The Demand for Wines: Variety and Region Effects

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Presented at Western Agricultural Economics Association 1997 Annual Meeting
July 13-16, 1997
Reno/Sparks, Nevada

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In recent decades, a number of states unassociated in the public mind with wine production have developed thriving wine industries. Because wine quality and taste differ so greatly by geographic origin as well as grape variety, many regions have substantial opportunities to carve out market niches (Meridith). Indeed, wine is a good example of a monopolistically competitive industry: a large number of firms competing to sell generically related but differentiated products. Part of the differentiation inheres in the producing region's climate and soil type, part in annual weather variations, and part in winemaking skill, sales promotion, and pricing. Even small firms and producing areas therefore have some leeway in price and promotion strategy.

Our purpose here is to examine consumer preferences for wines, with emphasis on their type and area-of-origin. The study focuses on Oregon consumption of West Coast wines, although in its major outlines it might apply to other areas of the United States as well. The Oregon wine industry had its earliest beginnings 35 years ago. In 1995, 110 wineries in Oregon shipped about $44 million worth of wine, primarily varietal rather than jug or generic wine. White varietals represented 61% of the value of Oregon wines, red varietals the remaining 39%. Sixty-six percent of Oregon wine is sold in state, 34% out of state (Oregon Agricultural Statistics Service, 1997).

Earlier Work

We have found only two studies of U.S. wine demand that make distinctions among wine types: Folwell and Baritelle, and Pompelli and Heien. The latter authors examined the 1980 white wine consumption behavior of 3,000 U.S. households. Demands for domestic white and imported white wine were each related to the prices of various domestic and imported wines, to household income, and to demographic characteristics such as family size, age, and location. Their estimate of the own-price elasticity of domestic white varietals was -0.85, compared with the average -0.64 in Folwell and Baritelle. Income elasticities in Pompelli and Heien were little more than zero (and indeed statistically nonsignificant), likely because the included demographic factors already accounted for income effects.

A critical issue in wine pricing is the effect of one wine's price on the quantity demanded of another, holding either nominal or real income constant. At first blush, we might think of reds and whites as substitutes for one another, alternative versions of the wine consumption experience. Yet the two wine types go with quite different foods, and consumers may think of them bundled in some manner. Pompelli and Heien provide tantalizing, but in the end inconclusive, evidence about whether red wines substitute for or complement white wines. Their cross-price elasticities were largely nonsignificant, probably from multicollinearity rather than from an absence of substitute or complement effects in the wine demands themselves.

The Data

In contrast to the household panels in these earlier studies, we use scanner data from Oregon retail stores. The data provide monthly information on price and quantity of each wine sold, distinguished by state of origin, winery, variety, and container size. Information on approximately 1,200 distinct wine labels was reported each month, representing hundreds of West Coast wineries. The series runs from April 1993 through September 1994.

We divided the data into four categories: Oregon reds, Oregon whites, California reds, and California whites. In each category and for each month, we summed the wine quantities sold and computed its weighted mean price. Container sizes other than the standard 750-ml bottle were excluded, since most Oregon wine is sold in this size and since the demand structure for liter and jug wine probably differs from the generally higher-quality wine marketed in standard bottles. On average, Oregon red wines sold in Oregon were priced 26% higher than were California reds sold in Oregon. Oregon white wines were priced only 6% higher than California whites. Approximately 80% of the wine consumed in Oregon is produced in Oregon or California.

Although scanner data tell us much more than do household panels about the product purchased, they provide no information about customer incomes or demographic characteristics. For this reason, Holdren argued that demand functions based on scanner data are "retail" rather than consumer demands. The data characterize, in other words, nothing more than net consumer responses to changes in price and to nonprice inducements such as advertising. However, Capps has shown under certain circumstances that consumer demand inferences can be drawn from such "retail" functions. Capps used a Houston food chain's weekly scanner records to regress aggregate sale quantities of various meat cuts against their prices, advertising space in local newspapers, and seasonal dummy variables. Capps said consumer income needn't be included, because most of the store's patrons were from high income brackets. Using this reasoning, his specification would indeed be consistent with a standard consumer demand model.

Our task is at once more difficult and easier than Capps'. His focus on a particular city and food chain enabled him to assess advertising effects, something we cannot do with data aggregated over numerous retail firms and an entire state. In any event, retail stores do very little wine advertising. Capps' single-firm scanner data probably understates the consumer's total demand for the item in question, inasmuch as customers may shop at other chains. We avoid most of this understatement because few Oregon consumers cross state lines to buy wine.

Wine Demand Estimates

The Rotterdam system was chosen to estimate the demand for each of the four wine categories described above (Deaton and Muellbauer, pp. 67 - 69; Alston and Chalfant).

Rationality restrictions from demand theory are easily maintained with this system. In particular, we restrict our estimates to satisfy Engel and Cournot aggregation and symmetry of the weighted Hicksian substitution matrix (implying, with Cournot aggregation, zero homogeneity in prices). Use of an expenditure variable in these equations, representing total expenditures on all four wine categories in a given month, assumes retail-level wine demands are separable from the demands for other products. This assumption was required by the nature of the data available. Nevertheless, it likely isn't too egregious considering the special role that wine plays in many households. Seemingly Unrelated Regression (SUR) estimates were computed using the SAS system.

We initially tested the endogeneity of the expenditure variable by regressing it, as an auxiliary equation in the SUR system, against a number of instruments, including Oregon monthly employment (LaFrance; Capps et al.). None of the auxiliary equations were significant and the exogenous specification was therefore retained. We also tested and rejected the hypothesis that wine demands increase during the winter holiday season.

Uncompensated Demands

Marshallian price and expenditure elasticities, estimated after removal of the seasonal dummy variable, are shown in table 1. Expenditure elasticities of California wines in table 1 are slightly higher than those of Oregon wines, although none are far from unity. Now observe the matrix at the top of the table. Demands for both Oregon and California reds (especially California's) are own-price inelastic (weighted average -0.25), an unsurprising result given the specialized appeal of many red varietals. By contrast, demands for both Oregon and California whites are elastic (weighted average -1.24), consistent with the less discriminating preferences which experts say most consumers have for white wines. Whites are consumed at cooler temperatures than are reds, so taste differences between Oregon and California whites would be more subdued than between the reds.

Perhaps more intriguing in table 1 is an opportunity to examine the question, unresolved in Pompelli and Heien, of the Marshallian interactions between red and white wines. The most unambiguous way to do so is to observe the cross-price elasticities between red and white Oregon wines (top left 2 x 2 matrix), then between red and white California wines (bottom right 2 x 2 matrix). The answer in both cases is that reds and whites appear to be complements: all four within-state cross-price elasticities are negative. The interactions are nonsymmetric. Reducing the price of Oregon white wines by 1% increases the demand for Oregon reds by 1.9%, while reducing the price of Oregon reds 1% increases the demand for Oregon whites by only 0.6%. This asymmetry is a natural result of white wine's higher share of the wine consumer's dollar.

On the other hand, a red (white) wine from one state is a substitute for a red (white) from the other state. If California producers were to cut the prices of their reds by 1%, the demand for Oregon reds would fall by nearly 2%. A 1% cut in prices of California whites would reduce the demand for Oregon whites by 1.90%. The substantial size of these effects suggests that, while the Oregon wine industry has some price latitude, it cannot depart very far from price changes initiated in California. Potential for Oregon leadership over California wine prices, on the other hand, is weak even among Oregon consumers. Substitution elasticities showing the impact of Oregon price changes on the demands for California wines are only 0.37 and 0.65, respectively. Much of this asymmetry in leadership potential likely reflects California's superior market share, although it may reflect in part its superior image as well. In any event, it underscores a new wine industry's strategic limits even in the confines of its own state.

Price Strategies

A complete system of demand equations serves as an excellent basis for a payoff matrix of pricing strategies. In table 2, we show the proportional and total retail revenue changes that would occur given alternative combinations of changes in Oregon red and white wine prices, assuming California prices remain fixed. The no-change scenario in the upper-left cell represents revenues accruing at sample-mean prices and quantities. Figures in the lower-right cell, where both prices change, are derived from the full differential versions of standard revenue-change formulae, which employ the sums of the elasticities in the appropriate column of table 1. Strategies involving price increases were clearly inoptimal and have been dropped.

Table 2 makes clear that reducing white wine prices increases white wine revenue whether or not red wine prices change. The gain is greater if red wine prices are reduced also, since the red-white complementarity implies that cutting red wine prices increases the demand for white wine. Complementarity also explains the strong red wine revenue gain when white wine prices fall, especially when red wine prices stay fixed. In contrast, cutting red wine prices reduces red wine revenues if white wine prices are held constant, since red wine demand is inelastic. Yet cutting white wine along with red wine prices actually increases red wine revenue by virtue of the strong complementarity between reds and whites.

Compensated Demands and Tax Policy

A way of examining the robustness of the complementarity between red and white wines is to ask whether the complementarity persists when consumers are compensated for the price changes in question. That is, how much of the complementarity in table 1 is income effect and how much is net complementation? The Hicksian elasticities, in which consumers are taxed or subsidized as compensation for the income effect of the price change, are shown in table 3 to answer this question.

All four cross-product terms in table 3 relating the red wine to the white wine of a given state (-1.739, -0.589, -0.234, -0.146) are algebraically larger than their Marshallian counterparts in table 1, as required for normal goods. Yet they all remain negative, implying that red and white wines are complements with one another even when income effects are ignored. The complementarity is decidedly weaker among California wines (where indeed it is statistically nonsignificant) than it is among Oregon wines. On another note, the compensated own-price elasticities in table 3 are, owing to moderate expenditure effects, not much below the Marshallian own-price elasticities in table 1. Demands for California reds are especially unresponsive to price, another confirmation of the belief that California cabernets have a specialized market.

Hicksian compensated demands are especially valuable for determining the welfare effects of policy changes. Proposals recently have been made to increase Oregon's alcoholic beverage tax. Two questions arise about such a proposal: how much revenue would the state government earn, and how much welfare would consumers lose? The latter question is answered by finding the equivalent or compensating variation of the tax, which is a line integral under the compensated demands from the pre-tax to the post-tax price. In the line integral, we integrate first under the compensated demand for Oregon red wine, holding the other three prices at pre-tax levels. We then integrate under the compensated demand for Oregon white wine that would prevail after the increase in the Oregon red wine price, and proceed in similar manner to obtain the integrals under the two California wine demands. The line integral is the sum of these four successively-price-adjusted integrals (Just, Hueth, and Schmitz, pp. 365 - 369).

Among other tax scenarios, we modelled the addition of a specific tax of \$0.60 per bottle (\$3.03 per gallon), imposed on wines of all origins. Licensed importers would pay this tax on non-Oregon wines; wineries would pay it on Oregon wines. If marginal costs are constant, the tax increase is therefore passed on fully to the retail level. We assume constant marginal costs in this study.

The equivalent variation of the tax increase, computed using table 3's compensated elasticities in conjunction with mean prices and quantities, is -$163,925 per month. That is, Oregon consumers would lose a monthly equivalent of $163,925 from the tax in the sense that they would be willing to pay this amount to avoid the tax, assuming the tax is not in fact imposed. The state's tax revenue, in contrast, is determined by multiplying the after-tax price times the Marshallian quantities demanded after the tax. Using the demand parameter estimates in table 1, footnote c, total tax revenue would be $151,930 per month. The $11,995 difference between equivalent variation and tax revenue is the deadweight loss of the tax, namely the amount by which consumer cost exceeds the state's gain (Mas-Colell, Whinston, and Greene, pp. 84 - 87). Deadweight loss in the present case is 8% of tax revenue, considerably lower than the 38% which Heien and Pompelli predicted for a nationwide tax on alcohol.

Summary

Consistent with our expectations, we find the demands for red wines to be inelastic and the demands for whites to be elastic. Reds and whites complement one another even in the absence of income compensation. Yet the red wines (and white wines) from two different regions serve as substitutes for each other, particularly so if the price change is initiated in California. Oregon wine prices are too high to maximize producer revenues: white wines because their demands are elastic, red wines because they are complements for white wines. Deadweight losses from a tax increase would be modest, largely because compensated own-price elasticities tend to be modest also.

An important qualification of these results is our assumption that the demand for retail store wines is weakly separable from the demand for everything else. This assumption is required by the data available and, given wine's special role in many households, it probably does not distort results very much. Above all, we have provided a relatively rare look at a disaggregated wine demand system, permitting an examination of the impacts of both wine type and region of origin.

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Table 1. Marshallian Retail Demand Elasticities and Expenditure Elasticities, Oregon Wine Consumption, April 1993 - September 1994.[a, b]

		Quantities Demanded (i)			
		Oregon Red	Oregon White	California Red	California White
Prices (j)	Oregon Red	-0.517	-0.642	0.373	-0.060
	Oregon White	-1.866	-1.413	-0.437	0.650
	California Red	1.983	-0.758	-0.193	-0.461
	California White	-0.351	1.902	-0.681	-1.190
Average Expenditures Shares (w_i)		0.057	0.169	0.297	0.476
Expenditure Elasticities (η_i)		0.751	0.911	0.938	1.061

[a] The Rotterdam model is $w_i \, d\ln q_i = b_i \, d\ln \bar{x} + \Sigma_j c_{ij} \, d\ln p_j$, where $i = 1, ..., 4$ indexes the good, $j = 1, ..., 4$ indexes the price, w_i is expenditure share, q_i is consumption, $\bar{x}$ is real (price-deflated)

expenditure, p_j is price, and $b_i = w_i \eta_i$ and c_{ij} are estimated parameters (Deaton and Muellbauer, pp. 67-70). Marshallian demand elasticities in this table were calculated as $e_{ij} = e^*_{ij} - w_j \eta_i$, where e^*_{ij} is the corresponding Hicksian compensated demand elasticity (see table 4), w_j is expenditure share at sample means, and η_i is expenditure elasticity.

[b] System weighted mean square error was 1.1724 with 58 degrees of freedom. System weighted R^2 was 0.962.

Table 2. Revenue Changes Given Alternative Pricing Strategies, Oregon Wine Consumption.[a]

		White Wines			
		Leave White Wine Prices Unchanged		*Reduce White Wine Prices 10%*	
Red Wines	*Leave Red Wine Prices Unchanged*			Whites:	+ 4.0% ($11,362)
				Reds:	+18.7% ($18,014)
				Total:	+7.7% ($29,376)
	Reduce Red Wine Prices 10%	Whites:	+6.4% ($18,180)	Whites:	+10.3% ($29,258)
		Reds:	-4.9% (-$4,720)	Reds:	+13.6% ($13,102)
		Total:	+3.5% ($13,460)	Total:	+11.1% ($42,360)

[a] Revenue changes are expressed relative to sample mean prices and quantities.

Table 3. Hicksian Compensated Retail Demand Elasticities, Oregon Wine Consumption, April 1993 - September 1994.[a, b]

		Quantities Demanded (i)			
		Oregon Red	Oregon White	California Red	California White
Prices (j)	Oregon Red	-0.474	-0.589	0.426	0.002
		(-1.26)	(-2.76)	(2.83)	(-0.01)
	Oregon White	-1.739	-1.259	-0.278	0.830
		(-2.76)	(-1.87)	(-0.72)	(4.07)
	California Red	2.206	-0.487	0.086	-0.146
		(2.83)	(-0.72)	(-0.14)	(-0.54)
	California White	0.007	2.335	-0.234	-0.685
		(-0.01)	(4.07)	(-0.54)	(-2.30)

[a] Hicksian compensated demand elasticities were calculated as $e^*_{ij} = c_{ij} / w_i$, where c_{ij} is as defined in table 2 and w_i is expenditure share at sample means (Deaton and Muellbauer, p. 68).

[b] t-values are shown in parentheses.