

The Economic Effect of Weather, Climate, and Climate Change on California Winegrape Industry

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California grape industry ranks second in California agricultural commodities with sales of over 3 billion dollars annually that account for over 8% of California farmers' revenues. Wine made in California accounts for over 90% (in liters) of the total US wine and California ranks fourth in the global wine market. California is divided to seventeen winegrape pricing or crush districts, and more than one hundred varieties grown commercially for wine production in these districts, with many varieties grown in each district and many districts growing each main variety. Prices of winegrapes grown in California differ dramatically across climatic regions and varieties. Price of a particular variety differs up to a factor of fourteen across crush districts and up to a factor of 48 across varieties grown in different crush districts. Previous studies have established relationships between climate, wine characteristics, and the price of wine. However, weather and climate affects the characteristics of wine through the grapes. Surprisingly there are only few studies that focused specifically on the relationships between climate, weather, characteristics, and prices of winegrapes.

In some cases prices of winegrapes are determined before weather and specific characteristics of grapes are known. Climate affects the price of winegrapes mainly through long term reputation. Weather affects vintage-to-vintage spot transaction prices through characteristics of spot market grapes, production cost and total crop size (through yield). Climate change is expected to affect yield, characteristics and prices of winegrapes. Hence, weather, climate and climate change are major considerations for the California winegrape industry.

A biophysical relationship between weather and sugar content in winegrapes measured by harvest Brix is known to exist and may be controlled to some extent by winegrowing practices. Most California winegrape contracts include penalty or bonus clause for sugar content and historical data of harvest degree Brix is readily available. This study estimates relationships among weather, climate, sugar content and prices of California winegrapes. The analysis is focused on the most popular varieties including Cabernet Sauvignon, Pinot Noir, Merlot, Zinfandel, Syrah, Chardonnay, French Colombard, Chenin Blanc, Sauvignon Blanc and Pinot Gris. The analysis is limited to these varieties because they are grown in most crush districts and data exist for a long period of time.

Data on historical climate change of variables important for winegrapes in California crush districts is not readily available and the scope of future climate change is still undecided. We use eight decades daily weather data from 86 weather stations across California to estimate trends of variables important to winegrapes in California crush districts. We show that climate change is not uniform across California crush districts and that climate changes differentially across weather variables within the same crush district. Furthermore, trend of monthly climate variables was significantly different for some weather variables and some districts indicating that for a particular weather variable and crush district climate changes differentially along the growing season. Elevated warming is demonstrated from 1960. Insignificant change in precipitation is demonstrated in most California crush districts.

We use time series cross sections of weather and winegrape data over several decades to model and document the effect of weather and climate on sugar content and prices of winegrapes grown in seventeen crush districts in California. Estimation is divided to three parts: weather and Brix relationship, Brix and price relationship, and weather, climate, and price relationship. Each crush district is considered a separate market. Nonetheless, grapes grown in different crush districts in California are in direct competition and their price is jointly determined.

We show that there are significant relationships between weather and sugar contents for some varieties and some regions, indicating that growers cannot fully adapt their growing practices to the weather and changing climate. Therefore, although California is endowed with high temperatures and plenty of sunshine, unlike some wine regions in Europe, weather is still a major consideration for the sugar content in some winegrape varieties grown in several locations. These results and the spatial differences in the relationship between sugar and weather dimensions for grapes grown in different climatic regions may have implications on the ability of grape growers to adapt to climate change.

Significant relationships between harvest degree Brix or other characteristics correlated with degree Brix and prices of winegrapes were found as well as significant relationships between slowly evolving climate and winegrape prices within districts and varieties, accounting for weather and time trends. Uneven climate change across regions may affect prices of winegrapes in each crush district and may change substitution and complementary relationships of grapes grown in competing crush districts.