	0.14	0.14	0.18	0.16	0.48	0.25
Obs.	420		174		127		119	

Notes: Vintage is the year when grapes used for wines were grown and harvested; *Market Price* is the average retail price of a bottle of wine (750 ml) a typical, non-member consumer would pay; *Price Gap* refers to the price difference between the primary (release) and secondary (open) markets for cult wines, measured in U.S. dollars; *Cases Produced* is the number of cases each winery produced in each given year; *Wine Score* refers to Wine Spectator's wine rating (on a 0–100 scale); *White Wines* is a dummy variable if the type of wine is white then it is equal to 1, otherwise 0; *Temp. APR–MAY* is the average temperature (degrees Fahrenheit) for the months of April and May; *Rain JAN–FEB* is the average precipitation (in inches) for the months of January and February.
*This applies to cult wines only.
**Denotes proportion of total.

https://doi.org/10.1017/jwe.2024.19

https://doi.org/10.1017/jwe.2024.19

Table 2. Summary statistics by cult status

	Cult wine		Non-cult wine	
Variable	Mean	SD	Mean	SD
Vintage	2,015.31	1.39	2,014.97	1.42
Market Price	324.87	393.85	74.32	43.18
Price Gap	121.61	239.12	–	–
Cases Produced	793.20	563.01	2,994.12	5,817.46
Wine Score	93.23	1.98	90.05	2.27
White Wines*	0.24	0.43	0.18	0.39
Temp. APR–MAY	60.53	2.20	60.72	2.54
Temp. JUN–JUL	70.52	2.78	71.91	2.66
Temp. AUG–SEP	70.00	2.40	70.81	2.00
Napa*	0.39	0.49	0.44	0.50
Sonoma*	0.39	0.49	0.19	0.40
Walla Walla*	0.22	0.41	0.37	0.48
Rain JAN–FEB	5.97	5.51	4.61	5.03
Rain APR–MAY	1.20	0.72	1.06	0.45
Rain JUN–JUL	0.21	0.28	0.31	0.34
Rain AUG/SEP	0.22	0.21	0.28	0.26
Obs.	229		191	

*Denotes proportions of total.

We also analyze interactions between region and weather variables to discern if weather affects prices differently across wine regions. Our primary coefficient vectors of interest are β and γ, which are instrumental in defining the effects of weather on prices. In constructing the weather variables, our model specification follows Ramirez (2008),[3] who identifies four subperiods each year that are important for wine grapes: a winter period (January and February), an early growing season period (April and May), a late growing period (June and July), and a harvest period (August and September). Ramirez's (2008) analysis is focused on the Napa region of California, whereas we also analyze the Sonoma and Walla Walla regions.

For the purposes of defining the regional interaction terms with weather, we combine Napa and Sonoma. The justification is that Napa and Sonoma have a contiguous border and similar latitude and rainfall levels. Napa's latitude is 38.5° north, and Sonoma is located 38.4° north. In contrast Walla Walla is located 46.1° north. Another difference is that Napa and Sonoma are close to the Pacific coast, while Walla Walla is on the eastern side of the Cascade mountains. As a result, Walla Walla has different weather patterns and receives less annual precipitation relative to Napa and Sonoma.

[3]We also estimated our models using Ashenfelter's (2008) weather specification, which focuses on the Bordeaux region of France. The results with this specification are available from the authors upon request. Ashenfelter (2008) partitions each year into two periods: a winter period (October from the previous year to March) and the growing season (April–September).

https://doi.org/10.1017/jwe.2024.19

Based on these considerations, for purposes of defining weather interactions with regions we define a *California* variable, which is the sum of the indicator variables for *Napa* and *Sonoma*. Walla Walla is designated as the baseline region.

To analyze the effects of weather on the magnitude of cult wine price gaps between the primary (release) and secondary (open) markets, we utilize equation specifications akin to equation (1), except the dependent variable is specified as $\ln\left(\text{Price Gap}_{\text{i,j,t}}\right)$, where $\text{Price Gap}_{\text{i,j,t}}$ = $\text{Market Price}_{\text{i,j,t}}$ - $\text{Release Price}_{\text{i,j,t}}$.[4] Thus, the price gap equation is the following:

$$\ln\left(PriceGap_{i,j,t}\right) = \alpha + \beta'\mathbf{Weather}_{i,j,t\text{-}k} + \gamma'\left(\mathbf{Region}_i \times \mathbf{Weather}_{i,j,t\text{-}k}\right) + \delta'\mathbf{X}_{i,j,t} + \lambda_t + \varepsilon_{i,j,t} \quad (2)$$

Note a difference in this research from prior research on wine prices (e.g., Ashenfelter, 2008; Ashenfelter and Storchmann, 2016; Oczkowski, 2016; Ramirez, 2008) is the use of FE for years (and later, firm FE when analyzing cases). Regarding the efficacy of incorporating the FE, a substantial majority are statistically significant across the models estimated, providing demonstrable evidence that for the data set and the models analyzed in this study, the approach is warranted.

Principal ways that weather could impact prices include its potential effects on the quantity and/or quality of wine produced. Regarding quantity, we investigate whether unfavorable temperatures and/or rainfall adversely affect the harvest volume of wine grapes, and consequently less wine would be produced, placing upward pressure on prices. To explore how weather is related to the supply of wine, we estimate the following model[5]:

$$\ln\left(Cases_{i,j,t}\right) = \alpha + \beta'\mathbf{Weather}_{i,j,t\text{-}k} + \mu_i + \lambda_t + \varepsilon_{i,j,t} \quad (3)$$

We introduce firm FE, μ_i, in equation (3) to control for size-of-operation and capacity effects across firms, which were notably heterogenous across firms (see Tables 1 and 2, and the standard deviations on the number of cases).

Finally, we analyze the relationship between weather and wine scores by estimating the equation:

$$Score_{i,j,t} = \alpha + \beta'\mathbf{Weather}_{i,j,t\text{-}k} + \lambda_t + \varepsilon_{i,j,t}. \quad (4)$$

IV. Results

In the presentation and discussion of results in this section, we will use the terms "strongly significant," "significant," or "weakly significant" consistently to denote an

[4]Note that since consumers can buy non-cult wines directly from the winemaker at the release price, there should not be a significant price gap. Further, since we estimate both the secondary market price and the price gap, it does not add to our discussion to also estimate the release price.

[5]We estimated linear, log-linear, and Box–Cox functional forms. In the Box–Cox, we could not reject that $\lambda = 0$ in the Box–Cox estimation, so we present the log-linear presentation. The statistical significance of variables is consistent across functional forms.

estimation result that is statistically significant at the 0.01, 0.05, or 0.10 levels of type I error, respectively. Stating that result was "not significant" will mean a statistical result was in none of the preceding categories. Similarly, in discussing rejections of null hypotheses, we will use the terms "strongly rejected," "rejected," or "weakly rejected."

A. Weather and market prices

Tables 3 and 4 present estimation results for the market price models for cult wines and non-cult wines, respectively, based on a linear functional form for the weather variables, as implemented in several past studies. These results include an analysis of interactions between weather and regions. We then investigate whether temperature and/or rain effects might exhibit nonlinear associations with market prices by estimating models that express the effects of weather in quadratic form. However, given the limited number of data observations relative to the number of parameters to be estimated, interaction effects with the California region were not estimated. This approach is consistent with the analysis conducted by Ramirez (2008) and implies the quadratic weather models depict average effects of variables across all regions, with no differentiation between regions.

A.1. Cult wines

For cult wines (Table 3), the statistical tests of variable exclusions, provided in the "F-Statistic—H_0: Exclusions" rows of the table, indicate that excluding any of the groups of weather interaction variables is not rejected, whereas attempting to exclude the non-weather variables (wine scores, regions, and white-wine indicator) is strongly rejected. Therefore, we focus attention on the models that include the non-weather variables, which is further supported by R^2 values. However here, and elsewhere, we avoid type II errors by not choosing one from among a set of unrejected models defined via variable exclusions when discussing results. Thus, we focus attention on models 2–5.

The base-level effect of early growing-season temperature (April–May) on market price is positive and strongly significant for model 4 but not elsewhere. Similarly, the temperature-California interaction for this period is positive and weakly significant in model 3 but nowhere else. Taken together, these limited results suggest that to the extent there is a positive early growing season temperature effect on price, it may be primarily associated with the California region. The base level effect of temperature during the late growing season (June–July) is negative and weakly statistically significant in models 3 and 4, but the interaction between June–July temperatures and California is not, suggesting the effect is not differentiated by region.

The base-level effect of rain in January–February is positive and statistically significant in model 3 that includes the temperature-California interaction variables but not in any of the other models 2–5. The base-level effect of rain in the early growing season (April–May) is negative and strongly statistically significant in models 4 and 5. The two models include rain-California interaction variables that are positive and statistically significant, strongly so in the full model, with nearly the same magnitudes but opposite in signs relative to the base level effects, suggesting that any association of rain in the early growing season with higher prices in cult wines corresponds to Walla Walla

https://doi.org/10.1017/jwe.2024.19

Table 3. Estimation of market prices for cult wines only

	(1)	(2)	(3)	(4)	(5)
Temp (APR–MAY)	0.0945* (0.0530)	0.0518 (0.0325)	−0.0482 (0.0847)	0.1255*** (0.0459)	0.0571 (0.1993)
Temp (JUN–JUL)	−0.0118 (0.0203)	−0.0467 (0.0304)	−0.1178* (0.0627)	−0.0920* (0.0554)	−0.1382 (0.2061)
Temp (AUG–SEP)	0.1491*** (0.0313)	0.0310 (0.0306)	0.0959 (0.0736)	−0.0347 (0.0577)	0.0714 (0.0687)
Rain (JAN–FEB)	0.0334*** (0.0122)	0.0117 (0.0112)	0.0314** (0.0131)	0.2389 (0.2938)	−0.1213 (0.3210)
Rain (APR–MAY)	−0.2257*** (0.0808)	−0.0979 (0.0707)	−0.1258 (0.0770)	−0.6620*** (0.2473)	−0.5380*** (0.1817)
Rain (JUN–JUL)	−0.6346** (0.3115)	−0.0842 (0.2178)	−0.2184 (0.2482)	0.2866 (0.4503)	0.0347 (1.1101)
Rain (AUG–SEP)	−0.5625 (0.4434)	−0.2783 (0.3488)	−0.4844 (0.3972)	0.4068 (0.9166)	0.0091 (1.2623)
Wine Score		0.0730*** (0.0178)	0.0720*** (0.0182)	0.0693*** (0.0178)	0.0693*** (0.0179)
White Wine		−0.1004* (0.0582)	−0.0786 (0.0634)	−0.0909 (0.0606)	−0.0809 (0.0629)
Napa Region		0.6606*** (0.2324)	−4.6691 (11.4764)	0.5851 (0.4062)	−0.2684 (29.1796)
Sonoma Region		−0.2411 (0.2612)	−5.7012 (11.4454)	−0.4783 (0.4049)	−1.3523 (29.1884)
Temp (APR–MAY) * CA			0.1629* (0.0936)		0.0992 (0.2014)
Temp (JUN–JUL) * CA			0.0187 (0.1140)		0.0622 (0.2446)
Temp (AUG–SEP) * CA			−0.0871 (0.1090)		−0.1454 (0.1388)
Rain (JAN–FEB) * CA				−0.2367 (0.2844)	0.1265 (0.3128)
Rain (APR–MAY) * CA				0.6407** (0.2617)	0.5311*** (0.1951)
Rain (JUN–JUL) * CA				−1.0303* (0.5812)	−0.7556 (1.4108)
Rain (AUG–SEP) * CA				−1.2001 (0.8564)	−0.7126 (1.2803)
Constant	−8.8813*** (2.9464)	−3.2280 (3.4290)	3.5209 (12.1176)	0.7030 (3.3574)	1.1320 (28.6620)
Observations	229	209	209	209	209
Adjusted R^2	0.5155	0.6903	0.6942	0.6975	0.6947
F-Statistic—H_0: Exclusions	12.659***	1.3899	1.0806	0.4127	
F-Statistic—Regression	21.2144***	29.9807***	25.8463***	24.9843***	21.5757***

Note: Robust standard errors in parenthesis.
*$p < 0.1$; **$p < 0.05$; ***$p < 0.01$ based on two-sided tests.

https://doi.org/10.1017/jwe.2024.19

Table 4. Estimation for the market price of non-cult wines only

	(1)	(2)	(3)	(4)	(5)
Temp (APR–MAY)	0.1750*** (0.0383)	0.0455 (0.0294)	−0.1293 (0.0953)	0.1285*** (0.0328)	0.0419 (0.1494)
Temp (JUN–JUL)	−0.0093 (0.0262)	−0.0342 (0.0346)	−0.1542** (0.0631)	−0.2063*** (0.0434)	−0.2477** (0.1232)
Temp (AUG–SEP)	0.0548* (0.0285)	0.0259 (0.0246)	0.0860 (0.0834)	−0.0459 (0.0386)	0.0479 (0.0864)
Rain (JAN–FEB)	0.0250 (0.0187)	0.0217* (0.0124)	0.0707*** (0.0218)	−0.5619* (0.3134)	−0.6681** (0.3318)
Rain (APR–MAY)	−0.1792 (0.1622)	−0.1701 (0.1040)	−0.3161*** (0.1046)	0.1668 (0.1913)	0.1063 (0.1882)
Rain (JUN–JUL)	0.3485 (0.2310)	0.1356 (0.2104)	0.0958 (0.3379)	−0.4774* (0.2630)	−0.3561 (0.6691)
Rain (AUG–SEP)	0.6240 (0.4001)	−0.1643 (0.3065)	−0.1980 (0.3598)	0.9105* (0.4696)	0.6695 (0.5765)
Wine Score		0.0612*** (0.0133)	0.0582*** (0.0121)	0.0580*** (0.0122)	0.0551*** (0.0119)
White Wine		−0.7062*** (0.0929)	−0.6282*** (0.0916)	−0.5846*** (0.0923)	−0.5586*** (0.0953)
Napa Region		0.1434 (0.2477)	−11.3553 (11.4905)	−0.1475 (0.4179)	−3.9042 (19.5332)
Sonoma Region		−0.3602 (0.3063)	−12.1755 (11.4888)	−1.1453** (0.4757)	−4.9461 (19.5286)
Temp (APR–MAY) * CA			0.3344*** (0.0910)		0.1870 (0.1592)
Temp (JUN–JUL) * CA			−0.0537 (0.1184)		0.0088 (0.1658)
Temp (AUG–SEP) * CA			−0.0766 (0.1502)		−0.1247 (0.1581)
Rain (JAN–FEB) * CA				0.5082* (0.2939)	0.6562** (0.3187)
Rain (APR–MAY) * CA				−0.2611 (0.2277)	−0.2631 (0.2232)
Rain (JUN–JUL) * CA				0.5363 (0.5076)	0.4381 (0.9519)
Rain (AUG–SEP) * CA				−3.3583*** (0.5357)	−2.3173*** (0.6849)
Constant	−10.1945*** (2.4821)	−3.2714 (2.3913)	11.7628 (12.8283)	9.8346*** (2.9640)	11.6424 (19.2582)
Observations	190	184	184	184	184
Adjusted R^2	0.3048	0.7025	0.7383	0.7501	0.7553
F-Statistic—H_0: Exclusions	29.352***	6.1775***	3.8654***	2.1601*	
F-Statistic—Regression	8.5325***	29.8074***	29.6798***	29.9089***	26.6731***

Note: Robust standard errors in parenthesis.
*$p < 0.1$; **$p < 0.05$; ***$p < 0.01$ based on two-sided tests.

https://doi.org/10.1017/jwe.2024.19

wines. Finally, the base level effect of rain in June–July is not significant in models 2–5, whereas the June–July rain-California interaction variable is negative and weakly statistically significant in the model 4 without temperature interactions.

For non-weather variables, the wine score has a strongly statistically significant positive association with cult wine price and the magnitude of the relationship is notably stable across all models, suggesting that at least with respect to perceptions of quality in the market, the score appears to be an important factor. The incremental effect of being a white wine is consistently estimated to be negative for all models but is not significant except being weakly significant in model 2 having no weather interaction effects with California (although it is on the cusp of being weakly significance in model 4).

Regarding regions, and relative to wines emanating from Walla Walla (the default region in the model), the incremental positive effect of the Napa region is strongly significant in model 2 having no weather interactions with California but in no other models. The incremental effect of the Sonoma region is nominally estimated to be consistently negative but is not statistically significant in any of the models. The insignificance of regions for cult wines is consistent with the results of Costanigro et al. (2010). Using quantile regression, they find that the impact on price of reputation premia changes from the region level to the level of the winemaker as prices increase. Their interpretation of this result relies on the role of search costs. Consumers may find it optimal to consider only the higher-level American Viticultural Area's (AVA's) 's reputation for inexpensive wines but may be willing to expend more search effort and costs to differentiate between considerably higher priced wines, forming quality expectations for specific winemakers.

A.2. Non-cult wines

For non-cult wines (Table 4), the statistical tests of variable exclusions, additionally supported by the outcomes of R^2 values, strongly reject excluding various groups of variables from the full model as depicted in models 1–3, albeit the exclusion of only the temperature interactions with California is weakly rejected in model 4. Given this outcome, we primarily focus attention on the results for the full model, with some reference to model 4.

The effect of the early growing season (Apr–May) temperature is positive and strongly significant in model 4 with no temperature interactions but not significant in the full model 5. The coefficient for the base-level temperature effect in June and July is negative and statistically significant in the full model 5, and strongly significant in model 4, but interaction with California is not significant. The base-level rain effect in January and February is negative and significant (weakly significant) in model 5 (model 4), which given the statistically significant (weakly significant) magnitudes of the estimated coefficients in model 5 (model 4) for the interaction compared to base-level effects (nearly equal, and opposite in sign) suggests that the association with winter season rain refers primarily to the Walla Walla region. The base-level effect of rain during the harvest season (Aug–Sept) is estimated to be positive in models 4 and 5, being weakly significant in the former but not significant in the latter, and the interaction with California is negative and strongly significant in both models 4 and 5. The large absolute values of the latter effects suggest that rain in California during harvest has a demonstrable negative association with price.

https://doi.org/10.1017/jwe.2024.19

For the other variables in the non-cult wine price models (Table 4), the wine score has a positive and strongly significant association with price across all models, and the magnitude of the effect is notably consistent across models. Unlike for cult wines, white wines are estimated to also have a strongly significant and appreciable negative association with price across models. The effects of the Napa and Sonoma regions are not statistically significant with the exception of the significant negative association with the Sonoma region estimated in model 4 where temperature-California interactions are excluded.

Unlike the case for cult-wines, the exclusion tests provide notable support for the notion that in addition to some of the base level effects of temperature and rain, some weather interaction effects with California are associated with market prices. Like the cult wine case, exclusion of the wine score, the white wine indicator, and the region group of variables to the exclusion set in addition to all California-weather interactions is strongly rejected, and thereby the weather-only model 1 is not supported. Consideration of the levels of adjusted R^2 and the F-statistics associated with the regression models provide additional support for concluding that some interactions between weather and California are impactfully associated with non-cult wine prices.

A.3. Quadratic specifications

The quadratic model estimation results for market price are provided in Table 5. Both for cult and non-cult wines, excluding the group of non-weather variables (wine scores, regions, and white wine indicators in models 3 and 7) is strongly rejected. Regarding whether exclusion of either of the groups of temperature or rain variables is supported, the former is rejected, and the latter is not rejected for cult wines. In the case of non-cult wines, exclusion of either group is rejected, and strongly so for temperature variables. Given these outcomes, we focus our primary attention on the full models for each wine type, with some reference made to model (1) for cult wines.

A.3.1. Cult wines. Consistent with results for the linear model, the temperature in the early growing season (Apr–May) is associated with cult wine prices positively (for temperatures $\geqslant 59^{\circ}$F, based on full model), with its linear and squared term coefficients being significant and strongly significant, respectively, indicating a convex relationship. The nominally estimated effect of June–July temperature is concave and positive to an estimated peak of 60.1°F (based on full model) and is consistent with the weakly significant negative effect estimated by one of the linear models, but the estimated coefficients are not significant in the quadratic model.

There is an isolated result from one of the linear models suggesting that rain in winter (Jan–Feb) might be positively associated with prices, but the relationship is not supported by the quadratic model. The negative association of Apr–May rain with prices in the linear model is supported by the full quadratic model, with the linear and quadratic term coefficients being significant and weakly significant, respectively. The estimated relationship is convex and negative for rainfall $\leqslant 3.25$ inches (based on full model), which encompasses the probable range of rainfall—see Table 2. Finally, there is isolated weak statistical support from one of the linear models for the possibility of a negative association between June–July rain and prices, but that result is not statistically supported by the results of the quadratic model.

Table 5. Estimation for market price with quadratic specification

	Cult				Non-cult			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Temp (APR–MAY)	−2.6412*** (0.9526)		−4.1525*** (1.1044)	−2.9125** (1.1469)	−1.5174** (0.7336)		−4.9393*** (1.3335)	−1.2639 (0.9062)
Temp (JUN–JUL)	0.2917 (0.8362)		4.6528*** (1.2482)	0.4810 (0.8644)	−3.1838*** (0.8481)		1.2963 (1.4451)	−3.1260*** (0.9247)
Temp (AUG–SEP)	−1.4874* (0.8194)		−3.7099*** (1.2061)	−1.0805 (1.0504)	−1.6565* (0.9335)		−8.4243*** (2.3860)	−0.8555 (1.4624)
Temp (APR–MAY)^2	0.0223*** (0.0079)		0.0347*** (0.0090)	0.0246*** (0.0094)	0.0130** (0.0060)		0.0421*** (0.0109)	0.0109 (0.0074)
Temp (JUN–JUL)^2	−0.0023 (0.0057)		−0.0321*** (0.0085)	−0.0040 (0.0060)	0.0213*** (0.0057)		−0.0089 (0.0098)	0.0209*** (0.0063)
Temp (AUG–SEP)^2	0.0106* (0.0058)		0.0263*** (0.0086)	0.0075 (0.0075)	0.0128* (0.0065)		0.0597*** (0.0169)	0.0065 (0.0103)
Rain (JAN–FEB)		−0.0073 (0.0354)	0.0606 (0.0461)	0.0039 (0.0349)		−0.0329 (0.0714)	−0.0207 (0.1287)	−0.0705 (0.0725)
Rain (APR–MAY)		−0.4170** (0.1674)	−0.4084* (0.2143)	−0.3813** (0.1670)		−0.8579** (0.3412)	−0.2054 (0.6790)	−0.1871 (0.3887)
Rain (JUN–JUL)		0.1321 (0.3986)	−2.2596*** (0.7983)	−0.3819 (0.5771)		−0.2953 (0.7092)	−0.0464 (1.3750)	−0.6108 (0.7557)
Rain (AUG–SEP)		−1.4681** (0.6497)	1.5848 (1.0600)	−1.6803* (1.0157)		−2.2553*** (0.6076)	0.3952 (1.1761)	−2.6418*** (0.7690)
Rain (JAN–FEB)^2		0.0003 (0.0012)	−0.0004 (0.0018)	0.0005 (0.0013)		0.0006 (0.0029)	0.0024 (0.0058)	0.0026 (0.0031)
Rain (APR–MAY)^2		0.0860*** (0.0317)	0.0507 (0.0474)	0.0585* (0.0330)		0.2631** (0.1275)	0.0803 (0.2714)	0.0277 (0.1459)

(*Continued*)

https://doi.org/10.1017/jwe.2024.19

Table 5. (*Continued.*)

	Cult				Non-cult			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Rain (JUN–JUL)^2		−0.2527 (0.3696)	1.9088*** (0.6779)	0.3049 (0.4409)		0.6651 (0.6228)	0.3331 (1.0700)	1.0200* (0.6094)
Rain (AUG–SEP)^2		1.3995* (0.7355)	−2.5445* (1.5098)	1.8537 (1.3196)		1.7431*** (0.5520)	0.4819 (0.9825)	2.2072*** (0.7658)
Wine Score	0.0685*** (0.0172)	0.0702*** (0.0179)		0.0655*** (0.0169)	0.0484*** (0.0126)	0.0600*** (0.0125)		0.0539*** (0.0136)
White Wine	−0.0433 (0.0553)	−0.1169* (0.0602)		−0.0387 (0.0591)	−0.6253*** (0.0958)	−0.7015*** (0.0903)		−0.6039*** (0.0916)
Napa Region	0.7399*** (0.1816)	0.9126*** (0.1833)		0.2482 (0.3256)	0.1864 (0.1451)	0.3648** (0.1752)		0.0776 (0.2550)
Sonoma Region	−0.2004 (0.1806)	0.0451 (0.1310)		−0.8376** (0.3413)	−0.5391*** (0.1939)	−0.1383 (0.1757)		−0.7638*** (0.2916)
Constant	119.7565*** (43.0810)	−0.7267 (1.5777)	92.1132 (63.3162)	111.1324* (58.4512)	215.9719*** (46.8382)	−0.3178 (1.1846)	397.4465*** (96.2376)	180.9581*** (63.4316)
Observations	209	209	229	209	184	184	190	184
Adjusted R^2	0.7049	0.6896	0.5761	0.7045	0.7377	0.7246	0.4100	0.7519
F-Statistic—H0: Exclusions	0.9639	2.6037**	22.671***		2.2101**	4.063***	57.08***	
F-Statistic—Regression	34.1225***	28.1781***	17.3072***	22.5557***	37.7677***	31.0987***	8.2955***	26.2143***

Note: Robust standard errors in parenthesis.
*$p < 0.1$; **$p < 0.05$; ***$p < 0.01$ based on two-sided tests.

https://doi.org/10.1017/jwe.2024.19

Overall, both the linear and quadratic models support the propositions that temperature in the early growing season (Apr–May) is positively associated with cult wine prices, and rainfall during the same season is negatively associated with those prices. In addition, the quadratic model suggests that these relationships may both be convex in functional form. Moreover, rain during the harvest season (Aug–Sept) was estimated to have a negative association with prices and was weakly statistically significant (at the 10% level), but the squared term was not significant and thus the linearity of the relationship was not rejected. The effect of rain in Aug–Sept was not statistically significant in the linear model.

As for non-weather variables, there was a positive and strongly statistically significant association between wine scores and prices, as in the linear models. The association with white wine was estimated to be nominally negative like in the linear models and was also not statistically significant, as in all but one of the relevant linear models. Sonoma is estimated to have a negative relationship with price like in the linear models, but in addition it is significant in the quadratic model. Finally, the association with Napa is estimated to be nominally positive but not statistically significant, whereas in the linear models signs were mixed, although one linear model indicated a significant positive association with price.

A.3.2. Non-cult wines. Consistent with results in the linear models, temperature in the early growing season (Apr–May) is associated with cult wine prices in a positive way (for average temperatures $\geqslant 58^{\circ}$F, based on full model). However, as with the full linear model, the estimates are not significance (it is strongly significant in one linear model that excludes the California temperature interactions, but the exclusion is also weakly rejected). As with the linear model, temperature in Jun–Jul is negatively associated with prices for average temperatures $\leqslant 75^{\circ}$F (within the probable range, see Table 2) and strongly significant in a convex relationship.

The association of prices with rain in Jan–Feb is nominally estimated to be negative (for rainfall $\leqslant$ 13.5 inches—within the probable range, see Table 2) like in the linear model. However, unlike the linear model the association is not significant. Consistent with the linear model, rainfall in Aug–Sept is negatively associated with price for rainfall $\leqslant$ .6 inches (within the probable range, see Table 2) and is strongly significant and convex.

Overall, both the linear and quadratic models support the proposition that temperature in the Jun–July growing season is negatively associated with non-cult wine prices. There is also joint support for the proposition that rainfall in the Aug–Sept harvest season is negatively associated with prices. In addition, the quadratic model suggests that these relationships may both be convex in functional form. Moreover, rain during the growing season (Jun–July) is estimated to have a positive association with prices and is weakly significant for the squared term, but the linear term was not significant. The effect of rain in Jun–July is not statistically significant in the linear model.

Regarding the non-weather variables, there is a positive and strongly significant association between wine scores and non-cult wine prices, as in the linear models. The strongly significant negative association for white wines is also consistent with the linear model results. Sonoma is estimated to have a negative relationship with price like in the linear models, but in addition it is strongly significant in the quadratic model. Finally, the association with Napa is estimated to be nominally positive but not significant.

B. Weather and price gaps

Since cult wines are available from winemakers only to buyers on their allocations lists which have waiting lists, the market price for cult wines is established in the secondary market. We analyze how weather affects price gaps, which we define as the difference between the secondary market price and the winemakers' release price. Note that we do not present price gap analyses for non-cult wines because gaps are expected to be zero, since there are no waiting lists for buying directly from the winemakers at their release prices.

B.1. Linear model specifications

For the linear models of price gaps (Table 6), the statistical tests of variable exclusions, additionally supported by the outcomes of R^2 values, weakly-to-strongly reject excluding groups of variables from the full model 5 except for the exclusion of temperature interactions with California in model 4. Given this outcome, we focus attention on results for the full model, with some reference to model 4.

The early growing-season (Apr–May) temperature has a positive and significant association with price gaps when interacted with California in the full model 5 that has a base level effect that is not significant, as well as having a strongly significant effect in base level form in model 4, which does not include California-temperature interactions. The two results suggest that the effect may be primarily for California. The coefficients on the base-level temperature association in the growing season (Jun–Jul) is negative and significant in the full model, with its California interaction counterpart being positive, weakly significant, and very close in absolute value to the base level effect. This suggests that the negative growing season temperature association primarily refers to the Walla Walla region. Also, the base-level effect of temperature during the harvest season (Aug–Sept) is estimated to be positively associated with price gaps and is weakly significant, while the California interaction is negative (and net negative accounting for the base level) but is slightly short of being at least weakly significant (p-value of 0.13).

The coefficients on the base level early growing season (Apr–May) rain effect are negative and strongly significant in both models 4 and 5, and the California interaction coefficients for early growing season rain are positive and strongly significant as well. The coefficient values on the base and interaction effects are close in absolute value but opposite in sign suggesting the primary relationship is with the Walla Walla region. The base-level effect of rain during the harvest season (Aug–Sept) is positive and weakly significant in the full model 5, the effect of the California-rain interaction for the harvest season is negative and statistically significant, and the coefficients are close in magnitude with opposite signs, again suggesting that the principal association is with the Walla Walla region.

Regarding other variables, the wine score is estimated to have a strongly significant positive association with the price gap. The effect of white wines is nominally estimated

https://doi.org/10.1017/jwe.2024.19

Table 6. Estimation of price gap for cult wines

	(1)	(2)	(3)	(4)	(5)
Temp (APR–MAY)	0.1889*** (0.0640)	0.1891*** (0.0615)	0.1301 (0.1543)	0.3160*** (0.0812)	−0.2724 (0.3494)
Temp (JUN–JUL)	−0.0470* (0.0285)	−0.0186 (0.0555)	−0.1235 (0.1157)	−0.1283 (0.0961)	−0.7473** (0.3345)
Temp (AUG–SEP)	0.1246** (0.0490)	0.1133** (0.0519)	0.3932*** (0.1509)	0.0343 (0.1142)	0.2046* (0.1207)
Rain (JAN–FEB)	0.0279 (0.0178)	0.0167 (0.0215)	0.0631** (0.0256)	0.6741 (0.5057)	0.0884 (0.5869)
Rain (APR–MAY)	−0.2585** (0.1098)	−0.1853 (0.1272)	−0.2146 (0.1355)	−1.4939*** (0.4841)	−1.7352*** (0.4054)
Rain (JUN–JUL)	0.0782 (0.4385)	0.2254 (0.4759)	0.1263 (0.4338)	0.6136 (0.9285)	−2.4985 (1.8225)
Rain (AUG–SEP)	0.2485 (0.5312)	0.1356 (0.6494)	−0.0092 (0.7032)	2.0844 (1.6366)	3.6760* (2.0456)
Wine Score		0.1197*** (0.0278)	0.1193*** (0.0286)	0.1109*** (0.0286)	0.1112*** (0.0290)
White Wine		−0.2087* (0.1129)	−0.1674 (0.1209)	−0.1809 (0.1168)	−0.1581 (0.1189)
Napa Region		0.0399 (0.3817)	9.2768 (23.0434)	0.0191 (0.7021)	−72.5173 (49.3978)
Sonoma Region		0.4837 (0.4664)	9.5518 (23.0163)	0.1436 (0.7231)	−72.3860 (49.4131)
Temp (APR–MAY) * CA			0.1859 (0.1660)		0.6876** (0.3458)
Temp (JUN–JUL) * CA			0.0754 (0.1966)		0.7608* (0.3885)
Temp (AUG–SEP) * CA			−0.3724* (0.1935)		−0.3713 (0.2454)
Rain (JAN–FEB) * CA				−0.6703 (0.4908)	−0.0922 (0.5744)
Rain (APR–MAY) * CA				1.4370*** (0.4899)	1.7772*** (0.4066)
Rain (JUN–JUL) * CA				−1.4747 (1.2199)	2.1806 (2.3423)
Rain (AUG–SEP) * CA				−2.7329* (1.4747)	−4.0580** (2.0599)
Constant	−12.4147*** (3.4111)	−24.9860*** (5.9686)	−33.7599 (24.9122)	−18.2849*** (6.2200)	51.3433 (48.7540)
Observations	229	209	209	209	209
Adjusted R^2	0.3101	0.3406	0.3560	0.3661	0.3710
F-Statistic—H_0: Exclusions	3.1383***	2.326**	2.1241*	1.4877	
F-Statistic—Regression	9.5404***	7.7139***	7.0520***	7.0059***	6.3335***

Note: Robust standard errors in parenthesis.
$^*p < 0.1$; $^{**}p < 0.05$; $^{***}p < 0.01$ based on two-sided tests.

https://doi.org/10.1017/jwe.2024.19

to be negative but is not significant, although it has probability value of 0.12 in model 4. The Napa and Sonoma region indicators are not significant.

The tests of variable exclusions in the price gap models suggest some additional overarching implications for the association between price gaps and weather. Focusing on models 4 and 5, early growing season (Apr–May) base level positive temperature effects and base level negative rain effects have statistical support. In addition, interactions with California vis-à-vis these effects are statistically supported, indicating that California weather effects differ from effects in the Walla Walla region. Similarly, there is statistical support for concluding that rain during the harvest season (Aug–Sept) expands price gaps for Walla Walla wines but does not for California wines, or else at best may have a slightly negative effect in California based on the values of estimated coefficients. Consideration of the levels of adjusted R^2 for the regression models also provides some modest additional support for adding weather interaction variables to the model. However, the relatively low levels of adjusted R^2 suggest that there are other notable factors are at work beyond weather and wine scores when values of price gaps are determined.

B.2. Quadratic model specifications

For the quadratic models of price gaps (Table 7), the statistical tests of variable exclusions, additionally supported by the outcomes of R^2 values, reject excluding groups of variables from the full model 5 except for the exclusion of rain variables, similar to the outcome in the quadratic model for cult market prices. Given this outcome, we primarily focus attention on results for the full model, with some reference to model 1.

Consistent with the linear model results, the effect on price gaps of early growing season (Apr–May) temperature is positive (for temperatures $\geqslant 58^{\circ}$F) and strongly statistically significant, with the relationship being convex. The quadratic analysis also suggests harvest season (Aug–Sept temperatures have a significant positive (for temperatures $\geqslant 70^{\circ}$F) and convex association with price gaps, which is consistent with the significant positive base level effect estimated in the linear model. The growing season (Jun–Jul) temperature is estimated to have a negative association with price gaps in the linear model, for the Walla Walla region, and the quadratic model estimates are nominally in agreement indicating a negative association as well (for temperatures $\geqslant 59^{\circ}$F, the probable range, see Table 2). However, the association is not significant in the quadratic model.

The association of rain with price gaps in the early growing season (Apr–May) is estimated to be negative (for rainfall $\leqslant 3$ inches, the probable range, see Table 2), and the linear and quadratic term coefficients are strongly significant and significant, respectively. The negative association is consistent with results from the linear model. Rain during the harvest season (Aug–Sept) is nominally estimated to be negatively associated with price gaps for rainfall $\leqslant .35$ inches, which is consistent with the modest negative association estimated for the California region in the linear model and consistent with the positive association estimated in the linear model for the Walla Walla region when rainfall is greater than 0.35 inches. However, the coefficients underlying this relationship are close to but do not achieve statistical significance at conventional levels (the probability values for the linear and quadratic term coefficients are 0.13 and 0.11, respectively).

https://doi.org/10.1017/jwe.2024.19

Table 7. Estimation of price gap for cult wines with quadratic specification

	(1)	(2)	(3)	(4)
Temp (APR–MAY)	−4.7143*** (1.4867)		−3.8077** (1.6815)	−4.5096*** (1.6990)
Temp (JUN–JUL)	0.0129 (1.4147)		0.1803 (1.4840)	0.4614 (1.6422)
Temp (AUG–SEP)	−4.4255*** (1.3475)		−2.9401* (1.6341)	−3.5403** (1.6429)
Temp (APR–MAY)^2	0.0403*** (0.0123)		0.0331** (0.0137)	0.0390*** (0.0140)
Temp (JUN–JUL)^2	−0.0003 (0.0097)		−0.0017 (0.0102)	−0.0039 (0.0114)
Temp (AUG–SEP)^2	0.0323*** (0.0094)		0.0214* (0.0117)	0.0254** (0.0116)
Rain (JAN–FEB)		−0.0110 (0.0645)	−0.0795 (0.0588)	−0.0123 (0.0591)
Rain (APR–MAY)		−1.2054*** (0.3057)	−0.6394** (0.3037)	−0.7948*** (0.2968)
Rain (JUN–JUL)		0.1747 (0.7411)	−0.3392 (0.9961)	−0.1111 (0.9395)
Rain (AUG–SEP)		−4.4806*** (1.0401)	−2.0428 (1.5059)	−2.5647 (1.7164)
Rain (JAN–FEB)^2		0.0001 (0.0023)	0.0037* (0.0021)	0.0012 (0.0020)
Rain (APR–MAY)^2		0.2477*** (0.0648)	0.1008 (0.0724)	0.1510** (0.0602)
Rain (JUN–JUL)^2		−0.3845 (0.6545)	0.3981 (0.8449)	0.1866 (0.8426)
Rain (AUG–SEP)^2		4.2814*** (1.1935)	3.6623* (2.1903)	3.6400 (2.2417)
Wine Score	0.1138*** (0.0268)	0.1053*** (0.0288)		0.1089*** (0.0275)
White Wine	−0.1281 (0.0962)	−0.2340** (0.1177)		−0.0976 (0.1041)
Napa Region	−0.0820 (0.2846)	0.0717 (0.3188)		−0.6260 (0.5340)
Sonoma Region	0.2548 (0.3226)	0.1216 (0.2300)		−0.5141 (0.5927)
Constant	283.3021*** (64.2650)	−3.4400 (2.5825)	209.9984** (90.0204)	235.2466*** (82.9181)
Observations	209	209	229	209
Adjusted R^2	0.3957	0.3157	0.3495	0.3944
F-Statistic—H0: Exclusions	0.9477	5.1386***	4.1974***	
F-Statistic—Regression	10.0811***	6.6443***	7.4468***	6.8900***

Note: Robust standard errors in parenthesis.
*$p < 0.1$; **$p < 0.05$; ***$p < 0.01$ based on two-sided tests.

For the non-weather variables, the wine score is estimated to have a strongly statistically significant positive association with the price gap. The effect of white wines is nominally estimated to be negative in model 5 as well as in model 1, but its statistical significance is not supported, as was the case in the linear price gap model. The Napa and Sonoma region indicators are also not significant, again consistent with the linear price gap model.

C. Association of weather with cases and scores

We also consider how weather might affect both the number of cases produced and the observed values of wine scores. The models for cases include both time and firm-level FE, with the latter being added to control for the varying sizes and capacities of the wineries in the data set, whose variability is evident from the standard deviations reported in Tables 1 and 2.

C.1. Cases

Table 8 presents results relating to cases of cult wines. Across all models, the only statistically significant coefficient is the constant. Moreover, all statistical tests relating to the exclusion of subsets of temperature and rain interaction effects with California are profoundly not significant, as well as the exclusion of all of the weather variables (both base level and interactions) simultaneously whose test outcome is listed in the "F-Statistic—H0: Exclusions" row of the table under the model 4 column. This is consistent with the notion that cult winemakers are capacity-constrained by the size of their estate vineyards, and capacity may also be self-imposed for the explicit purpose of supply control.

Table 9 presents the results for cases of non-cult wines. Similar to results for cult wines, all statistical tests relating to the exclusion of subsets of temperature and rain interaction effects with California are not significant, as well as the exclusion of all of the weather variables (both base level and interactions) simultaneously. The non-cult wineries are also producing wines that are relatively high-quality wines and many, but not all, face estate winery-type constraints on capacity similar to those for cult-wine producers. This may partially explain why, like for cult wines, weather is estimated to not have demonstrable associations with the number of cases produced. Lack of substantial weather variability over the study period of 2016–2020 might also be a factor.

Unlike for cult-wines, there are a few weather variables that are indicated as achieving some level of statistical significance in models estimated with variable exclusions imposed, none of which were eliminated via the outcomes of variable exclusion tests. In model 1, there is some evidence that temperatures in the late growing season (Jun–Jul) and early harvest season (Aug–Sept) have a positive and weakly significant association with the number of cases. The base-level rain coefficient and the associated coefficient on the California interaction with rain during the Jan–Feb period are significant in model 3, where temperature variables are excluded, and their signs and magnitudes suggest that rain is negatively associated with cases in the Walla Walla region but only slightly so or not at all in California. However, no effects are statistically significant at any conventional level in the full model. Similar to the cult wine analysis, because all statistical tests relating to the exclusion of subsets of temperature and rain variables are

Table 8. Estimation for cases of cult wines only

	(1)	(2)	(3)	(4)
Temp (APR–MAY)	0.0214 (0.0410)	0.0563 (0.0778)		0.0334 (0.3549)
Temp (JUN–JUL)	−0.0321 (0.0425)	0.0390 (0.0471)		0.0253 (0.3427)
Temp (AUG–SEP)	−0.0351 (0.0444)	−0.0062 (0.0821)		−0.0073 (0.1170)
Rain (JAN–FEB)	0.0035 (0.0193)		0.0428 (0.4218)	0.1092 (0.8124)
Rain (APR–MAY)	0.0554 (0.1087)		−0.1015 (0.5323)	−0.1879 (1.0303)
Rain (JUN–JUL)	0.0068 (0.3364)		−0.0787 (0.3035)	−0.0415 (1.9703)
Rain (AUG–SEP)	0.0799 (0.4307)		0.1893 (0.5864)	0.1105 (1.8278)
Temp (APR–MAY) * CA		−0.0695 (0.0920)		−0.0476 (0.3316)
Temp (JUN–JUL) * CA		−0.1573 (0.1146)		−0.1299 (0.3495)
Temp (AUG–SEP) * CA		0.0673 (0.1097)		0.0697 (0.2042)
Rain (JAN–FEB) * CA			−0.0380 (0.3992)	−0.1052 (0.7869)
Rain (APR–MAY) * CA			0.1775 (0.5383)	0.2123 (1.0075)
Rain (JUN–JUL) * CA			0.2089 (0.5932)	−0.0278 (2.0428)
Rain (AUG–SEP) * CA			0.3049 (0.5688)	0.0691 (2.0220)
Constant	9.0220** (3.5984)	10.7456*** (2.8960)	5.5490*** (0.3831)	9.7259** (4.2166)
Observations	210	210	210	210
Adjusted R^2	0.4927	0.4980	0.4898	0.4757
F-Statistic—H_0: Exclusions[a]	0.1564	0.0243	0.1847	0.2623
F-Statistic—Regression	8.8057***	9.2927***	8.4321***	6.7472***

Note: Robust standard errors in parenthesis.
[a]The value in the "F-Statistic—H_0: Exclusions" row for the full model (4) refers to setting all of the listed coefficients for the rain and temperature variables to zero other than the constant.
**$p < 0.05$; ***$p < 0.01$ based on two-sided tests.

not significant, including the exclusion of all of the weather variables simultaneously, the results are inconsistent for claiming that associations between weather and cases for non-cult wines exist.

Regarding the effects of quadratic terms in the models for cases, the overall conclusions regarding the association of weather and the number of cases are unaltered,

https://doi.org/10.1017/jwe.2024.19

Table 9. Panel fixed-effects estimation for cases of non-cult wines only

	(1)	(2)	(3)	(4)
Temp (APR–MAY)	0.0155 (0.0590)	0.0119 (0.0796)		−0.2065 (0.2350)
Temp (JUN–JUL)	0.0923* (0.0485)	0.0322 (0.0783)		0.0547 (0.2303)
Temp (AUG–SEP)	0.0868* (0.0467)	0.0891 (0.1060)		−0.0348 (0.2253)
Rain (JAN–FEB)	−0.0369 (0.0326)		−1.2575** (0.5336)	−0.7052 (0.8109)
Rain (APR–MAY)	0.1545 (0.2334)		0.3499 (0.2877)	0.2567 (0.3232)
Rain (JUN–JUL)	0.1830 (0.3805)		−0.5172 (0.4217)	−0.8403 (1.0434)
Rain (AUG–SEP)	0.1424 (0.5098)		0.1961 (0.5612)	0.3113 (1.1113)
Temp (APR–MAY) * CA		0.0063 (0.1303)		0.1793 (0.2513)
Temp (JUN–JUL) * CA		0.0214 (0.2313)		0.0327 (0.3934)
Temp (AUG–SEP) * CA		−0.0344 (0.1780)		0.2433 (0.4025)
Rain (JAN–FEB) * CA			1.1412** (0.4827)	0.6048 (0.7550)
Rain (APR–MAY) * CA			0.0014 (0.3538)	0.1335 (0.4234)
Rain (JUN–JUL) * CA			0.3545 (0.6572)	1.1602 (1.6113)
Rain (AUG–SEP) * CA			−0.3620 (0.8201)	0.7986 (1.9775)
Constant	−8.5972 (6.6580)	−3.5836 (13.6822)	6.9467*** (0.8375)	16.9393 (32.5022)
Observations	189	189	189	189
Adjusted R^2	0.7018	0.6999	0.7029	0.6973
F-Statistic—H_0: Exclusions[a]	0.6561	0.8292	0.5114	0.6259
F-Statistic—Regression	16.8054***	17.2363***	16.3356***	13.3733***

Note: Robust standard errors in parenthesis.
[a]The value in the "F-Statistic—H_0: Exclusions" row for the full model (4) refers to setting all of the listed coefficients for the rain and temperature variables to zero other than the constant.
*$p < 0.1$; **$p < 0.05$; ***$p < 0.01$ based on two-sided tests.

and we do not present tables of these results here. In particular, even with quadratic terms added, the F-tests for exclusion of the weather variables, both separately for temperature and rain as well as simultaneously, are not significant suggesting that a demonstrative association between weather and number of cases of either wine type cannot be concluded from the data analyzed.

https://doi.org/10.1017/jwe.2024.19

C.2. Scores

Table 10 presents the estimation results for associations between wine scores and weather, which includes quadratic models for weather variables (models 2–4 and 6–8). First, it is noteworthy that the adjusted R^2 values for all of the models are low. This indicates that the association of all of the weather variables with wine scores are overall low, and that there are many other factors that contribute to observed wine score outcomes besides any effects of weather.

For cult wines, we first note that the exclusion tests for one or both sets of quadratic weather variables are not significant, so that none of the model specifications are statistically rejected. Moreover, no model dominates the other in terms of appreciably different R^2 values. Across all of the models all coefficients on rain variables are not significant. As for associations with temperature, the negative effect for temperature $\leqslant$ 62°F in Apr–May is weakly significant in the full model and convex in form. Temperature during the harvest season (Aug–Sept) is weakly significant, positive, and linearly associated with wine scores for cult wines in two of the models that exclude all or the temperature-related quadratic weather variables.

Results for non-cult wines are notably different than for cult wines. Exclusion of the quadratic rain variables is weakly rejected, and excluding the quadratic temperature variables, either with or without quadratic rain terms, is strongly rejected. Additionally, the full model 8 exhibits the highest R^2, which further suggests that some weather effects are associated with wine scores for non-cult wines.

Focusing on the full non-cult score model, the negative temperature association (for temperature $\leqslant$ 60°F) in the early growing season (Apr–May) is defined by strongly significant linear and quadratic term coefficients. Temperature during the Aug–Sept harvest season is also associated with wine scores in a weakly significant convex relationship that is positive for temperature $\geqslant$ 68.5°F. Rain during the harvest season (Aug–Sept) has a strongly significant positive association (for $\leqslant$ .7 inches of rain, which is highly probable, see Table 2) with scores in a concave relationship. Rain in the winter months (Jan–Feb) is also estimated to be in a concave relationship with scores, being positively related for rain $\leqslant$ 16 inches (also in the highly probable range, see Table 2), albeit the coefficient on the squared term is close to, but not statistically significant at conventional levels (probability value of 0.12). Finally, there is possibly also a concave positive (for rain $\leqslant$ .5 inches) relationship between rain and score in the summer months (Jun–Jul), albeit while the coefficient on the squared term is weakly significant, the probability value of the linear term is 0.13.

Overall, the results for the analysis of scores suggest that weather is not notably associated with wine scores assigned to cult wines, whereas there is statistical evidence to suggest that weather is more demonstrably associated with non-cult wine scores. Also, there is a substantial amount of variation in wine scores outcomes that is not associated with variations in weather.

V. Conclusions and implications

The popularity of cult wines has increased dramatically in the United States over the last few decades. As cult wines are ultra-premium products with ultra-premium prices and have waiting lists for the privilege of buying the wines, we expect that cult

Table 10. Estimation for wine score

	Cult				Non-cult			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Temp (APR–MAY)	−0.0754 (0.1820)	−6.0810 (3.8851)	−0.1622 (0.2350)	−7.2992* (4.3630)	0.3711** (0.1734)	−17.0224*** (4.9704)	0.3872* (0.2063)	−19.4581*** (5.8487)
Temp (JUN–JUL)	0.0601 (0.1104)	6.6837 (5.5951)	0.0859 (0.1257)	6.9614 (5.6120)	−0.0057 (0.0988)	0.3804 (4.8489)	0.1352 (0.1147)	−1.8206 (5.2273)
Temp (AUG–SEP)	0.2558* (0.1388)	−3.4964 (5.4007)	0.3241* (0.1766)	−2.7791 (6.0144)	0.1756 (0.1228)	−14.8345** (7.3478)	0.2178 (0.1837)	−14.4577* (8.3481)
Rain (JAN–FEB)	0.0436 (0.0532)	0.0568 (0.0566)	0.2480 (0.2329)	0.2070 (0.2324)	0.0377 (0.0998)	0.1202 (0.0945)	1.2349*** (0.4082)	1.0069** (0.4506)
Rain (APR–MAY)	−0.2804 (0.4009)	−0.2219 (0.4564)	−0.5149 (1.1139)	−0.3602 (1.1990)	0.1460 (0.6509)	0.1973 (0.7110)	−3.2570 (2.3309)	−0.8794 (2.6131)
Rain (JUN–JUL)	−1.4830 (1.1647)	−1.2318 (1.1774)	−3.2683 (3.4234)	−4.2018 (3.5856)	−0.5648 (0.9449)	−0.1557 (0.9655)	12.4804*** (4.3416)	7.4203 (4.8321)
Rain (AUG–SEP)	−0.9397 (1.9668)	−0.1014 (2.1212)	2.9911 (4.3852)	3.5943 (4.5155)	3.3619* (1.9291)	3.9342** (1.8336)	10.1664** (4.6383)	16.0131*** (5.1547)
Temp (APR–MAY)^2		0.0496 (0.0316)		0.0590* (0.0352)		0.1426*** (0.0406)		0.1619*** (0.0478)
Temp (JUN–JUL)^2		−0.0455 (0.0383)		−0.0473 (0.0384)		−0.0027 (0.0330)		0.0126 (0.0356)
Temp (AUG–SEP)^2		0.0247 (0.0371)		0.0198 (0.0418)		0.1058** (0.0515)		0.1055* (0.0591)
Rain (JAN-FEB)^2			−0.0073 (0.0085)	−0.0051 (0.0090)			−0.0494*** (0.0176)	−0.0308 (0.0198)

(*Continued*)

https://doi.org/10.1017/jwe.2024.19

Table 10. (*Continued.*)

	Cult				Non-cult			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Rain (APR–MAY)^2			0.0487 (0.2267)	0.0038 (0.2518)			1.5765* (0.9295)	0.4490 (1.0409)
Rain (JUN–JUL)^2			2.4825 (2.5063)	3.8857 (2.8487)			−11.3851*** (3.6787)	−7.5786* (4.0651)
Rain (AUG–SEP)^2			−6.1115 (6.1156)	−5.8880 (6.1981)			−5.6531 (4.2282)	−11.1805** (4.7963)
Constant	77.410*** (9.9116)	159.2069 (189.285)	75.887*** (10.823)	161.4549 (238.432)	53.334*** (8.789)	1,099.198*** (318.772)	35.0798*** (11.146)	1,226.306*** (404.551)
Observations	209	209	209	209	184	184	184	184
Adjusted R^2	0.1216	0.1266	0.1148	0.1237	0.0982	0.1465	0.1239	0.1682
F-Statistic—H_0: Exclusions	1.0666	0.8401	1.6484		3.0692***	2.1008*	3.9808***	
F-Statistic—Regression	3.3992***	3.0095***	2.6858***	2.5449***	2.8108***	3.2444***	2.7259***	3.0560***

Note: Robust standard errors in parenthesis.
*$p < 0.1$; **$p < 0.05$; ***$p < 0.01$ based on two-sided tests.

https://doi.org/10.1017/jwe.2024.19

winemakers are well located for producing and selling wine, both geographically and by their position in the market for wines. As such, they may be somewhat insulated from the effects of weather variations. Cult wines in the United States are produced exclusively in both California and Washington State, which have different weather conditions.

In this article, we examined how weather conditions are related to prices of both cult and non-cult wines. We also considered the relationship between weather variables and price gaps between release prices and secondary market prices for cult wines. Moreover, we investigated associations between weather conditions and the number of cases produced and wine scores assigned for both cult and non-cult wines. We further examined whether associations with weather differ across wine regions. Implementing an FE methodology, cult and non-cult wines from three U.S. regions were studied: both Napa and Sonoma in California, and Walla Walla on the border of Washington State and Oregon.

The estimation results are many and vary across the multiple models that are analyzed relating to the various aspects of the wine markets. However, focusing attention on the subsets of estimated models that are not demonstrably rejected based on joint statistical tests of variable exclusions identified some commonality of results and overall themes relating to associations of weather and non-weather variables on prices, price gaps, cases produced, and wine scores.

With regard to prices for cult and non-cult wines, price gaps for cult wines, and their relationships with non-weather-related variables, there is a uniformly consistent and strongly positive association with expert wine scores. This suggests that consumers definitively value the information conveyed by such scores vis-à-vis the quality of wines. White wines are estimated to have a negative association with prices, although this result was only strong and definitive in the case of non-cult wines but not for cult wines. This suggests that in cult wine markets, white wines are not considered to be notably inferior in value relative to reds, unlike what was found in the non-cult wine market. As for the regional origins of wine, there is some support gleaned from the quadratic models that Sonoma has a negative association with the overall levels of both cult and non-cult wine market prices in comparison to wines from both Napa and Walla Walla, where neither of the latter two regions is estimated to have a demonstrable association with the level of market prices. However, that result does not apply to the price gaps for cult wines, for which no overarching association with regions is found.

Regarding associations with weather variables per se, it is notable that for the number of cases of cult wine produced, no definitive relationships with any of the weather variables is found. This suggests that in so far as any associations of weather with cult wine prices or price gaps is concerned, the relationship is primarily driven by quality issues as opposed to the quantities of cult wine placed on the market. The result is somewhat different for non-cult wines, where weather has some degree of association with quantities based on statistical tests of individual weather-related coefficients. In particular, there is at least weak statistical support for higher temperatures during both the late growing season and the harvest season being favorably associated with cases produced, and somewhat stronger statistical support for winter rain being negatively associated with the number of cases primarily in the Walla Walls region. But results for cases of non-cult wine remain somewhat tentative given the nondefinitive outcomes of variable exclusions tests across models.

In terms of associations between weather variables and wine scores, the results provide only weak support for temperature effects, in the early growing season and during the harvest season, having an association with scores. This may reflect the more limited variability in the qualities of the wines that are released in the ultra-premium category. The situation is different for non-cult wines. While still relatively high-quality wines, they have lower scores with higher variability (see Table 2), and there are a number of weather effects that are more demonstrably associated with the wine scores assigned, involving both temperature and rain effects. In particular, temperature in the early growing season and rain during the harvest season appear to be definitively associated with wine scores. There is also some statistical support, albeit weaker, for temperature during the harvest season to be associated with the wine scores assigned. There is some more limited support for rain at other times of the year (winter, late harvest) to exhibit some association with scores. Overall, these results suggest that wine scores are reflecting both the levels of quality and the variability in those qualities that are inherent to the two categories of wine, and the fact that ultra-premium wines are expected to have more consistency in quality levels.

In terms of the additional association of weather with prices and price gaps when accounting for wine scores, regions, and whether the wine is a red or white, there are associations with weather that find some degrees of support. Considering results across all models not rejected at some level by variable exclusion test outcomes, temperatures in the early growing season exhibit some degree of positive association with prices for both cult and non-cult wines, as well as for cult wine price gaps. Temperature during the late growing season is strongly negatively associated with non-cult wine prices but not so for cult wines. A negative association of late growing season temperature with price gaps finds somewhat stronger statistical support, and a positive association with harvest season temperature also finds notable statistical support.

Finally, in terms of the association of rain with prices and price gaps, rain during the early growing season has a demonstrable negative relationship with both cult wine prices and price gaps and appears mostly applicable to the Walla Walla region. Early growing season rain is not found to be associated with non-cult prices. Alternatively, harvest season rain exhibits relatively strong statistical support for a negative association with non-cult wine prices, whereas a negative association with cult wine prices is not definitive. An association between harvest season rain and cult wine price gaps has modest statistical support for a positive association focused on the Walla Walla region.

Overall, the analysis suggests that weather is associated with various characteristics of wine markets, including prices, price gaps for cult wines, wine scores, and cases produced. The nature of the associations depends on the type of wine (cult or non-cult, red or white), timing of weather conditions throughout the year and growing region. Weather associations exist even after wine scores, regions, and whether the wine is red or white is explicitly accounted for. Thus, one is left to conclude that there is notable additional information contained in the weather environment surrounding wine production that transcends the information portrayed by the non-weather variables.

https://doi.org/10.1017/jwe.2024.19

The results suggest that climate change may effect wine regions and wine categories differently, and because climate change affects temperature and precipitation both in terms of their means and their variances, winemakers in various regions will face incentives to adapt differentially. Wine is an additionally interesting product because both the wine maker's and the region's (e.g., the AVA) reputation can affect prices, and the effect of a history of past quality can have a greater impact than current quality (Costanigro et al., 2010). The perceived location of the best wine regions could eventually change due to the effect of climate change (Ashenfelter and Storchmann, 2016), but reputations will likely change more slowly. The cult winemakers considered in this analysis have built their reputations into major assets. A question for future research is whether their individual reputations will survive the changing climate. Moreover, it would be interesting for future research to expand the analysis to a wider scope of wine qualities and pricing beyond cult and high-quality non-cult wines to determine to what extent the finding on weather associations are consistent or become even more varied.

Acknowledgments. The authors wish to thank Felix Munoz-Garcia and an anonymous reviewer for comments. This article is based upon work supported by the National Institute of Food and Agriculture, U.S. Department of Agriculture.

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Appendix

Table A1. Cult wines used in this analysis

Company	Region	Wine products
Abreu	Napa	Cappella St. Helena, Madrona, Thorevilos, Las Posadas Howell Mountain
Colgin Cellars	Napa	Tychson Hill, Cariad, IX Estate, IX Estate Syrah
Dalla Valle	Napa	Cabernet Sauvignon, Maya
Eisele Vineyard	Napa	Cabernet Sauvignon, Altagracia, Syrah
Grace Family	Napa	Cabernet Sauvignon
Scarecrow Wine	Napa	Scarecrow
Schrader Cellars	Napa	Beckstoffer to Kalon Vineyard Cabernet Sauvignon, CCS Cabernet Sauvignon, GIII Cabernet Sauvignon, LPV Cabernet Sauvignon, RBS Cabernet Sauvignon, T6 Cabernet Sauvignon
Screaming Eagle	Napa	Cabernet Sauvignon Oakville
Aubert	Sonoma	Chardonnay Eastside, Chardonnay Lauren, Chardonnay Powder House, Chardonnay UV-SL, Pinot Noir UV, Pinot Noir UV-SL
Kistler	Sonoma	Chardonnay Dutton, Chardonnay Trenton Roadhouse, Chardonnay Vine Hill, Chardonnay Durell, Chardonnay Stone Flat, Chardonnay McCrea, Chardonnay Cuvée Cathleen, Pinot Noir Laguna Ridge, Pinot Noir Silver Belt Cuvée Natalie
Rochioli	Sonoma	Chardonnay River Block, Pinot Noir Little Hill
Williams Selyem	Sonoma	Pinot Noir Olivet Lane Vineyard, Pinot Noir Westside Road Neighbors, Zinfandel Bacigalupi Vineyard, Chardonnay Heintz Vineyard
Cayuse	Walla Walla	Armada Vineyard Syrah, Bionic Frog Syrah, Cailloux Vineyard Syrah, En Cerise Vineyard Syrah, En Chamberlin Vineyard Syrah, Flying Pig, Widowmaker Cabernet-Sauvignon, God Only Knows Grenache, The Lovers
Leonetti Cellars	Walla Walla	Merlot
No Girls	Walla Walla	Syrah La Placiencia, Grenache La Placiencia

Table A2. Non-cult wines used in this analysis

Company	Region	Wine products
B Cellars	Napa	Cabernet Sauvignon Oakville, Cabernet Sauvignon Oakville Ehrlich Vineyard
Cade	Napa	CADE Estate Cabernet Sauvignon Howell Mountain
Etude	Napa	Cabernet Sauvignon Oakville, Cabernet Sauvignon Rutherford
Far Niente	Napa	Cabernet Sauvignon Oakville
Groth	Napa	Cabernet Sauvignon Oakville, Cabernet Sauvignon Oakville Reserve
Howell Mountain Vineyards	Napa	Zinfandel Howell Mountain Old Vine, Cabernet Sauvignon Howell Mountain
Kenefick Ranch	Napa	Sauvignon Blanc, Merlot, Cabernet Sauvignon Calistoga Chris's Cuvée
Pine Ridge	Napa	Cabernet Sauvignon Oakville, Howell Mountain Cabernet Sauvignon
Tamber Bey	Napa	Cabernet Sauvignon Oakville, Sauvignon Blanc Oakville Lizzy's Vineyard
Turnbull	Napa	Cabernet Sauvignon Calistoga Amoenus Vineyard, Cabernet Sauvignon Oakville Fortuna Vineyard, Merlot Oakville Fortuna Vineyard, Cabernet Sauvignon Oakville Leopoldina, Cabernet Sauvignon Oakville Reserve, Cabernet Sauvignon Oakville Black Label
Chalk Hill	Sonoma	Chalk Hill Estate Red
J Vineyards & Winery	Sonoma	Chardonnay Russian River Valley Bow Tie Vineyard, Pinot Noir Russian River Valley Bow Tie Vineyard, Pinot Noir Russian River Valley Canfield Vineyard, Pinot Noir Russian River Valley Eastside Knoll Vineyard, Pinot Noir Russian River Valley Foggy Bend Vineyard
Kunde Family	Sonoma	Sauvignon Blanc Block 4SB20, Magnolia Lane Sauvignon Blanc, Reserve Century Vines Zinfandel, Chardonnay Sonoma Valley, Zinfandel Heritage Block, Merlot Sonoma Valley
ÀMaurice	Walla Walla	Estate Syrah "Fred," Night Owl, Estate Viognier "Sparrow," Estate Cabernet Sauvignon "Owl and Crown"
Dusted Valley	Walla Walla	Tall Tales Syrah
L' Ecole No. 41	Walla Walla	Apogee Pepper Bridge Vineyard, Estate Seven Hills Vineyard Syrah, Estate Ferguson Vineyard, Luminesce Seven Hills Vineyard, Merlot Walla Walla Valley, Perigee Seven Hills Vineyard
Spring Valley Vineyard	Walla Walla	Katherine Corkrum Cabernet Franc, Frederick Red Wine, Uriah Red Wine, Nina Lee Syrah
Woodward Canyon	Walla Walla	Chardonnay Washington

Cite this article: Okhunjanov, B., McCluskey, J. J., and Mittelhammer, R. C. (2024). Wine prices and weather: Are cult wines different?. *Journal of Wine Economics*, 19(3), 201–231. https://doi.org/10.1017/jwe.2024.19