The Elasticity of Demand for California Winegrapes

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The demand for California winegrapes is quite elastic–i.e., responsive to prices. This demand elasticity reflects substitution between wine from California and other sources and between quality categories. We estimate elasticities of demand for winegrapes from three regions of California that range from –2.6 to –9.5.

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In California, grapes rank as the highest-valued agricultural crop and the second-highest valued agricultural product after milk and cream. Winegrapes alone contributed roughly $2.1 billion, or 5.9%, to the total value of California farm production in 2010, with a further $0.9 billion contributed by table grapes, raisin grapes, and grapes crushed for other uses. California produced 86% of both the volume and value of U.S. winegrapes in 2010.

Measures of demand response to economic factors, including price and income, are often used in economic analysis of markets and policies. The elasticity of demand for winegrapes is useful for estimating the price, quantity, and economic welfare effects of anything that causes a change in the production or consumption of winegrapes—new policy, disease, or pests, for example. Despite the economic importance of this industry, and the usefulness of elasticities, estimates of demand response for California winegrapes are scarce.

In our recent article in the *Journal of Wine Economics* we report estimates of demand response for California winegrapes. We also discuss the pitfalls and challenges of the estimation of demand response for commodities that are highly differentiated, with huge variation in price by agronomic variety, geographic location of production, and other characteristics that affect "quality" and end-use of winegrapes. Here, we summarize the main findings of that work, leaving aside the technical details, which can be found in the longer article in the *Journal of Wine Economics*. We focus on *price elasticities of demand* for winegrapes, which measure the percentage change in quantity demanded in response to a one-percent increase in price.

Conceptual Issues and Practical Considerations

Several aspects of the demand for California winegrapes are pertinent when estimating elasticities (measures of price and income responsiveness) that will be useful for policy and market analysis, and in interpreting the results from estimation. First, it is appropriate to estimate an "inverse" demand model, in which the market price varies in response to variations in market quantity, rather than vice versa. Winegrapes are a perennial crop, for which current production is determined to a great extent by decisions made years, or even decades, earlier. Thus, variations in the current market price have comparatively little influence over the quantity supplied in the current season. Consequently, we can treat year-to-year quantity variation as determined by factors other than the current price, including past vineyard investment decisions, as well as current pest and disease incidence and weather, and treat the market-clearing price as responding to these quantity variations.

Second, as for most farm commodities, the demand for California winegrapes does not reflect final consumer demand, but rather demand from processors who use grapes to produce a consumer product. This is important for how we approach the estimation problem and how we interpret the resulting estimates.

Third, California wine is sold in the rest of the United States and exported, and competes in these markets—even in California—with wine produced in other states and other countries. Thus, global supply and demand conditions influence the demand for California wine and hence the demand for California winegrapes from which California wine is derived. With close substitutes in the market (in the form of wine produced elsewhere), we expect the quantity of California winegrapes demanded to be more sensitive to price than it would be otherwise.

Fourth, wine is highly differentiated, made from highly differentiated winegrapes of many varieties produced across a diverse range of agroecologies. Reflecting this differentiation and diversity, the California Department of Food and Agriculture (CDFA) collects

Table 1. Regional Statistics for California Winegrapes, 2010 Values					
California Winegrape Region	Value of Production	Average Price	Total Crush	Bearing Area	Average Yield
	Millions of 2010 $	2010 $/ton	Thousands of Tons	Thousands of Acres	Tons/ Acre
High-Price (H)	835.0	2,526	331	100.4	3.30
Medium-Price (M)	1,051.6	737	1,427	224.3	6.36
Low-Price (L)	529.8	289	1,831	132.2	13.85
State Aggregate	2,416.4	673	3,589	456.9	7.85

detailed data for each of the 17 geo-graphically based California "crush districts." Broadly speaking, Napa and Sonoma vineyards produce compara-tively few tons per acre at comparatively high cost per ton. In the Central Valley, especially in the southern San Joaquin Valley, yields are up to 10 times higher and grape prices per ton are in the range of one tenth of prices in the Napa and Sonoma crush districts. The rest of the state has a range of yields, costs and prices that fall between these extremes.

For the purposes of our demand analysis, we aggregated the 17 crush districts into three regions that we defined as "High," "Medium," and "Low" based on their average winegrape prices, while noting that every region produces a range of winegrape variet-ies and characteristics. The regions are depicted in Figure 1. Table 1 presents regional statistics on value of produc-tion, average price per ton, total crush, and average vineyard yield in 2010.

Derived Elasticities of Demand

As noted, in this work we focus on price elasticities of demand for wine-grapes, which measure the percent-age change in quantity demanded in response to a one-percent increase in price. James Fogarty (2010) reviewed the worldwide literature on demand for alcohol. He reported estimates of the own-price elasticities of demand for beer, wine, and spirits from 141 studies. He reported 177 estimates

of the elasticity of demand for wine with respect to its own price (31 of which refer to the United States) ranging from –1.86 to –0.18.

These are measures of price respon-siveness of demand for *wine,* a finished product, which is different from the demand for *winegrapes*, an input. In what follows we use an average value of –0.80 for the elasticity of demand for wine together with other infor-mation to derive estimates of elas-ticities or price responsiveness of the demand for California winegrapes.

The demand for California wine-grapes as an aggregate category is derived from the demand for California wine in conjunction with technology of winemaking and the supply of wine-making inputs. Hence, the elasticity of demand for California winegrapes can be represented as a specific mathemati-cal function of several factors including:

- the overall elasticity of demand for wine from all sources
- the elasticity of supply of winegrapes in the rest of world (ROW—represent-ing all regions other than California)
- the elasticity of price transmission between countries or regions, and
- the elasticity of supply of winemak-ing inputs other than grapes.

We evaluated this equation using a range of values for the parameters related to ROW winegrape supply response, supply response of winemak-ing inputs, and international price trans-mission, combined with a value of –0.80

for the elasticity of demand for all wine. The resulting estimates of the own-price elasticity of demand for California winegrapes range from –0.4 to –4.5. The range reflects alternative assump-tions about the elasticity of supply of winegrapes from the rest of the world, price transmission, and the elasticity of supply of other winemaking inputs. Using intermediate values for these key parameters and available data, we esti-mated the overall elasticity of demand for California winegrapes as –2.2.

The demand for California wine-grapes can be further decomposed into interdependent demands for winegrapes by quality category. The corresponding elasticities of demand for winegrapes from different quality regions can be measured as a function of the overall elasticity of demand for California winegrapes, market shares, and the extent to which the differ-ent quality categories can substitute for one another in winemaking.

We derived the equations for these disaggregated elasticities and evaluated them using data on market shares, the intermediate value for the overall elastic-ity of demand for California winegrapes (–2.2), and a range of substitutability (low, moderate, and high) between the different qualities of winegrapes. Allowing for quality differentiation

Figure 1. California Winegrapes Regions

- High-Price
- Medium-Price
- Low-Price
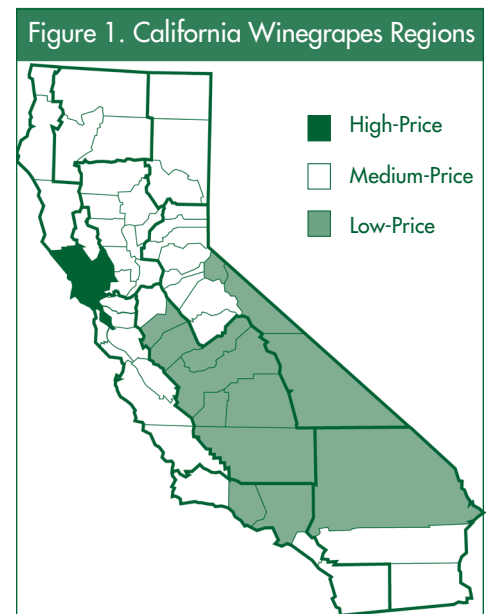
and imperfect substitution among winegrapes from the three different regions—as defined Figure 1—gives a full set of own- and cross-price elasticities as shown in Table 2. (The own-price elasticities reported here are the percentage change in quantity demanded of a particular quality category of winegrapes in response to a one percent increase in its own price. The cross-price elasticities are the percentage change in quantity demanded of a particular quality category of winegrapes in response to a one percent increase in price of a different quality category). The own-price elasticities are in boldface.

Econometric Estimates

In addition to the "derived" estimates just discussed, we estimated elasticities using an econometric model of demand. We estimated inverse demand system models for the three quality-cum-regional categories of winegrapes defined in Figure 1 and with differences in average prices and yields as illustrated by the summary statistics in Table 3. The models were estimated using annual data on prices and quantities of California winegrapes taken from the annual NASS/CDFA Crush Reports for the years 1985–2010.

Table 2 shows the elasticities estimated using this method in Column (4). The own-price elasticity of demand for high-priced winegrapes is fairly large in magnitude (–9.5), suggesting that a one percent increase in price for winegrapes from Napa and Sonoma counties, holding all other prices constant, would induce a 9.5% decrease in quantity demanded. The other own-price elasticities are substantially smaller in absolute value (–5.2 and –2.6); a one percent increase in price for medium- or low-priced winegrapes, holding all other prices constant, would result in roughly a 5.2% or 2.6% decrease in quantity demanded, respectively.

Thus, demands for all three categories are fairly elastic. The econometric estimates indicate that demand for high-priced winegrapes is the most elastic and the demand for low-priced winegrapes, mostly from areas in the southern San Joaquin Valley, is the least elastic. We might have anticipated the converse, given the very strong international competition in the bulk wine market, and we have some reservations about putting too much credence in any particular disaggregated elasticities for particular quality categories estimated in this fashion.

Several points are clear from the comparison of the econometric estimates in Column (4) and the derived estimates in Columns (1), (2), and (3)—the latter computed using a range of assumptions about substitutability among different qualities of winegrapes (low, moderate, or high) and an elasticity of aggregate demand for California winegrapes of –2.2.

First, reflecting our assumptions, the derived estimates of cross-price elasticities are all positive numbers whereas some of the econometric estimates are negative numbers, indicating complementary relationships—though small values relative to the negative own-price and positive cross-price effects. While cross-price elasticities are of some interest, analysts are typically more concerned with own-price

Table 2. Elasticities of Demand for California Winegrapes

Quantity Region	Price Region	Alternative Sets of Derived Estimates			Econometric Estimates
		s = 3	s = 5	s = 10	
		(1)	(2)	(3)	(4)
L	L	**–2.9**	**–4.5**	**–8.7**	**–2.6**
	M	0.4	1.2	3.4	–0.6
	H	0.3	1.1	3.0	3.1
M	L	0.1	0.5	1.3	–0.5
	M	**–2.6**	**–3.8**	**–6.6**	**–5.2**
	H	0.3	1.1	3.0	5.0
H	L	0.1	0.5	1.3	1.9
	M	0.4	1.2	3.4	5.6
	H	**–2.7**	**–3.9**	**–7.0**	**–9.5**

Notes: Entries denote the percentage change in quantity of winegrapes from each respective "Quantity Region" with respect to a one percent increase in price of winegrapes from each respective "Price Region." "L" denotes the low-priced region, "M" denotes the medium-priced region, and "H" denotes the high-priced region. Derived estimates in columns (1), (2) and (3) are based on low (s=3), medium (s=5), or high (s=10) substitutability between winegrapes from different regions.

Table 3. Data Sample Statistics by Region of California, 1985–2010

	California Winegrapes, Annual Quantity Crushed by Region				California Winegrapes, Annual Average Price by Region			
	High Price (H)	Medium Price (M)	Low Price (L)	State Total	High Price (H)	Medium Price (M)	Low Price (L)	State Avg.
	(thousand tons per year)				(2010 $/ton)			
Average of Annual Values	262.3	787.1	1,415.5	2,465	2,118	866	290	674
Standard Deviation	63.0	383.1	147.1	541.1	621	180	58	141

elasticities, and for this comparison we would place greater weight on own-price elasticities while giving some weight to cross-price elasticities.

Second, while the econometric estimates are broadly comparable to the derived estimates they are not completely consistent with any particular assumption about the degree of substitutability, denoted s, among winegrape qualities. The econometric estimates for the "Low"-price region are closest to the derived estimates assuming low substitutability (s=3); those for the "Medium"-price region are closest to the derived estimates assuming moderate or high substitutability (s=5 or 10); and those for the "High"-price region are closest to the derived estimates assuming high substitutability (s=10).

Conclusion

This article presents estimates of price responsiveness (or elasticities) of demand for winegrapes from different regions in California, differentiated on the basis of average prices as an indicator of quality. It adds to the wine economics literature by estimating measures of demand responsiveness for the most important input in winemaking—winegrapes—comparing derived and econometric estimates. The two approaches have different strengths and weaknesses and in this sense they are complementary.

Our derived estimates of elasticities of demand for wine and winegrapes were calculated using readily available information along with careful guesswork and sensitivity analyses where data were not available. These calculations show that basic estimates of demand elasticities can be made without econometric estimation, but that the results can be sensitive to assumptions and thus are conditional and uncertain.

Previous studies have estimated elasticities of demand for wine by final consumers. These studies suggest that the overall demand for wine in total

is probably inelastic—that an increase in price results in a less-than-proportional decrease in quantity demanded. We use a value of –0.8 as our best estimate of this elasticity. Using this estimate and other information, we derive estimates of the elasticity of the demand for California winegrapes as an aggregate input to wine production ranging from –0.4 (in the very short run) to –4.5 (in the very long run).

The longer-run elasticities represent the consequences of substitution between wine from California and other places and between winegrapes and other winemaking inputs when the price of California winegrapes changes. In the very short run, the demand for aggregated California winegrapes is inelastic. This means that, holding other factors constant, weather damage causing yield losses in the current season will result in a more-than proportionate increase in price and thus an increase in the total value of the crop. In the long run, however, demand is elastic. Hence, holding other factors constant, increases in production resulting from investment in capacity will result in much less-than proportional decreases in price, and an increase in the total value of the crop.

We use an intermediate value of –2.2, for the elasticity of demand for California winegrapes in aggregate, to derive elasticities of demand for the three quality categories of California winegrapes as would apply if we allow some time (say, several years) for response in production of winegrapes and winemaking to changes in winegrape prices. The resulting own-price elasticities range from moderately elastic (around –3) to highly elastic (around –7), depending on the assumed degree of substitutability among different qualities of winegrapes.

Our econometric estimates, based on 25 years of data, also suggest that the demand for every category of California winegrapes is quite elastic, consistent with the derived elasticities, albeit with

some differences in detail. The two approaches yield estimates that are of comparable magnitudes, at least for the majority of combinations of parameter values used for the derivations. The two approaches are complementary, each providing reinforcement to the other and strengthening our confidence in the general results, which indicate that the demands for individual categories of winegrapes are elastic and that winegrapes from different regions are substitutable for one another to some extent.

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For additional information, the authors recommend:

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