Forecasting California Wine Grape Supply Cycles

A modern approach to a systematic model of grape prices offers a better way of forecasting grape prices.

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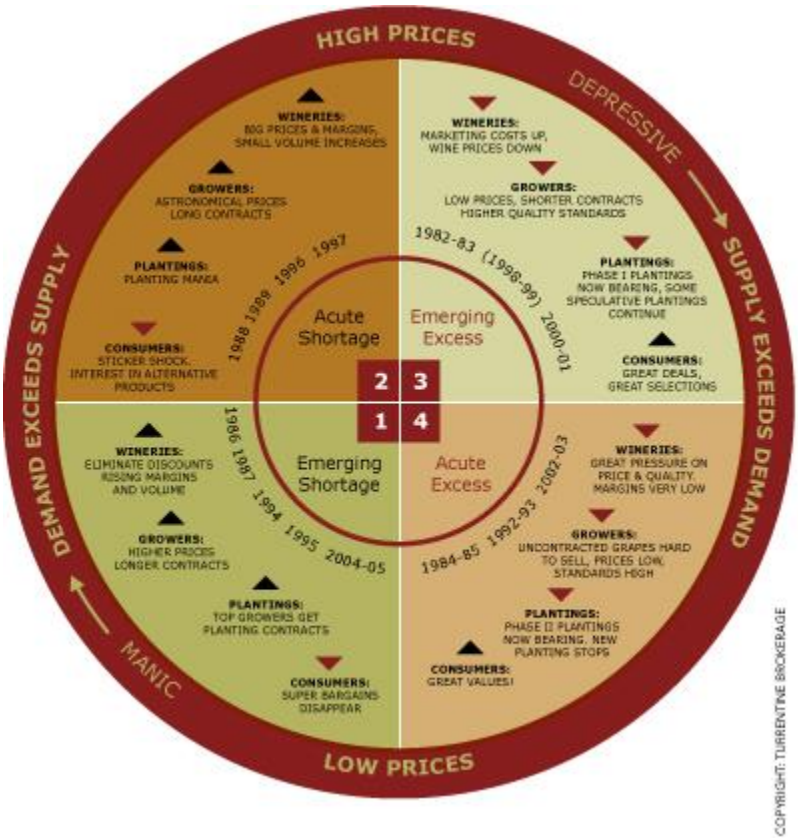
The cyclical nature of the wine industry is common knowledge to those inside the business. Understanding this cyclical nature of this industry is vital for everyone, from the vintners and grape growers, to the investors and all those whose business relies on its performance.

One particularly insightful attempt to understand the cyclical nature of the wine industry is provided by grape and wine broker **Bill Turrentine**, with his Manic Depressive Wheel. The Manic Depressive Wheel, which has become a mainstay in the wine industry, provides a fairly complete description of the various phases of wine business cycles and the ramifications that these peaks and troughs have on bottle price, grape prices and planting decisions.



Unfortunately, what the Wheel of Fortune does not provide is a way to predict where you are in the cycle. This deficiency is understandable given the complexity in analyzing not just the long-term trend and short-term fluctuations of grape prices, but also given that grape prices vary by varietal and region. We attempt to remedy this problem by providing a systematic model of grape prices by region and varietal that identifies both the long-term trend and short-term cyclical fluctuations.

FIGURE 1

North Coast Chardonnay Prices

Consider, for example, the price per ton of California North Coast Chardonnay grapes. Figure 1 shows that California North Coast Chardonnay grapes provide the prototypical example of cyclicality. In addition to an upward trend, there is a clearly identifiable cycle around the long-term trend in grape prices. However, despite the obvious cyclicality, both leading industry consultants and academic analysts continue to use simple linear models to create forecasts, ignoring the inherent cyclicality.

Figure 2 shows the same data as Figure 1 using a linear trend to forecast grape prices. Although the linear trend describes the overall long-term trend in prices, it does not reflect the inherent cyclicality in prices and the information contained therein. For short-term decision-making, a linear forecast will consistently be wrong, either under-estimating or over-estimating grape prices. In fact, using regression analysis we found that the explanatory power of a linear model is less than 50 percent, meaning that you would have better luck forecasting grape prices if you simply flipped a coin.

" />Clearly, given the impact that grape prices have on the wine industry and the subsequent effect on local economies, the wine industry can do better than flipping a coin. In order to systematically model grape prices and provide interested parties with more accurate grape price forecasts, we have developed a mathematical model that takes into account the inherent cyclicality of the wine industry and the interdependence among acres planted, tons yielded and market prices.

FIGURE 2

North Coast Chardonnay Prices

This price model is an improvement on the simple linear models used by industry analysts to forecast grape acreage and yield for several reasons. First, as noted above, the simple linear model ignores the cyclicality of the data. Second, examining acreage and yield only accounts for the supply side of the grape market and does not take into account the demand side of the market.

Economic theory tells us that price is determined by the interaction of supply and demand, so that analyzing market price implicitly takes into account both sides of the market. Finally, and more importantly, it is price that determines profitability of farmers and vintners. Perhaps because of the difficulties in forecasting price, most analysts concentrate on only the supply side of the market, examining acres planted and tons harvested of grapes. Ignoring the demand for one's product in making business decisions does not seem like the best strategy for any business, let alone one in which the product is perishable.

The model we have developed treats price, acres and tons as interdependent and thus forms what is referred to mathematically as a system of simultaneous equations. This system of simultaneous equations is then used to predict price. We believe our simultaneous equations model is an improvement over the simple single-equation linear models used to predict acreage and yield for several reasons. To begin with, it is clear that the price per ton of grapes depends on the current year's harvest. Similarly, the current year's harvest depends on the amount of acreage cultivated (i.e., the supply side of the market). The amount of acreage currently cultivated will in turn depend on the current price and past price of grapes. Again, economic theory tells us that when the price of grapes is high,

suppliers will increase the amount of grapes planted. Likewise, high prices in the past, which induced suppliers to increase acres planted, will result in a greater current grape stock.

Thus we see that not only is there interdependence among prices, acres and tons, there is also an inter-temporal effect where today's supply decisions are in part based on both today's market conditions and decisions made in the past. The model we develop explicitly accounts for all of these effects.

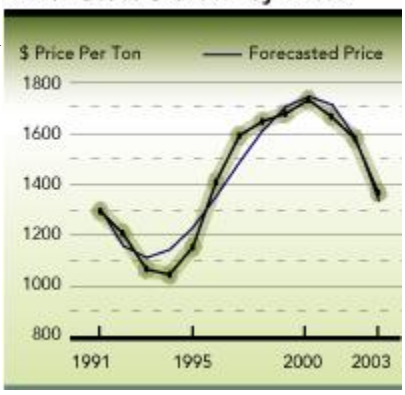
Using data from the annual California Grape Reports, which provides data on price, acres planted, and tons harvested by varietal and American Viticulture Area for the years 1991 through 2003, we estimate a model consisting of a set of simultaneous equations that account for the interdependence among price, acreage and yield. Formally, the model specifies that:

$Price_t=f(Harvest_t)$
$Harvest_t=f(Acreage_t)$
$Acreage_t=f(Prices_{t-n})$

Because each region and varietal can be expected to follow its own cycle, a set of dummy and interaction variables were created to account for the seven leading varietals: Chardonnay, Cabernet Sauvignon, Merlot, Sauvignon Blanc, Pinot Noir, Syrah and Zinfandel, and the four major California growing regions: North Coast, Central Coast, Northern Interior and Southern Interior. Finally, we used a non-linear specification to capture the cyclical nature of the data.

" />Figure 3 shows the actual and predicted price per ton for North Coast Chardonnay using the new model. As can be seen, the new model fits the data significantly better than the linear model shown in Figure 2. Forecasts based on the new model will not only account for the long-term trend, but will also allow grape growers, vintners and others to more accurately forecast the price of grapes in the near future and understand where prices are in the current cycle.

FIGURE 3
North Coast Chardonnay Prices



For example, from Figure 3, you can see that in the six years since 1994, when the price of North Coast Chardonnay bottomed out, price rose and reached its peak in 2000. Since 2000, the price of North Coast Chardonnay grapes has been on the downward part of the cycle. Based on the model, over the 13-year period analyzed, North Coast Chardonnay grape prices have grown at a rate of approximately 3.2 percent per year. More importantly, however, the model shows that North Coast Chardonnay grape prices follow a six-year cycle from peak to trough.

Currently North Coast Chardonnay grapes prices are in the fifth year of a six-year cycle, and we would expect the price of North Coast Chardonnay grapes to begin the upward part of the next cycle. This is clearly an improvement over the linear forecast, which would lead to a similar statement that North Coast Chardonnay grape prices can be expected to increase regardless of where they are in the cycle.

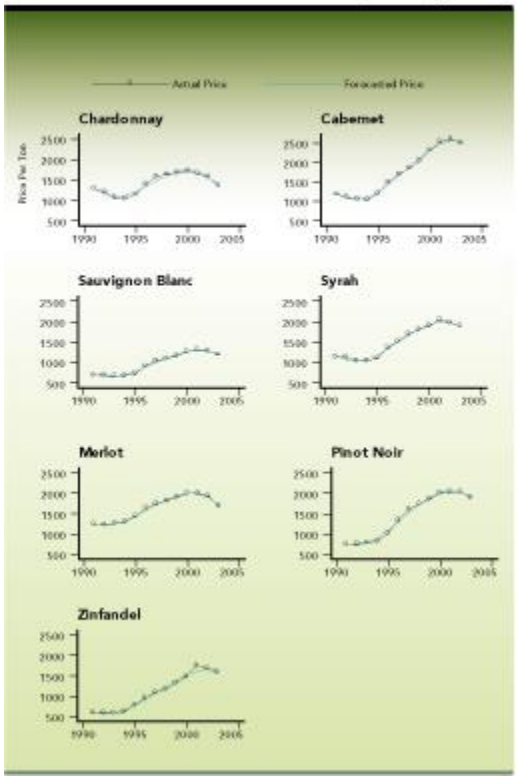
Because of its simplicity, the linear forecast is right less than half the time; more than half the time it is wrong. Compare that with the current model. Regression analysis shows that the model presented here accounts for approximately 91 percent of the variation in grape prices. This is not to say that the new model will perfectly predict the future; no model will do that. However, it does utilize more of the information available to provide a significant improvement over the linear model. Improved forecasts improve operational efficiency at every stage of the production process, reducing costs and increasing profitability.

Furthermore, the model is robust enough to accurately forecast grape prices for each varietal and region. Figure 4 shows the price of grapes for the seven main varietals of the North Coast region. From Figure 4, you can see that the price of North Coast Chardonnay, Cabernet Sauvignon, Merlot, Pinot Noir, Sauvignon Blanc, Syrah and Zinfandel

grapes each follow different cycles and trends. However, even though each varietal follows its own trend and cycle, the model provides a fairly precise forecast of each.

For example, the cycle and trend for Chardonnay grape prices is very different from the cycle and trend for Cabernet Sauvignon grape prices in the North Coast: the cycle is much more pronounced for Chardonnay than for Cabernet Sauvignon grapes, representing greater fluctuations and more volatility in Chardonnay grape prices. The long-term trend in Chardonnay grape prices, however, has been flatter than that of Cabernet Sauvignon grape prices, which have been experiencing faster growth.

FIGURE 4
North Coast – Actual vs. Predicted Price per ton by Varietal



According to our model, over the 13-year period analyzed, North Coast Cabernet Sauvignon grape prices have grown at a rate of approximately 8.7 percent per year, compared with 3.2 percent for Chardonnay prices of the same region. The model also shows that North Coast Cabernet Sauvignon grape prices follow a 10-year cycle from peak to trough.

Currently, North Coast Cabernet Sauvignon grape prices are in the third year of a downward cycle. However, because of the relatively long length of the cycle, we are only able to observe a full expansion and are unable to observe a full cyclical downturn. It is unlikely that the length of the downward cycle is the same as the length of the upward cycle in the 13-year period observed. Consequently, to provide a more accurate forecast of the North Coast Cabernet Sauvignon grape prices, a longer time series would be required. The remaining varietals of the North Coast region are summarized in Table 1 below.

TABLE 1: REMAINING VARIETALS OF THE NORTH COAST REGION

Region	Long-term growth rate	Length of cycle (years)	Length of cycle (months)
Chardonnay	3.2	7.1	84.6
Cabernet	8.7	10.3	123.9
Merlot	4.3	8.4	100.2
Pinot Noir	10.1	9.2	110.9
Sauvignon Blanc	6.7	8.7	104.7
Syrah	6.3	8.6	103.2
Zinfandel	10.5	9.9	119.4

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As previously stated, the linear model currently used by industry analysts accounts for less than 50 percent of the variation of grape prices; our model accounts for approximately 91 percent of the variation in grape prices. The model presented provides a fairly accurate picture of the grape market. This allows for accurate short-term as well as long-term forecasts, providing long-term growth rates, short-term cycle length and intensity by grape varietal and region.

With increased consolidation across the industry, from grower to distributor, the ability to hedge business decisions against current and future market conditions is of the utmost importance. If recent history has taught us anything, it is that the ability to accurately forecast price, acres and tons is a key element in the planning cycle and is vital to profitable decision-making. As the wine industry begins to come out of a slump that was, in part, due to an "unexpected" oversupply of grapes, the costs of poor forecasts should be abundantly clear.

The multi-billion-dollar California wine industry needs to follow the lead of other major industries and adopt more sophisticated modeling techniques. The model presented here provides a more accurate picture of the grape market that takes into consideration both supply and demand decisions of the market, identifies the long-term trend as well as the short-term cyclicality of the market, and provides a more powerful insight into the California Grape Supply Chain. **wbm**

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