Price and Quality in the California Wine Industry: An Empirical Investigation

Tony Lima, Ph.D.
Professor of Economics
California State University, Hayward

April, 1999

Acknowledgements

I am indebted to many individuals and institutions who provided invaluable help in this study. Varietal Fair (Sebastopol, California) was kind enough to supply me with their database, saving me many hours of tedious data entry. Many thanks to the organizers of the various wine competitions who spent hours on the telephone describing how their judges are selected and the ways they organize their competitions. California State University, Hayward, gave me sabbatical leave and other support that encouraged me in this work. Professors Alex Cassuto, Leo Kahane Nan Maxwell, and Steve Shmanske of Cal. State, Hayward, provided valuable discussion that helped me past a number of mental blockages. Mr. Harvey Steiman of the *Wine Spectator* suggested there might be a problem with sample selection bias. Participants in the Seminar in Economic Research at California State University, Hayward provided valuable feedback on an early draft of this paper. Yet another draft was presented to the annual meetings of the Western Economic Association, July, 1998. Thanks to all who read and discussed this paper, especially Douglas S. West (University of Alberta), John H. Huston (Trinity University, San Antonio, TX), and Gregory K. Dow (Simon Fraser University). Two anonymous refereed provided valuable suggestions on an earlier draft. Special thanks to D. Romana Freimanis and Kim Wagner who discovered the Varietal Fair data in the course of a directed reading seminar at CSUH. Unfortunately, none of these individuals or institutions were inclined to accept responsibility for errors; those remain mine alone. Comments are welcome and should be directed to `tlima@csuhayward.edu`.

Abstract

This paper examines price and quality in the California wine industry using medals won in nine tasting events in 1995 as indexes of quality. For each tasting event, there were four possible medals: double gold, gold, silver, and bronze. Using stagewise and ordinary least squares regression analysis, we estimate demand curves for the 807 wines in our sample treating quality as exogenous to the supply curve. We also look at results for some wine types, including chardonnay and cabernet sauvignon. The results are largely as expected. Increased production of wine of a given quality will tend to lower the price: holding quality constant, the demand curve for wine slopes downward. The San Francisco Fair appears to be the best predictor of quality with the Dallas Morning News tasting second best.

Since the pioneering work of Chamberlin, economists have recognized that quality differences can influence supply and demand. Chamberlin called these markets monopolistically competitive; the name has stuck over the years. Unfortunately, Chamberlin's theoretical work had some serious flaws, with the result that 40 years elapsed before economists once again revisited his core ideas.[1] Led by Rosen (1974) and followed by Dixit and Stiglitz (1977), economic theorists incorporated quality[2] measures into standard supply-demand analysis. The results are well-known: quality differences can cause price differences in monopolistically competitive markets, affecting demand and/or supply. Monopolistically competitive markets are ofen segmented with different groups of buyers purchasing goods that are similar to each other but with different combinations of characteristics. The automobile market provides an excellent example of product differentiation. Those who purchase BMWs are a different group from those who purchase Ford Escorts. In the vernacular of monopolistic competition a good is simply a specific combination of characteristics in specified quantities.

Researchers who wish to measure the quantitative impact of quality differences are confronted with the difficulty of measuring quality in any of its dimensions. Thus empirical tests of monopolistic competition have been few and far between. Fortunately, proxy variables can sometimes be found that make it possible to measure some aspects of quality differences.

The study of monopolistic competition has two major schools of thought. Lancaster (1966) includes the price of a good, its quality characteristics, and the prices of similar goods in the demand function. Rosen (1974) derives a hedonic price model in which price is a function of quality characteristics in a standard demand-supply framework. This paper takes Rosen's approach.

In this paper, we apply Rosen's theoretical results to the California wine industry, performing empirical tests of the relationship between price and quality. For quality, we use medals won in each of nine different tastings. This data is available from Varietal Fair (Devine and Devine, 1996) and is published

[1] Demsetz (1972) provides an excellent critique.
[2] "Quality" refers to the usual vector of qualities that can different similar products.

annually. These tastings differ in standards, judges, and restrictions on the wines entered.[3] However, the tastings have a few things in common. Each tasting awards four possible medals: double gold, gold, silver, and bronze.[4] Each tasting invites entries from all wineries that meet the entrance requirements. And the data are made public.[5] Further, all tasting competitions are broken down by wine type (often, but not always, corresponding to the grape varietal used predominately in making the wine).

This approach corresponds to the "quality index" model. A single index (or several indexes) is used to summarize the quality characteristics of a good. In this case, the index is whether a particular wine won a specific medal at a given tasting. Since the same wine can win more than one medal, multiple quality indexes are being used. The objective of this paper is to determine which indexes are the best measures of wine quality.[6]

One way of looking at a specific judging is to consider the location of a wine in its product characteristic space. Each judge selects a wine that is the minimum "distance" from their bliss point. While different judges may well have different bliss points, the objective of this paper is to determine which tasting seems to have the greatest value in predicting consumer preferences.[7]

The results are what any economist would expect. For all wines and each wine type, the demand curve for wine slopes downward. For all wines and most wine types, some tastings were better measures of quality than others. For the overall data set, the San Francisco tastings appear to be the best measures of

[3] For example, some tastings impose a minimum quantity requirement, rejecting wines that have fewer than a specified number of cases bottled.

[4] The "double gold" medal category actually refers to special medals awarded at some of the tastings. In 1996, the Dallas Morning News tasting did not award any of these special medals. Others awarded from two (West Coast) to 21 (Riverside). The criteria for winning a special medal obviously varies greatly among the competitions. This lack of consistency will become apparent when the empirical results are examined.

[5] I owe a great debt to Varietal Fair of Sebastopol, California, who publish this data in their annual volume *California Wine Winners* and were kind enough to allow me to use their data in this study, as well as supplying it in a machine-readable format.

[6] The index is a proxy for wine quality.

[7] There is a question of causality that cannot be overlooked. On the one hand, the tastings may be predictive of consumer behavior. On the other hand, winning a medal in a particular competition may influence consumer behavior, acting as a signal to the market that a particular wine is worth buying. As is often the case, there is no apparent way to determine the direction of causation from the available data.

quality. Other tastings that yielded significant positive results were the Dallas Morning News tasting, the Orange County Fair and the New World International tasting.

Measuring Wine Quality

Everyone agrees that different wines have different characteristics. Beyond that, there is hardly any agreement about how to measure those differences. One way of looking at a wine's qualities is by component tasting to determine the levels of oak, tannin, and other components present in the wine. While this technique can yield valuable information, it does not take into account complementarities among the various components. For example, high levels of tannin in red wines are often balanced with high levels of oak to improve the wine's cellaring potential. A tasting system that focuses on individual wine components will probably not yield a satisfactory measure of a wine's quality.

Prof. Ann C. Noble has proposed a "aroma wheel" approach to wine sensory evaluation shown in Figure 1.

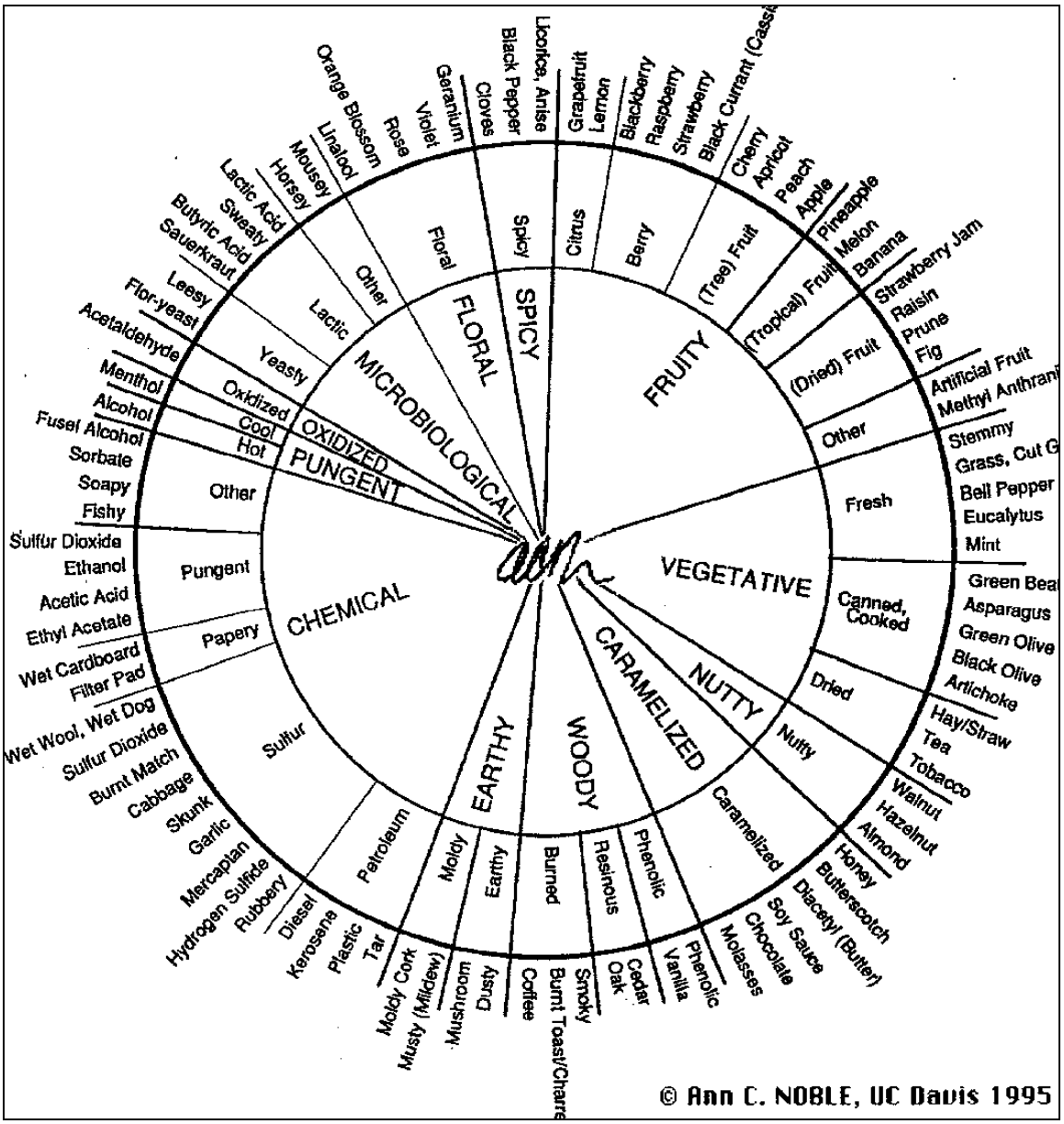

Figure 1: Noble's Aroma Wheel. Copyright © 1990 Ann C. Noble, University of California, Davis. Used by permission of Ann Noble. Colored laminated plastic wine aroma wheels may be obtained from A. C. Noble, Dept. Viticulture and Enology, Univ. California, Davis, CA 95616. Phone 530 752 0387; FAX 530 752-0382; Email acnoble@ucdavis.ed, http://wineserver.ucdavis.edu

Noble describes the aroma wheel as using "specific terms to precisely provide a photograph of flavor."[8] Her approach has the advantage of trying to model the complementarities among different components by expanding their single dimensionality into a second dimension. Unfortunately, the aroma wheel is too descriptive to be empirically useful.

Other measures of wine quality are more empirical. Oczkowski (1994) uses the quality ratings in a popular consumer wine guide (Shield and Meyer's *Penguin Good Australian Wine Guide*). The quality scale employed is the international show judging system which scores each wine on a scale with 20 points possible: 3 for color, 7 for nose, and 10 for palate. The total score is then divided by 4.0 to produce a 5 point rating scale, corresponding to the following ratings: modest (2.5), good (3.0), very good (3.5), extremely good (4.0), brilliant (4.5), and very rare (5.0). Oczkowski correctly assigns a dummy variable to each of these ratings, using these as independent variables with price the dependent variable. With the exception of the extremely good group, all coefficients have the expected sign (negative for the lowest three, positive for the highest three) and are significant at the 5 percent level.

Combris, Lecocq, and Visser (1997) use individual characteristics of each wine as evaluated by expert tasters in blind tastings. There are 16 sensory characteristics evaluated, including aromatic intensity, suppleness, flatness, fat, finish, and keeping in vault needed. We will discuss their results later. For now, it is sufficient to say that there is likely to be substantial disagreement among the jury members about some (or perhaps all) these characteristics.

The Theory of Hedonic Pricing

Following Rosen (1974), the wine market is a market for a class of commodities described by a vector of characteristics $\mathbf{z} = (z_1, z_2, ..., z_n)$. Consumers vary in their valuations of each characteristic; all consumers agree about the quantity of characteristic z_i contained in a particular wine.[9] Rosen assumes a

[8] Ann Noble, personal communication, Jan. 27, 1998.

[9] It is consumers that form the market for wine, not experts. To the extent that expert opinions of wine quality mirror or influence consumer tastes, those expert opinions can be used as an index of quality. The average consumer may not sense individual wine qualities, e.g., the amount of tannin or oak present in a specific wine. However, our database uses panels of expert tasters who can be expected to recognize individual components of a particular wine. Consumers are

large number of differentiated products are available, making the consumer's choice problem a choice from a virtually continuous set. This condition is surely met in the California wine market, with over 800 wineries producing a multitude of wines.[10]

The Consumption Decision

Each wine has a quoted market price which is the price for the particular vector of characteristics embodied in that particular wine so $p(\mathbf{z}) = p(z_1, z_2, ..., z_n)$ is the function that translates qualities into a price. Rosen assumes that the price function is an increasing function of all characteristics. This means consumers find additional units of characteristic z_i desirable, while producers will face increased costs if they increase the quantity of quality z_i in their product. Unfortunately, this ignores complementarity among product characteristics. More of a given characteristic is not always better in wine if that characteristic must be combined with other qualities to produce a given overall quality. This is a serious defect in Rosen's model. We will discuss this problem as it arises throughout this paper.

The demand function is

$$Q_d = D(p,\mathbf{z}) \qquad (2)$$

where quantity demanded is a decreasing function of price and demand is an increasing function of each element of the vector **z**. This demand function is derived from the usual utility maximization process. Again following Rosen, the utility function is $U(x, \mathbf{z})$ where x is all other goods consumed.[11] Setting the price of x equal to unity and measuring income (y) in units of x, the household budget constraint can be written as

$$y = x + p(\mathbf{z})$$

Maximizing utility subject to this (nonlinear) budget constraint requires choosing x and **z** to satisfy the budget constraint and the first-order condition

---

responding to the specific combination of characteristics in a wine, making use of a quality index (to anticipate forthcoming results) desirable.

[10] However, there may be problems when we attempt later to look at individual wine types, some of which suffer from a shortage of data.

$$\partial p/\partial z_i = p_i = U_i / U_x \qquad i = 1, ..., n$$

Optimality is achieved by purchasing a wine that both offers the desired combination of characteristics and is within the consumer's budget constraint.[12]

[11] Rosen does not make it clear whether x is a scalar or a vector. We assume x is an index of the total quality obtained from consuming all other goods.

[12] The latter condition is missing from Rosen's analysis.

Rosen notes that problems of this sort are common in urban economics and other location analysis fields. Stressing this essential relationship,[13] Rosen defines a bid function $\theta(\mathbf{z}; u, y)$ which defines an iso-utility curve

$$U(y - \theta, \mathbf{z}) = u$$

The θ function is what a consumer is willing to pay for different values of **z** to maintain a given level of utility u given their current income. θ defines a family of indifference surfaces relating **z** to its opportunity cost, namely the quantity of x foregone. Differentiate this bid function to obtain

$$\theta_i = U_i / U_x > 0$$

$$\theta_u = -1/U_x < 0$$

$$\theta_{ii} = (U_x^2 U_{ii} - 2U_x U_i U_{xi} + U_i^2 U_{xx})/U_x^3 < 0$$

These equations show that the bid function θ is an increasing function of **z** and that the marginal value of each element of **z** is positive, but increasing at a decreasing rate. In other words, diminishing marginal utility of additional units of quality holds.[14] θ_i is the opportunity cost of an additional unit of quality element i. An alternative interpretation of θ_i is as the reservation price for an additional unit of z_i.

The amount the consumer is willing to pay for **z** at a fixed utility index and income is $\theta(\mathbf{z}; u, y)$ but $p(\mathbf{z})$ is the price that must be paid in the market. Utility is maximized when $\theta(\mathbf{z^*}; u^*, y) = p(\mathbf{z^*})$ and $\theta_i(\mathbf{z^*}; u^*, y) = p_i(\mathbf{z^*})$ where **z*** and u* are optimum quantities. In other words, the optimum occurs where the $p(\mathbf{z})$ function is tangent to $\theta(\mathbf{z}; u, y)$.

Because the budget constraint is nonlinear, many of the usual comparative static results do not apply. Rosen notes that even though higher income allows the consumer to purchase more of each element of the vector **z**, that will most likely not happen. Instead, as income rises, consumers will move from one combination of qualities to another, increasing some elements of **z** while decreasing consumption of others. In the wine market, this can be easily seen as the tradeoff between wines that are ready for consumption

[13] Since used widely by a number of other authors; see Shmanske (1991) for example.

immediately versus wines that must be cellared for a significant amount of time before they are ready to drink. Wines that need aging have certain characteristics that are different from those ready for immediate consumption. Higher levels of both tannin and oak are common in red wines that require aging, for example. This example merely emphasizes Rosen's point that a consumer buying a bottle of wine is buying a particular combination of characteristics that are pleasing. Increasing the quantity of only a single characteristic may well decrease the overall utility from the bottle of wine. In other words, individual characteristics may be either substitutes or complements.

Parameterizing tastes across consumers, an individual consumer's utility function can be written as $U(x_1, \mathbf{z}; \alpha)$ where α is the parameter representing tastes; it will take on different values for different consumers.[15]

Rosen follows Houthakker (1952) to derive the income-compensated utility function $U(x_1, \mathbf{z}, m)$ where m is the number of units consumed of a wine with the characteristic vector. Once again, the budget constraint is $y = x + mp(\mathbf{z})$. The first-order conditions are:

$$\partial U/\partial m = -p(\mathbf{z})U_x + U_m = 0$$

$$\partial U/\partial z_i = -mp_i(\mathbf{z})U_x + U_i = 0$$

As Rosen shows, the implications of these first-order conditions are the same as those derived earlier: θ_i will be proportional to U_i/U_x. However, the second-order conditions are more complex. The details need not concern us here.

The Production Decision

Wineries face a basic decision: what qualities shall they incorporate into a particular bottle of wine? To a certain extent, this decision is constrained by available resources, most notably the qualities inherent in the grapes of a particular varietal - vintage year combination. How well the winery adapts to changing grape quality over the course of a number of seasons will largely determine its long-run success. However, we can

[14] However, complementarity and substitutability still may exist among characteristics since marginal utility assumes the quantities of all other characteristics are held constant. This does not rule out nonzero cross-partial derivatives.

take grape quality for a given year and varietal as a given, largely outside the control of the winery. Ashenfelter, Ashmore and Lalonde (1993) have shown that, in the French wine market, grape quality is largely a function of weather conditions, with annual rainfall playing a key role. It would be surprising if California grapes did not exhibit the same behavior. Therefore, we shall assume that grape quality is exogenous to the production decision.[16]

Following Rosen once again, let M(**z**) be the quantity of wine produced by a firm incorporating characteristic vector **z**. Rosen's model is limiting in that there are no spillover effects from one product to another. Clearly, in most wineries, that assumption will not hold, as improvements in winemaking technique that apply to one grape varietal often apply to others as well. Rosen models the firm as a collection of perfectly competitive production units, each acting independently from the other. This is potentially a major problem applying Rosen's model to the wine industry. We will follow Rosen's analysis, noting exceptions as they occur.

Each firm is assumed to produce output according to a supply function

$$P_s = S(Q,\mathbf{z}) \tag{1}$$

where **z** is a vector of product qualities. Let M(**z**) be the quantity of wine produced by a winery with characteristics **z**. Rosen assumes no economies of joint production, an assumption that does not correspond well with practice in some wineries. There are recognized economies of scale from production of more than one type of wine. For example, a bottling line is used very little during the year. The more wines a winery produces, the more intensively they can use their bottling line, reducing per unit costs.[17] Total costs will be

---

[15] x_1 is the quantity of other goods and services consumed by this individual.

[16] A more complete theoretical model would incorporate wine quality as a random variable in the production function. Unfortunately, such a model will quickly get bogged down in issues involving cross-partial derivatives; in other words, to what extent are different qualities substitutes for and complements to other qualities in production. The scope of such a modelling effort is beyond what is necessary for this paper. Note that, to the extent that wineries produce wine from grapes they grow, quality may not be exogenous to production. Vertical integration implies quality will be a consideration from bud break on the vine to the first tasting. The market for wine grapes, however, is very large and the number of wineries that produce wine only from their own grapes is small, so we will maintain the assumption that quality is exogenous.

[17] Technically, of course, the winery has simply reduced average fixed cost since most of the costs of a bottling line are fixed.

C(M, **z**; ϑ). This function is derived by minimizing the cost function subject to an output constraint. The shift parameter ϑ represents factor prices and other production function parameters. Each winery maximizes profits. Making the usual convexity assumptions, the profit function is

$$\pi = Mp(\mathbf{z}) - C(M, \mathbf{z}) \tag{2}$$

The firm maximizes this function by choozing M and **z**, giving the usual result:

$$p_i(\mathbf{z}) = C_i(M, \mathbf{z})/M \qquad i = 1, ..., n$$

$$p(\mathbf{z}) = C_M(M, \mathbf{z})$$

In other words, at the optimum combination of qualities, marginal revenue from an additional unit of each characteristic equals the marginal cost of adding that unit. Further, the total quantity of a wine produced will be that quantity that makes unit revenue p(**z**) equal marginal production cost $C_M(M, \mathbf{z})$.

At this point, Rosen develops a model of production that parallels his model of consumption. Specifically, let $\phi(\mathbf{z}; \pi, \beta)$ be the offer function. This function yields the unit price (per wine type) the firm will accept for various combinations of characteristics (**z**) at a constant level of profit when the quantities produced of each wine type are optimally chosen. The function ϕ(**...**) defines a family of production "isoprofit surfaces" which include characteristics in addition to quantity as independent variables. ϕ(**...**) can be found by eliminating M from the two functions

$$\pi = M\phi(...) - C(M, \mathbf{z})$$

$$C_M(M, \mathbf{z}) = \phi(...)$$

Solving for ϕ in the resulting equation gives a function of **z**, π, and β. Differentiating the two previous equations gives

$$\phi_i = Ci/M > 0$$

$$\phi_\pi = 1/M > 0$$

The marginal reservation price for characteristic i at constant profit (assumed increasing in z_i) is ϕ_i. Profit is maximized by maximizing the offer price subject to the constraint $p = \phi$. Maximum profit and the optimum combination of characteristics must satisfy

$$p_i(\mathbf{z}^*) = \phi_i(\mathbf{z}^*; \pi^*, \beta) \qquad i = 1, ..., n$$

$$p(\mathbf{z}^*) = \phi(\mathbf{z}^*; \pi^*, \beta)$$

Producer equilibrium is characterized by a tangency between a product characteristic isoprofit line and the market price surface (including all characteristics as variables).

The empirical content of the β parameter is important. It is anything that causes cost differences among firms. The two most obvious factors that will shift a cost function are factor prices and technology.[18] Rosen does not assume identical factor prices among all firms. This assumption is quite reasonable for the wine industry in that different wineries pay different prices for the same grape varietal – albeit from different vineyards. Wineries are looking for a specific set of characteristics in grapes, so (like the wines themselves), different wineries may value the same lot of grapes quite differently.

Market Equilibrium

Equilibrium in this market is dependent on both the quantity of output and a set of qualities that will appeal to a large enough market segment with sufficient expenditure to allow the marginal firm to make a normal accounting profit (zero economic profit). In this paper, however, the important aspect of this theory is that both the supply and demand functions depend on the vector of characteristics. For each tasting, this vector is collapsed into a single index of quality, namely the medal(s) (if any) won by a particular wine.

Rosen notes that the problem is finding a function $p(\mathbf{z})$ such that $Q^d(\mathbf{z}) = Q^s(\mathbf{z})$ for all $\mathbf{z}$ when buyers and sellers act in the ways previously described. While this sounds straightforward, it is not because both $Q^d(\mathbf{z})$ and $Q^s(\mathbf{z})$ depends on the entire function $p(\mathbf{z})$.

Consider, for example, a wine with characteristic vector $\mathbf{z}_o$. Suppose there is excess demand for this wine. In conventional markets, the price of this wine will rise. In this market, however, a rise in the price of

one wine induces substitutions and locational changes everywhere on the plane. In fact, the price of this wine may fall as consumers substitute other wines of slightly different quality for this one. Rosen handles this problem by dealing with some special cases, all of which have n=1. This treatment will simply not be sufficient for wines for which the number of characteristics is certainly greater than 1.[19] Fortunately, we can consider our dataset at this point since it matches Rosen's assumption rather well.

The data we will use is data on medals won by different wines in nine different tastings. Winning a specific medal (double gold, gold, silver, or bronze) is designated by a dummy variable. With four possible medals in each of nine different tastings, there will be 36 such dummy variables. Each can be regarded as an index of quality, corresponding quite well to Rosen's assumption of a single characteristic.[20]

Without going into too many details, Rosen's equilibrium model implies that price will be a nonlinear function of quality. If all producers must be in the market (a reasonable assumption for wineries), Rosen shows that price will be a log-linear function of quality.

Viewed this way, it should not surprise anyone that different wines win medals at different tastings. Wine is a complex product (the vector of qualities is large). Different judges assign different weights to various qualities in their evaluation of a wine. There is broad agreement on certain aspects of quality such as oak and tannin. There is also a general consensus that some wines, properly made, should include a specific characteristic. For example, the traditional vegetal aroma and flavor associated with sauvignon blancs is quite well known. However, beyond these areas of agreement are a host of subtleties that must distinguish one judge from another.

For this paper, we assume that quality evaluation is consistent within a particular tasting. Later, this assumption is extended to cover tastings of particular wine types.

---

[18] Rosen overlooks a factor that is important in wine production: economies of scale will also shift the cost function.
[19] Other empirical research in the wine industry attempts to measure many different characteristics of wine and assign a marginal value to each using statistical techniques. Much of this research relies on Rosen's theory. However, Rosen's market equilibrium model is restricted to goods with a single characteristic. Using this equilibrium theory to model wines is likely to lead to incorrect conclusions.

Previous Empirical Work in the Wine Industry

Coombris, Lecocq and Visser (1997) used the results of an independent panel of tasters to show that price and quality are not correlated in the French wine industry (specifically wines produced in the Bordeaux appellation). In that paper, they perform a hedonic regression using the logarithm of price as the dependent variable and measures of wine quality as independent variables. Subjective quality measures were obtained from a tasting study held by the *Institut National de la Consommation* (INC). Additional quality measures such as the vintage year, the group (as defined by the French government), and the rank (*grand cru, cru burgeois, or cru non classé*) were obtained from the information on the label of the bottle. In this study, twenty panelists purchases two bottles of wine each from 600 Bordeaux wineries.[21] The authors recognize that the price of wine purchased at the winery probably is greater than the market price. Discounting from suggested retail price is unlikely to be uniform across all wineries, so there will be distortions introduced by this methodology.[22] The authors conclude that the "market price of Bordeaux wine can be explained primarily by the objective characteristics appearing on the label of the bottle."[23] Ignoring the fact that the price used is probably not the market price, the authors conclude that tasting information is not the best determinant of wine price and (therefore) consumers ignore the actual characteristics of the wine when making a purchase decision.

Fortunately for the current study, California is not France. There is no vineyard classification scheme in the California market (although there has been a recent trend toward use of an appellation system). We argue that the market for California wine is considerably more competitive than the French market and (therefore) price is more likely to reflect quality. More on this shortly.

In a related study, Oczkowski (1994) estimates a hedonic price function for Australian wine. This paper uses data from The Penguin Good Australian Wine Guide (1991 and 1992 editions). The data in these

---

[20] Others have noted that Rosen's theory implies that price or quality should be regressed on a reasonably complete vector of characteristics. However, using Rosen's equilibrium theory seems to imply that an index of overall quality might be a measure more consistent with the theory.

[21] However, only 541 wines were included in the study because 59 wineries were closed when the panel visited them.

[22] This criticism applies equally well to the current study in which we use suggested retail prices as posted by the wineries.

volumes includes suggested retail price and quality assessments from the same panel of expert tasters. Additional data includes vintage year, location where grapes were grown, and cellaring potential recommendations. Oczkowski's sample of 1,604 wines is impressive, but necessary since he employs 104 dummy variables. He concludes that there are six major determinants of price: "quality, cellaring potential, grape variety/style, grape region, grape vintage, and producer size."[24]

The maintained hypothesis in this study is that there are objective measures in the form of medals won at tastings that will reflect quality. Whether this quality measure impacts price is an empirical question. It is also true that the market for California wine is not the same as the market for French wine. French winemakers have a tradition that spans centuries, while the California wine industry is barely entering its second century. With over 800 wineries in California, the industry is also quite competitive (both in price and quality). Because of this level of competition, a California winemaker is less able to rely on brand loyalty than his French counterpart. Thus, we would expect that the market for California wine would not respond to quality in the same way as the market for French wine.

Additionally, neither paper recognizes the possibility of substitution and complementarity among characteristics. For example, to have cellaring potential a red wine will often have high levels of both oak and tannin. However, a high level of either characteristic without the other is undesirable. To correctly measure this quality would require inclusion not just of a dummy variable for each characteristic, but also dummies for interactive terms, including pairs, triples, quadruples, etc. Failure to recognize this possibility is a major shortcoming of these studies. Oczkowski implicitly includes some complementarity variables by including dummies for certain combinations of vintage year and grape region; vintage year and grape variety; and year marketed, grape variety and vintage. Clearly, however, inclusion of all the various combinations of wine characteristics possible would quickly exhaust the available degrees of freedom.

We solve this problem by using indexes of wine quality. A specific medal won in a particular tasting is such an index. This abstracts from the problems of substitutes and complements among

[23] Combris, Lecocq and Visser (1997), p. 401.

characteristics by simply collapsing the vector of wine characteristics into a single summary measure of quality.

The Data

Data from the 1995 tastings was used.[25] While data is available from earlier years, it is missing quantity data. Collecting quantity figures for these tastings is more costly for the wineries and is likely to result in a less than robust sample size. There were 18 wine types entered in tastings that year. Of all wines entered, 1,745 wines won at least one medal in one tasting. Entry information required by the tasting includes estimated retail price; the suggested retail price for each wine is listed in *California Wine Winners* (Devine and Devine, 1996). Unfortunately, no quantity data is included in the *California Wine Winners* data.

To remedy this problem, in the fall of 1996 the wineries in the data set were surveyed, asking for information on the quantity of each wine originally bottled, as well as the quantity released in 1995. Quantity bottled data was received for 807 wines and quantity released data for 761. However, the data on quantity released was noisy. Some wineries interpreted the question as intended, namely the number of cases of each wine released by the winery from their inventory for sale during 1995. Some wineries replied flatly that they did not hold inventories of wine; once a wine was released, it was all available for sale at any time. Still other wineries interpreted this question to mean quantity sold during the year 1995.

The best quantity measure would be the flow supply to the market, corresponding to unit retail sales in 1995. Gathering this data would be quite costly. Wholesale sales from the winery would be a good second best measure. Anticipating difficulties (and a lowered response rate to the questionnaire), this question was not asked. Quantity bottled can serve as a legitimate proxy for the flow supply if flow supply is proportional to the stock quantity bottled. This assumption will be maintained throughout this paper.

Thus, 46 percent of the wines that won at least one medal are represented in this study with quantity bottled data. There is most likely some bias in this data in favor of larger wineries. Larger wineries usually

[24] Oczkowski (1994), p. 108.

have a larger staff, making it less costly for them to complete the questionnaire. However, it is commonly believed in the wine industry that there is no correlation (either positive or negative) between winery size and wine quality. Therefore, even though there may be some bias in responses to the questionnaire, the direction of the bias this introduces into the empirical results is uncertain.

In addition to reporting results for the 807 wines for which quantity data is available, some results will also be reported for each of the 18 wine types.[26] The number of responses for each type is shown in Table 1, along with summary statistics for price and quantity bottled. Small sample size will clearly be a problem in a number of cases.

Wine Type	n	Price		Quantity[27]	
		Mean	Std.	Mean	Std.
Chenin Blanc	14	$6.82	$1.30	27,897.5	44,834.9
Cabernet Franc	11	$14.73	$3.96	3,764.2	9,186.3
Chardonnay	145	$14.09	$4.91	43,337.5	121,297.3
Cabernet Sauvignon	158	$18.25	$10.89	18,685.7	41,611.2
Gewurtztraminer	23	$9.39	$2.41	2,783.3	3,112.4
Johannisberg Riesling	28	$11.38	$8.68	8,432.9	16,746.1
Merlot	71	$14.76	$4.18	19,781.0	48,303.9
Petite Sirah	16	$11.44	$3.07	7,643.6	10,469.8
Pinot Blanc	10	$10.90	$2.95	10,930.4	24,956.8
Pinot Noir	55	$16.06	$6.32	6,726.8	7,253.2
Red Meritage	29	$25.45	$9.42	4,575.3	5,965.6
Sauvngnon Blanc	72	$9.42	$2.27	18,076.1	27,739.1
Semillon	9	$9.61	$2.32	5,730.3	9,324.0
Sparkling Wine	42	$16.98	$7.04	54,093.8	230,475.4
Syrah	18	$16.89	$7.11	2,262.62	2,303.69
White Meritage	5	$16.40	$2.07	2,324.8	1,337.7
White Zinfandel	10	$5.75	$0.54	77,821.5	84,055.3
Zinfandel	91	$12.00	$3.77	10,047.8	21,075.8
Entire sample	807	$14.49	$7.61	21,656.7	79,922.2

Table 1

The tastings themselves are a possible source of bias. Tastings begin in January and end in July. Many wines entered in the early competitions are sold out by the time the later competitions begin. While this undoubtedly introduces a bias in the data, the only way we can know the direction of this bias is to know

[25] Much of the material in this section is drawn from *California Wine Winners* [1996].
[26] *California Wine Winners* does not include all wine types that won a medal in any tasting (e.g., Garnay, Grenache and Port are all excluded). Only those types that are included in most of the tastings are also included in this volume and this study.
[27] Quantity bottled, gallons.

which competitions are the best predictors of quality. In that direction lies circular reasoning; we will simply forge ahead, having faced this issue squarely, acknowledged its potential importance, and realized there is little that can be done about it.

Another potential source of bias is sample selection. Not all wines are entered in every competition. If by some chance, only high-quality wines are entered in one competition, that will bias the statistical results. Again, there is no way to tell whether this is a problem, but it must be noted as a potential difficulty.[28]

Entering a competition is costly for the winery. Obvious direct costs include entry fees and the time and effort expended on getting wine to the tasting. Less obvious is the cost of the wine itself. In many competitions, winning entries must donate a quantity of wine to the fair. For example, the San Francisco Fair requires gold medal winners to reserve up to 10 cases to sell to the fair. This means smaller wineries are less likely to enter the San Francisco tasting, biasing the sample for that tasting somewhat. As *California Wine Winners* notes, "Many of these small producers sell out all their wines every year."[29] There is little incentive for a winery in that fortunate situation to bother entering any competitions at all, especially smaller wineries with limited production available for sale. Table 2 gives more details about the requirements for each competition.

Varietal Fair also calculates a point total for each wine. Points are assigned as follows: double gold, 7; gold, 5; silver, 3; and bronze, 1. Interestingly, point totals for each winery are also calculated. Based on these point totals, the "best" winery in California is Kendall-Jackson with 291 points. Second "best" is Geyser Peak (281), while Fetzer is third (273).[30]

---

[28] I am indebted to Mr. Harvey Steiman (Editor at large, *Wine Spectator*) and Prof. Orley Ashenfelter (Princeton University) for valuable discussion on this subject.

[29] *California Wine Winners* [1996], p. 5.

[30] *California Wine Winners* [1996], p. 118. Note that this ranking is not very meaningful. The wineries with the most total points are likely to be those that enter a large number of wines in many competitions. A more meaningful measure is points per entry. Unfortunately, *California Wine Winners* only reports wines that won medals, not all wines entered.

COMPETITIONS	ENTRIES # Wines Wineries In Calif.	MEDALS Total # From CA In book	AWARDS Double gold Gold Silver Bronze	1996 Entry Dead-line Judging Dates	ENTRY Fee Bottles to send Minimum produced Minimum inventory at judging	WINNERS Require-ments after judging	JUDGING SCOPE Geographic Area Covered Judging Categories Entry Restrictions
Los Angeles County Fair P.O. Box 2250 Pomona, CA 91769 (909) 623-3111	1845 364 284	651 513 386	6 89 143 148	May 15 June 20-23	$25.00 Six 120 gal. "Some"	Golds only to sell 2-3 cases to fair	Any wine from any of the American continents. Some judged in vintage groups. Limit of one entry per class.
Orange County Fair P.O. Box 11059 Costa Mesa, Ca 92627 (714) 546-8664	2305 ? ?	1025 1025 880	10 114 312 444	May 15 June 1-2	No charge Six None "Some"	All wineries invited to pour at the fair	California wines available in Orange Co. Judged in price categories. Not all entries voluntary. Current releases only.
Farmers Fair, Riverside 18700 Lake Perris Dr. Perris, Ca 92571 (909) 657-4221	1504 296 ?	717 593 485	21 39 147 278	Mar. 25 May 5-6	$24.00 Four 500 gal. 50 cases	All entries invited to pour at the fair	Any U.S. wine. Same judged in vintage groups.
San Francisco Fair 455 Golden Gate Ave., #2095 San Francisco, CA 94102 (415) 703-2729	2150 497 313	733 502 408	15 26 131 236	May 31 June 15-16	$50.00 Five None 50 cases	Golds to reserve up to 10 cases to sell to the fair	Any wine in the world. No limit on number of entries. Wines judged in vintage groups.
Dallas Morning News P.O. Box 38643 Dallas, TX 75328 (214) 319-7000	1484 350 ?	493 371 298	0 32 95 171	Mid. Dec. Jan. 27-28	$55.00 Four 120 gal. 5 cases	Golds to give 5 cases for tastings.	Any U.S. wine. Limit of 3 entries per category.
California State Fair P.O. Box 15649 Sacramento, CA 95852 (916) 263-3159	1724 386 386	676 676 534	18 62 211 243	June 7 July 12-14	$25.00 Six 180 gal.	Reserve to sell up to 10 cases for the fair.	Any California wine. Wines judged in 10 geographical groups. Limit of 2 entries per class per region.
New World International P.O. Box 5306 Diamond Bar, CA 91765 (800) 845-9463	1700 401 309	850 680 584	14 140 215 215	Jan. 25 Feb. 11-12	$35.00 Six None "Some"	All entries invoted to pour at awards	Any wine from the New World. All wines judged in price groups. Must be available to buy in at least one state.
Reno-West Coast Competition P.O. Box 837 Reno, NV 89504 (702) 827-7618	1314 261 225	687 610 541	2 58 162 319	Early April May 8-10	$17.00 Six 500 gal. 150 cases	Golds are required to pour at events	Wines from CA, ID, OR, WA, NV and AZ. Some grouped in vintage/price. No limit on entries.
San Diego Competition P.O. Box 880881 San Diego, CA 92168 (619) 421-9463	1693 381 281	709 590 504	3 63 138 300	April 12 April 27 & 28	$30.00 Four 300 gal. No min.	All winners to donate 1 case for charity sale	Any U.S. vinifera wine. Some judged in vintage groups. No limit on number of entries except same wine in 2 classes.

Source: *California Wine Winners* [1996], pp. 6-7. Copyright, 1996, Varietal Fair. Reproduced with permission.

Table 2

Judge Selection

One source of differentiation among the nine competitions is the methodology for selecting judges. We would expect that more professional judging panels would be better able to predict wine quality. Rather than trying to quantify professionalism, we conducted a telephone survey of eight of the nine competitions to find out how judges were selected.[31] The results were far more interesting than we ever expected. Each competition has its own technique for selecting panels of judges. However, some common threads emerged.

Many competition organizers look for judges who can work well on a panel, rather than simply judges that have well-developed palates. (One competition organizer said creating a judging panel was similar to assembling a seating chart for a dinner party.) Most competitions have some sort of screening mechanism. The California State Fair is notable in this regard, as they encourage judges to take a one-day course at the University of California Davis, followed by a test to screen judges. Many competitions try to keep good judges from year to year. Many competition organizers look for people they've judged with in the past.

Here are some comments from specific competitions.[32]

The Los Angeles County Fair competition is organized by Ms. Mary Ellen Cole. They have a wine steering committee which makes suggestions to Prof. Bob Small, Chair of the Department of Hospitality and Tourism at California Polytechnic University, San Luis Obispo. Prof. Small selects the judges based on his experience.

The Orange County Fair selects judges from people in the industry.

The Farmers Fair (Riverside, CA) competition is organized by Ms. Nancy Johnston. Mr. Dan Berger is in charge of selecting the judges. The most important criterion is that the judge has served on a tasting panel with Mr. Berger in the past so that he knows their tasting and judging style. They look for ability and experience in judging.

[31] We were unable to contact the Reno West Coast competition.

The San Francisco Fair competition is organized by Mr. Anthony Dias-Blue with assistance from Mr. David Gadd.[33] They try to select an international panel of judges with a broad range of experience. They specifically look for expertise in various areas. Judging panels are organized by wine type; the organizers try to get people whose expertise corresponds to the wine being tasted. They also try to get a cross-section of journalists and wine professionals. Judges must have some experience judging wine competitions. The organizers try to mix less experienced judges with several people who are very experienced. The competition requires that opinions of a panel are unanimous around the table.

The Dallas Morning News competition is organized by Ms. Rebecca Murphy. She selects judges with whom she has judged in the past. The judges are drawn from wine writers, restaurant owners, and wine shop owners. Ms. Murphy looks for people with judging experience, but tries to include a few novices.

The California State Fair competition in Sacramento is organized by Ms. Kem Pence. Judges must pass a qualifying exam to get on the list of people eligible to judge the competition. Potential judges are encouraged to take a class at the University of California, Davis.[34] After taking the course, individuals are invited to take the test. The test itself begins with a tasting of wines to see if the judges can detect components and flaws in the wines.[35] In the next stage, a flight of eight chardonnays and eight cabernets are tasted three times each in a different sequence, looking for consistency in judging. Note that passing this test only puts a prospective judges name on the list of those eligible to judge. Ms. Pence, like most other organizers, looks for those who can work well with a panel. The California State Fair wine competition is unique in that wines are judged by region of origin, with the "best of show" award pitting the top wines from each region.

---

[32] These comments are based on my notes from telephone conversations with the competition organizers. All were extremely helpful. If there are errors in what follows, said errors result from my misunderstanding or bad note taking, not from their lucid descriptions of the process.

[33] Actually, there is no longer a San Francisco County Fair since the state cut off funding for this event. The wine competition continues as the San Francisco International Wine Competition. See http://www.sfwinecomp.com for details.

[34] The U.C. Davis wine program is world famous.

[35] Ms. Pence stressed that this is not a multiple choice test. Participants must identify the component or flaw with no prompting from the exam or the examiners.

The New World International competition is organized by Mr. Jerry Mead. Judges are selected based on his experience in the industry. He looks for people with whom he has tasted and judged in the past whose palates he knows and respects. In Mr. Mead's opinion, the biggest problem for a judge is a lack of self-confidence working with a panel. He believes there is a tendency among some judges to vote every wine a silver or bronze medal to avoid embarrassment. He, on the other hand, wants strongly opinionated judges who aren't afraid to give medals. His other main concern is judges who are too frugal. Mr. Mead believes the reason for the existence of wine competitions is to alert consumers to new wines they have not tried. He also believes wine quality has improved so drastically over the last 20 years that maintaining some arbitrary percentage of gold medals (for example) makes no sense. Noting that the wines entered in competitions are already pre-screened by the wineries, he encourages judges to award many medals. Unlike most other competitions, wines in the NWI competition are judged in price groups. The judges determine the gold medals in each wine type - price category, then pit the four price category winners against each other.

The San Diego competition[36] is organized by Mr. Russ St. Jean and Mr. David Lake. They try to replace about one-third of their judges each year, retaining judges for several years once they have served on a panel. There are 33 judges organized into 11 panels of three each. Mr. St. Jean and Mr. Lake review a list of candidates, trying to get a group that is about one-third each winemakers, members of the wine trade, and wine writers and aficionados. They try to have one winemaker on each panel to supply expertise. They also try to geographically diversify their panels, but that is dependent on their budget for a given year. Like most other competitions, they try to get people who have worked together in the past, considering personalities and temperaments.

Estimation Techniques

There are 36 possible medals that each wine can win. In addition, we face the usual problem of simultaneous equation bias since both supply and demand determine price and quantity. We will maintain

[36] For more information, visit http://www.sdnwc.org.

two hypotheses. First, we assume that the price and quantity data are drawn from markets in equilibrium. Second, we assume that shifts in the demand curve are only caused by changes in product quality.

The first assumption is not too troubling. However, those familiar with the wine industry will immediately recognize potential problems with the second assumption. Many factors can cause the demand curve for wine to shift, including marketing, promotion, and distribution. An otherwise excellent wine with limited distribution is less likely to command a lower price than a wine of equal quality and greater distribution. While at least a few of these variables are amenable to quantitative measurement (marketing expenditures, for example), gathering the data would be very costly both for the researcher and the winery. In addition, since many wineries are privately held, they would be reluctant to part with financial information of the type that would be useful. We will maintain the hypothesis that the sole cause of shifts in the demand curve is variations in quality. Figure 2 illustrates this point.

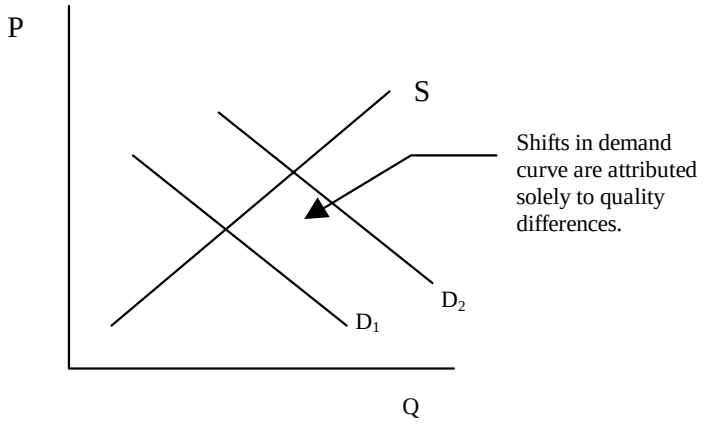

Figure 2

The specific estimation technique used is a variation of stagewise least squares (Draper and Smith, 1966). Stagewise least squares is, in turn, a variant of two-stage least squares in which the "best" combination of independent variables is selected at each stage of the regression.[37] Clearly this procedure is suited to situations in which there are a large number of independent variables with no way to select the subset most likely to be related to the dependent variable based on theoretical considerations alone.

The variation of stagewise least squares used in this paper is to perform a straightforward stepwise regression at each stage. In the first stage, quantity is regressed on each of the medal dummies as well as the summary statistics for each wine. The summary statistics for each wine are calculated as a number of points for each tasting, with a double gold medal[38] worth 7 points, a gold 5, a silver 3, and a bronze 1. These summary statistics are included both for each tasting and as the total number of points for all tastings.[39] This first stage regression corrects for supply curve shifts, leaving us free to estimate a true demand curve in the second stage.

Note that medals won and total points are predetermined variables since quantity bottled must be done with little information on wine quality.

In the second stage, the fitted value from the first stage is forced into the regression as the first independent variable. The stepwise procedure is then allowed to select among the various dummy variables for medals won at the different tastings. Both price and log(price) are used as dependent variables as suggested by Rosen.

Empirical Results

[37] The stagewise regression procedure is straightforward, if somewhat computationally expensive. At each stage, regressions are run using all possible combinations of independent variables. The usual criterion for selection of the best regression is the one with the highest F-statistic. Clearly, this procedure is appropriate for a situation in which there are many independent variables with no apparent way to select those most likely to be related to the dependent variable using theory alone.

[38] See previous footnote. This category includes any special medals over and above gold. However, as Devine and Devine note (1996, p. 5), "We do not include the best of region and best of region varietal awards from the [California] State Fair for these [point totals]."

[39] For those interested in this statistical measure, the California winery that amassed the highest point total was the Kendall-Jackson Winery, Santa Rosa, with 291 points. Second was Geyser Peak, Geyserville (281), followed by Fetzer Vineyards, Hopland (273). Note, however, that these point totals are somewhat less meaningful than one might think since one of the key determinants of total points is the number of wines and the number of tastings entered.

We examine the data two different ways. First, our modified stagewise procedure is used on all the wines in the sample (n=807). Second, each wine type is analyzed separately to see whether particular tasting events are better at evaluating specific wine types.

Overall Results (n=807)

The first results are for all wines combined. In the first stage, the two instrumental variables selected were SFNO, the total number of points won by the wine at the San Francisco Fair and NZIP, the numeric value of the postal Zip code.[40] The equation is

```
QBOTTLED = -570,926.51 - 3,672.07 SFNO + 6.27 NZIP
                         (2,202.82)     (3.34)
R2 = 0.0043            F = 2.86
(Numbers in parentheses are standard errors of the coefficient.)
```

In the second stage, fitted values from this regression are forced into the regression as the first independent variable (QBOTHAT). The resulting equation is:

```
PRICE = 15.32 - 0.0000856 QBOTHAT - 1.78 RIVBRNZ + 9.10 SFGOLD
                (0.0000446)          (0.68)         (1.99)

        +  2.12 SFSILV + 3.86 SFBRNZ + 5.78 DMNGOLD
          (0.96)        (0.76)        (2.76)

        +  1.63 DMNBRNZ + 3.26 NWIGOLD
          (0.86)          (1.02)

R2 = 0.10              F = 11.82
(Numbers in parentheses are standard errors of the coefficients.)
Dummy variables included in this model:
RIVBRNZ:  Bronze medal, Farmer's Fair, Riverside (CA)
SFGOLD, SFSILV, SFBRNZ:  Gold, Silver, and Bronze medals, San Francisco
Fair
DMNGOLD, DMNBRNZ:  Gold and Bronze medals, Dallas Morning News
NWIGOLD:  Gold medal, New World International
```

There are several issues raised by the above model that need discussion. First, despite its high standard error, the sign of the quantity variable (QBOTHAT) is negative. This is what we would expect since we are estimating a series of demand curves. Second, winning a bronze model at the Riverside tasting seems to have a negative impact on price. Remember, however, the implicit assumption that all other independent variables are held constant. This means a wine that has won gold medals at the San Francisco, Dallas Morning News, and New World International events, and several other medals, is likely to have a somewhat lower price if it wins a bronze medal at Riverside. Third, the size of the coefficients is

[40] The selection of the latter variable (and its positive coefficient) can be attributed to the fact that northern California includes the Napa and Sonoma regions which produce a great deal of wine. Zip codes in California generally increase from south to north.

interesting. Apparently winning a gold medal at the San Francisco tasting has the greatest quantitative impact on a wine's price. The coefficient of 9.10 indicates that the price will be boosted by an average of $9.10 from a gold medal in this event. A gold medal in Dallas will boost the price by an average of about $5.78. Overall, winning a medal in San Francisco appears to have the greatest significant impact on a wine's price.

When log(price) is used as the dependent variable in the second stage, the results are:

```
LNPRICE = 2.56 - 0.0000011 QBOTHAT - 0.1832 LAGOLD + 0.1115 OCSILV
                (0.0000024)          (0.0769)        (0.0444)

        + 0.3025 RIVPLUS + 0.1964 SFGOLD + 0.0882 SFBRNZ
          (0.1647)         (0.1156)        (0.0451)

        +  0.3812 SDPLUS
           (0.2171)

R2 = 0.03              F = 3.77
(Numbers in parentheses are standard errors of the coefficients.)
Dummy variables included in this model:
RIVPLUS:  Double gold medal, Farmer's Fair, Riverside (CA)
SFGOLD, SFSILV:  Gold and Silver medals, San Francisco Fair
DMNGOLD, DMNBRNZ:  Gold and Bronze medals, Dallas Morning News
LAGOLD:  Gold medal, Los Angeles
OCSILV:  Silver medal, Orange County
SDPLUS:  Double gold medal, San Diego
```

With no theoretical basis for choosing the linear or log-linear functional form, we instead look at the statistical results. Comparing the F-statistics of these two regressions, we see that the linear functional form gives superior results. (Naturally, we cannot compare the R^2 of the linear and log-linear functional forms.) Thus, for the overall results, a linear model seems to describe the market better than a log-linear form. However, it is interesting to note that winning a gold or bronze medal at the San Francisco Fair contributes positively to price in both functional forms.

The very low R^2 in the first stage of this procedure suggests that two-stage least squares may not be appropriate for this data. Note that the quantity of a particular wine bottled is largely determined by the quantity of grapes purchased and crushed. Wine quality and price at that point in the production process are

highly uncertain variables. All this suggests treating quantity bottled as a predetermined variable, using ordinary least squares.[41] Naturally, the stepwise procedure will be used. The results are:

[41] The two-stage least squares procedure was also used for each wine type. In every case, equally good or better results were obtained using ordinary least squares. Therefore, only the OLS results are reported in this paper.

```
PRICE = 13.64 - 0.00000881 QBOTTLED + 6.0792 LAPLUS
               (0.00000318)          (3.3000)

      - 1.7582 RIVBRNZ + 10.4938 SFGOLD
       (0.6733)          (1.8334)

      + 2.9023 SFSILV + 4.0800 SFBRNZ + 5.6201 DMNGOLD
       (0.8636)        (0.7533)        (2.7487)

       + 1.8690 DMNBRNZ + 2.8217 NWIGOLD - 1.6310 NWISILV
        (0.8630)         (1.0392)         (0.8815)

R2 = 0.1172           F = 10.57
(Numbers in parentheses are standard errors of the coefficients.)
Dummy variables included in this model:
LAPLUS:  Double gold medal, Los Angeles
RIVBRNZ:  Bronze medal, Farmer's Fair, Riverside (CA)
SFGOLD, SFSILV, SFBRNZ:  Gold, Silver, and Bronze medals, San Francisco
Fair
DMNGOLD, DMNBRNZ:  Gold and Bronze medals, Dallas Morning News
NWIGOLD, NWISILV:  Gold and Silver medals, New World International
```

There are two major differences between the ordinary least squares results and the two-stage least squares. The OLS regression includes the double gold medal at the Los Angeles tasting with a fairly large positive coefficient. The OLS regression also includes the silver medal at the New World International tasting with a negative coefficient. The R^2 and F statistic are comparable to the stagewise procedure.

Next, let us look at the results of the OLS procedure using a log-linear functional form:

```
LNPRICE = 2.4994 - 0.00000067 QBOTTLED + 0.3508 LAPLUS
                  (0.00000018)          (0.1880)

      + 0.1039 OCGOLD + 0.0916 OCSILV
       (0.0535)        (0.0428)

      - 0.0932 RIVBRNZ + 0.4887 SFGOLD
       (0.0389)         (0.1052)

      + 0.2007 SFSILV + 0.2305 SFBRNZ + 0.3018 DMNGOLD
       (0.0495)        (0.0433)        (0.1572)

       + 0.1224 DMNBRNZ + 0.1755 NWIGOLD - 0.1317 WCGOLD
        (0.0491)         (0.0594)         (0.0715)

       - 0.0965 WCSILV + 0.09819 SDSILV
        (0.0499)        (0.05646)

R^2 = 0.1313           F = 8.55
(Numbers in parentheses are standard errors of the coefficients.)
Dummy variables included in this model:
LAPLUS:  Double gold medal, Los Angeles
OCGOLD, OCSILV:  Gold and Silver medals, Orange County Fair
RIVBRNZ:  Bronze medal, Farmer's Fair, Riverside (CA)
SFGOLD, SFSILV, SFBRNZ:  Gold, Silver, and Bronze medals, San Francisco
   Fair
DMNGOLD, DMNBRNZ:  Gold and Bronze medals, Dallas Morning News
NWIGOLD:  Gold medal, New World International
WCGOLD, WCSILV:  Gold and Silver medals, Reno-West Coast Competition
SDSILV:  Silver medal, San Diego Fair
```

These results seem to indicate that there is little to be gained by using stagewise least squares. Certainly, any possible small gains are not worth the additional cost. While stagewise least squares were used in all the results reported after this point, the result was uniformly the same: ordinary least squares performed as well with no apparent loss of robustness. Therefore, only the OLS results will be reported after this.

At the same time, we should attempt to determine whether the type of each wine has any measurable influence on price. We created 18 dummy variables, one for each wine type. An ordinary stepwise regression was then run. The resulting equation is shown below.

```
PRICE = 14.49 - 0.0000088 QBOTTLED + 9.6388 OCPLUS + 1.6768 OCGOLD
              (0.0000028)          (4.5018)        (0.8286)

        - 0.9586 OCBRNZ - 1.5993 RIVBRNZ + 9.4278 SFGOLD
         (0.5651)        (0.5962)         (1.6238)

        +  2.1915 SFSILV + 3.1858 SFBRNZ + 1.5479 DMNBRNZ
          (0.7695)        (0.6728)        (0.7677)

        +  2.3735 NWIGOLD - 1.4085 NWIBRNZ - 7.6331 ISCB
          (0.9039)         (0.7811)         (1.7253)

        +  3.6771 ISCS - 5.0110 ISGW - 2.8307 ISJR
          (0.6177)      (1.3676)      (1.2556)

        -  3.1384 ISPS - 4.4970 ISPB + 8.5073 ISRM
          (1.6290)      (2.0380)      (1.2510)

        -  5.8018 ISSB - 6.1727 ISSM - 8.2020 ISWZ
          (0.8356)      (2.1498)      (2.0366)

        -  3.1541 ISZN
          (0.7524)

R^2 = 0.33             F = 17.63
(Numbers in parentheses are standard errors of the coefficients.)
Dummy variables included in this model:
RIVBRNZ:  Bronze medal, Farmer's Fair, Riverside (CA)
SFGOLD, SFSILV, SFBRNZ:  Gold, Silver, Bronze medals, San Francisco Fair
DMNBRNZ:  Bronze medal, Dallas Morning News
OCPLUS, OCGOLD, OCBRNZ: Double gold, Gold, Silver medal, Orange County
NWIGOLD, NWIBRNZ:  Gold, Bronze medals, New World International
ISCB:  Dummy variable, 1 if chenin blanc, 0 if not
ISCS:  Dummy variable, 1 if cabernet sauvignon, 0 if not
ISGW:  Dummy variable, 1 if gewurtztraminer, 0 if not
ISJR:  Dummy variable, 1 if johannisberg riesling, 0 if not
ISPS:  Dummy variable, 1 if petite sirah, 0 if not
ISPB:  Dummy variable, 1 if pinot blanc, 0 if not
ISRM:  Dummy variable, 1 if red meritage, 0 if not
ISSB:  Dummy variable, 1 if sauvignon blanc, 0 if not
ISSM:  Dummy variable, 1 if semillon, 0 if not
ISWZ:  Dummy variable, 1 if white zinfandel, 0 if not
ISZN:  Dummy variable, 1 if zinfandel, 0 if not
```

Of the 18 wine type dummies, the stepwise procedure selected eleven for inclusion, indicating that wine type is an important predictor of wine price differentials. Note the sign of the coefficients of these

dummies. In every case except cabernet sauvignon, the coefficient is negative, indicating that wines of those types have lower than average prices. The positive coefficient for the cabernet sauvignon dummy indicates cabernets are priced somewhat above average.

Also note that many of the medal variables selected by this procedure are the same as those selected by the two-stage procedure earlier. In particular, the San Francisco, Dallas Morning News, and New World International tastings appear to have significant impacts on price in both regressions. However, the ordinary least squares regression includes several additional variables, notably Orange County. In addition, winning a bronze medal at the Riverside tasting has a negative impact on price in both regressions.

Results for Wine Types

Some wine types are likely to cause statistical problems due to the small number of observations. With this as a caveat, we proceed to examine the impact of tastings on the demand for each type. Somewhat arbitrarily, we will first look at the results for the two wines with over 100 observations: chardonnay and cabernet sauvignon. We will then look at sample sizes between 50 and 100, followed by a few comments on those wines with fewer than 50 observations. For each wine type, quantity bottled was forced into the regression as an independent variable. The statistical software then selected dummy variables for medals won using the usual stepwise regression procedure. While both the linear and log-linear functional forms were estimated, little additional information was gained from using the log-linear form. Therefore, only the linear regression results are reported.

Chardonnay (n=145)

The estimated equation is:

```
PRICE = 13.81 - 0.0000066 QBOTTLED + 10.2131 SFGOLD + 4.9081 DMNSILV
               (0.0000031)           (3.2501)        (2.0663)

        + 11.2593 SACPLUS + 3.2954 WCGOLD
          (4.5480)          (1.6506)

R2 = 0.1778           F = 6.01
(Numbers in parentheses are standard errors of the coefficients.)
Dummy variables included in this model:
SFGOLD:  Gold medal, San Francisco Fair
DMNSILV:  Silver medal, Dallas Morning News
SACPLUS:  Double gold medal, Sacramento
WCGOLD:  Gold medal, West Coast
```

Next the results of the log-linear form:

```
LNPRICE = 2.5367 - 0.00000053 QBOTTLED + 0.2779 OCGOLD
                  (0.00000022)          (0.1124)

        + 0.4718 SFGOLD + 0.1806 SFSILV + 0.2958 DMNSILV
          (0.2311)        (0.0957)        (0.1452)

        +  0.1331 SDBRNZ  - 0.6082 RIVPLUS
          (0.0675)         (0.3368)

R2 = 0.2020           F = 4.96
(Numbers in parentheses are standard errors of the coefficients.)
Dummy variables included in this model:
OCGOLD:  Gold medal, Orange County
SFGOLD, SFSILV:  Gold and Silver medals, San Francisco Fair
DMNSILV:  Silver medal, Dallas Morning News
SDBRNZ:  Bronze medal, San Diego
RIVPLUS:  Double gold medal, Farmer's Fair, Riverside (CA)
```

There is little reason to prefer one functional form over the other. Winning a gold medal in San Francisco or a silver medal in Dallas seems to be a good predictor of chardonnay quality.

Cabernet Sauvignon (n=158)

Comparing the linear and log-linear functional forms, the linear form has an F statistic of 7.19 while the log-linear form has an F of 7.56. As was the case with the chardonnay results, there is clearly not much evidence to choose one form over another, so we will report the results of both. First, the results of the linear form:

```
PRICE = 18.32 - 0.000040 QBOTTLED + 32.0549 SFGOLD + 7.8959 SFBRNZ
               (0.000019)           (10.1617)        (2.4239)

        - 4.7454 NWIBRNZ
         (2.5354)

R2 = 0.1583           F = 7.19
(Numbers in parentheses are standard errors of the coefficients.)
Dummy variables included in this model:
SFGOLD, SFBRNZ:  Gold and bronze medals, San Francisco Fair
NWIBRNZ:  Bronze medal, New World International
```

Next the results of the log-linear form:

```
LNPRICE = 2.8327 - 0.0000032 QBOTTLED - 0.2060 RIVBRNZ
                  (0.0000008)           (0.0948)

      + 1.1100 SFGOLD + 0.2644 SFSILV + 0.2731 SFBRNZ
       (0.4212)        (0.1237)        (0.1022)

          - 0.2007 NWIBRNZ
           (0.1057)

R2 = 0.2311                 F = 7.56
(Numbers in parentheses are standard errors of the coefficients.)
Dummy variables included in this model:
RIVBRNZ:  Bronze medal, Farmer's Fair, Riverside (CA)
SFGOLD, SFSILV, SFBRNZ:  Gold, Silver, and Bronze medals, San Francisco
Fair
NWIBRNZ:  Bronze medal, New World International
```

One thing is clear from these results: winning a gold, silver, or bronze medal at the San Francisco Fair is a good measure of quality. Interestingly, winning a bronze medal at the Riverside or New World International events may measure lower quality as evidenced by the negative sign of the coefficient in the log-linear regression. However, since only one of the two was selected in the linear regression, these results are at least somewhat suspect. In addition, the coefficient for a bronze medal at New World International is not significant at the 5 percent level, making that result even more suspect.

Intermediate Sample (50 - 100 observations)

Merlot (n=71)

Merlot is a red wine. In Bordeaux, merlot is blended with cabernet sauvignon to add depth and character to the wine. Over the last 20 years, merlot has developed a following of its own in the world market. With 71 observations, there should be enough degrees of freedom to allow reasonable statistical confidence. However, the only variable that is included in the final regression is QBOTTLED. It is, at least, statistically significant. The resulting equation is:

```
PRICE = 15.34 - 0.0000296 QBOTTLED
                (0.0000098)

R2 = 0.1164                  F = 9.09
(Numbers in parentheses are standard errors of the coefficients.)
```

The log-linear results are:

```
LNPRICE = 2.6870 - 0.0000026 QBOTTLED + 0.1941 DMNSILV
                   (0.0000007)          (0.1133)

R2 = 0.2141            F = 9.26
(Numbers in parentheses are standard errors of the coefficients.)
DMNSILV:  Silver medal, Dallas Morning News
```

We can safely say that this approach doesn't explain much about the merlot market. While the log-linear model is clearly the superior functional form, the statistics in both cases are simply too weak to use the model for any sort of predictive purposes. We can cautiously say that winning a silver medal at the Dallas Morning News tasting may add to the perception of quality in the market.

Pinot Noir (n=55)

Pinot noir is also a red wine. It is widely used in the French Rhône district. In the U.S. pinot noir is known as a difficult grape to vinify. However, Oregon wineries are known for their ability to handle this prima donna. Randall Graham of the Bonny Doon Winery (Felton, CA) is also famous for his ability to produce superior pinot noirs.

The linear equation is:

```
PRICE = 13.76 - 0.0001181 QBOTTLED + 4.4570 LASILV + 5.3531 OCSILV
               (0.0000920)           (2.0849)        (1.9334)

       + 12.4570 SFGOLD + 4.8837 DMNSILV + 4.5419 SACSILV
         (5.2103)         (2.89126)        (1.7090)

       - 9.3034 SDPLUS + 4.6975 SDSILV
         (5.1658)        (2.3150)

R2 = 0.5404           F = 6.76
(Numbers in parentheses are standard errors of the coefficients.)
LASILV:  Silver medal, Los Angeles Fair
OCSILV:  Silver medal, Orange County Fair
SFGOLD:  Gold medal, San Francisco fair
DMNSILV:  Silver medal, Dallas Morning News tasting
SACSILV:  Silver medal, California State Fair
SDPLUS, SDSILV:  Double gold and silver medals, San Diego tasting
```

The log-linear results are

```
LNPRICE = 2.5901 - 0.0000088 QBOTTLED + 0.3686 LASILV
                  (0.0000063)          (0.1360)

           + 0.2599 OCSILV + 0.2512 SACSILV + 0.3539 SDSILV
             (0.1265)        (0.1089)         (0.1565)

R2 = 0.3848                F = 6.13
(Numbers in parentheses are standard errors of the coefficients.)
LASILV:  Silver medal, Los Angeles County Fair
OCSILV:  Silver medal, Orange County Fair
SACSILV:  Silver medal, California State Fair
SDSILV:  Silver medal, San Diego tasting
```

In this case, the problems are intriguing. Even though the linear functional form has a slightly higher value for the F statistic, the negative coefficient of the double gold San Diego tasting dummy is troubling. We can say with quite a bit of confidence that silver medals almost anywhere are good measures of quality, a result that is intriguing (to say the least). Silver medal dummies for Los Angeles, Orange

County, the California State Fair, and San Diego all are significant in both the linear and log-linear functional forms.

Sauvignon Blanc (n=72)

Sauvignon blanc is a white wine. It is sometimes called the poor man's chardonnay. Many sauvignon blancs are known for their vegetal aromas; asparagus is a common description.

The linear equation is:

```
PRICE = 9.4076 - 0.00000083 QBOTTLED + 4.5933 OCPLUS
                (0.00000853)          (2.0091)

       - 3.0188 WCGOLD + 4.6045 SDSILV
        (1.0244)        (1.4278)

R2 = 0.2742           F = 6.3301
(Numbers in parentheses are standard errors of the coefficients.)
OCPLUS:  Double gold medal, Orange County Fair
WCGOLD:  Gold medal, Reno-West Coast Competition
SDSILV:  Silver medal, San Diego Fair
```

The log-linear results are:

```
LNPRICE = 2.2210 - 0.00000003 QBOTTLED + 0.4180 OCPLUS
                  (0.00000084)          (0.1983)

           - 0.4149 WCGOLD + 0.4150 SDSILV
            (0.1011)        (0.1409)

R2 = 0.3184                F = 7.83
(Numbers in parentheses are standard errors of the coefficients.)
OCPLUS:  Double gold medal, Orange County Fair
WCGOLD:  Gold medal, Reno-West Coast Competition
SDSILV:  Silver medal, San Diego Fair
```

The linear and log-linear forms give about the same results. Further, all three dummy variables are included in each regression. It appears that winning a double gold medal at Orange County or a silver medal in San Diego contributes positively to quality. Winning a gold medal at Reno-West Coast contributes negatively to quality.

Zinfandel (n=91)[42]

Zinfandel is a red wine. It is one of the few wines made from a grape native to North America. Zinfandels are often described as rougher than cabernets or merlots.

The linear equation is:

```
PRICE = 12.5639 - 0.0000561 QBOTTLED
                 (0.0000180)

R2 = 0.0983                F = 9.71
(Numbers in parentheses are standard errors of the coefficients.)
```

The log-linear results are

```
LNPRICE = 2.4818 - 0.0000058 QBOTTLED + 0.1954 NWIBRNZ
                  (0.0000014)          (0.1097)

R2 = 0.1944                F = 10.62
(Numbers in parentheses are standard errors of the coefficients.)
NWIBRNZ:  Bronze medal, New World International tasting
```

[42] This category includes red zinfandels only. White zinfandel is a separate wine type.

These results are not encouraging. The statistical results are so poor that the only comment we can make is that zinfandel wines don't seem amenable to this form of analysis.

Small Sample (Less Than 50 observations)

In this section, we present statistical results for wines with reasonably good statistics. In general, the small number of observations means very few variables are selected in the second stage of the regression process. For some wines, only the fitted quantity values from the first stage regression are included as independent variables in the second stage. These wines are also characterized by a low number of observations; they are not discussed in this section as the results are not very interesting. Wines experiencing this problem include chenin blanc (n=11), cabernet franc (11), petite sirah (16),[43] pinot blanc (10),[44] syrah (18),[45] white meritage (5), and white zinfandel (10).

Gewurztraminer (n=23)

Gewurztraminer is a spicy grape, popular in German wine-making. The linear form is

```
PRICE = 9.6537 - 0.00045880 QBOTTLED + 3.7674 RIVSILV
                (0.00018337)              (1.4515)

           + 4.5987 DMNGOLD + 3.6675 SDSILV
            (1.9435)         (1.9401)

R2 = 0.5049                F = 4.59
(Numbers in parentheses are standard errors of the coefficients.)
RIVSILV:  Silver medal, Farmers Fair
DMNGOLD:  Gold medal, Dallas Morning News competition
SDSILV:  Silver medal, San Diego competition
```

The log-linear results are

```
LNPRICE = 2.3458 - 0.00004852 QBOTTLED - 0.2502 SACBRNZ
                  (0.00002012)          (0.1316)

                 - 0.4376 SDGOLD + 0.2872 RIVSILV
                  (0.2143)        (0.1649

R2 = 0.4531            F = 3.73
```

[43] Several dummy variables were selected in the second stage of the regression for petite sirah. However, in both the linear and log-linear form, most of the coefficients were negative. These results are not reported here because they are counterintuitive.

[44] Frankly, the results for pinot blanc are simply too good to be believed. The linear form reports an R^2 of 0.97, while the log-linear form claims an R^2 of 1.00!

[45] Like pinot blanc, the results for syrah are too good to believed and are undoubtedly caused by the small sample size.

```
(Numbers in parentheses are standard errors of the coefficients.)
SACBRNZ:  Bronze medal, California State Fair
SDGOLD:  Gold medal, San Diego competition
RIVSILV:  Silver medal, Farmer's Fair, Riverside
```

In this case, the linear form is clearly superior, providing both a higher F statistic and more intuitively appealing coefficients (although the negative coefficient of the silver medal in the San Francisco tasting is somewhat counterintuitive). The best that can be said of these results is that winning a silver medal in Riverside provides the best valuation of quality for gewurztraminer.

Johannisberg Riesling (n=28)

Johannisberg riesling can be a difficult grape with which to work. Its light, fruity style can easily be overwhelmed by the winemaking process. The linear form is

```
PRICE = 12.1093 - 0.00033004 QBOTTLED - 6.0005 OCBRNZ
                 (0.00009093)          (3.1852)

      + 21.9051 SFBRNZ
        (4.2451)

R2 = 0.5362           F = 9.25
(Numbers in parentheses are standard errors of the coefficients.)
OCBRNZ:  Bronze medal, Orange County Fair
SFBRNZ:  Bronze medal, San Francisco Fair
```

The log-linear results are

```
LNPRICE = 2.2333 - 0.00002278 QBOTTLED + 1.1435 SFBRNZ
                  (0.00000468)          (0.2108)

                + 0.6121 SACGOLD - 0.2974 SACBRNZ
                 (0.3171)         (0.1715)

                + 0.7752 NWIGOLD + 0.4635 WCBRNZ
                 (0.3171)         (0.1957)

R2 = 0.7086           F = 8.51
(Numbers in parentheses are standard errors of the coefficients.)
SFBRNZ:  Bronze medal, San Francisco Fair
SACGOLD, SACBRNZ:  Gold, bronze medal, California State Fair
NWIGOLD:  Gold medal, New World International competition
WCBRNZ:  Bronze medal, Reno-West Coast competition
```

The log-linear form of the equation appears to be preferable. However, the negative coefficient for a bronze medal in the California State Fair combined with the positive coefficient for a gold medal in the

same event appear somewhat counterintuitive. Four different tastings appear good evaluators of quality: San Francisco, California State Fair, New World International, and Reno-West Coast.

Red Meritage (n=29)

Red Meritage wines are simply interesting blends. Despite the relatively small sample size, the statistical results are interesting. The linear form is

```
PRICE = 24.8519 - 0.0003188 QBOTTLED - 12.9690 RIVBRNZ
                 (0.0002076)           (3.2587)

           + 20.7144 SFGOLD + 8.1766 DMNBRNZ + 19.5867 NWIGOLD
             (3.8382)        (3.1610)          (5.1529)

R2 = 0.6581           F = 8.85
(Numbers in parentheses are standard errors of the coefficients.)
RIVBRNZ:  Bronze medal, Farmers Fair (Riverside)
SFGOLD:  Gold medal, San Francisco Fair
DMNBRNZ:  Bronze medal, Dallas Morning News competition
NWIGOLD, NWIBRNZ:  Gold, bronze medals, New World International
```

The log-linear results are

```
LNPRICE = 3.2151 - 0.00000221 QBOTTLED - 0.5019 LASILV
                  (0.00000916)          (0.2152)

                 - 0.3140 RIVSILV - 0.5715 RIVBRNZ
                  (0.1698)         (0.1122)

                 + 0.6298 SFGOLD + 0.2820 DMNBRNZ
                  (0.1333)        (0.1092)

                 + 0.7746 NWIGOLD - 0.6347 NWIBRNZ
                  (0.1764)         (0.2185)

R2 = 0.7699           F = 8.36
(Numbers in parentheses are standard errors of the coefficients.)
LASILV:  Silver medal, Los Angeles County Fair
RIVSILV, RIVBRNZ:  Silver, bronze medals, Farmers Fair
SFGOLD:  Gold medal, San Francisco Fair
DMNBRNZ:  Bronze medal, Dallas Morning News competition
NWIGOLD, NWIBRNZ:  Gold, bronze medals, New World International
```

Statistically, the two functional forms are about the same. Note that many of the independent variables selected are the same for the two regressions (with the same sign of the coefficient). Winning a silver medal at the Los Angeles fair, a bronze medal at the Farmers Fair, or a bronze medal at the New World International competition almost certainly are indicators of below-average quality. Winning a gold

medal in San Francisco or at the New World International, or a bronze medal at the Dallas Morning News competition almost certainly are indicators of above-average quality. Also note that the coefficients in the linear form are extremely large; the absolute value of five of the six dummy coefficients is greater than 10. This indicates the positive and negative dummy coefficients are, to a certain extent, offsetting each other.

Semillon (n=9)

Semillon is a white wine grape. With only nine observations, we fully expected no statistical results worth talking about. We were mistaken. The linear form is

```
PRICE = 9.4224 - 0.0001508 QBOTTLED + 3.1591 SACBRNZ
                (0.0000600)           (1.1183)

R2 = 0.6647            F = 5.95
(Numbers in parentheses are standard errors of the coefficients.)
SACBRNZ:  Bronze medal, California State Fair
```

The log-linear results are

```
LNPRICE = 2.2513 - 0.00001261 QBOTTLED + 0.4175 SACBRNZ
                  (0.00000554)          (0.1146)

           - 0.2419 WCBRNZ
            (0.1168)

R2 = 0.7846           F = 6.07
(Numbers in parentheses are standard errors of the coefficients.)
SACBRNZ:  Bronze medal, California State Fair
NWIBRNZ:  Bronze medal, New World International
```

Winning a bronze medal at the California State Fair seems a good indicator of quality for semillon.

Sparkling Wine (n=42)

Sparkling wine is often incorrectly called "Champagne." In fact, the name Champagne is properly used only to refer to sparkling wines made in the Champagne region of France. Sparkling wine is the designation adopted by many California wineries. The linear form is

```
PRICE = 15.0952 - 0.0000017 QBOTTLED + 8.4644 OCSILV
                 (0.0000042)          (2.9917)

           + 6.1184 NWIGOLD - 6.8617 WCGOLD
            (2.2445)         (3.7550)

R2 = 0.3127           F = 4.21
(Numbers in parentheses are standard errors of the coefficients.)
OCSILV:  Silver medal, Orange CountyFair
NWIGOLD:  Gold medal, New World International
WCGOLD:  Gold medal, Reno-West Coast Competition
```

The log-linear results are

```
LNPRICE = 2.8077 - 0.00000020 QBOTTLED - 0.4115 LABRNZ
                  (0.00000023)          (0.2021)

R2 = 0.1123           F = 2.47
(Numbers in parentheses are standard errors of the coefficients.)
LABRNZ:  Bronze medal, Los Angeles Fair
```

Based on these results, we would hesitate to make any definitive statement about the tasting that is the best predictor of quality for sparkling wine.

Summary

One way of summarizing these results is by examining the significant coefficients. Table 3 shows the results for the linear form while Table 4 shows the log-linear form. In both cases, only the ordinary least squares results are reported.

Linear Form	Overall (806)	Char-donnay (145)	Cabernet Sauvignon (158)	Gewurz-traminer (23)	Johannis-berg Riesling (28)	Merlot (71)	Pinot Noir (55)	Red Meritage (29)	Sauvignon Blanc (72)	Semillon (9)	Sparkling Wine (42)	Zinfandel (91)
LAPLUS	+6.0792											
LAGOLD												
LASILV							+4.4570					
LABRNZ												
OCPLUS									+4.5933			
OCGOLD												
OCSILV							+5.3531				+8.4644	
OCBRNZ					-6.0005							
RIVPLUS												
RIVGOLD												
RIVSILV				+3.7674								
RIVBRNZ	-1.7582							-12.9690				
SFPLUS												
SFGOLD	+10.4938	+10.2131	+32.0549				+12.4570	+20.7144				
SFSILV	+2.9023											
SFBRNZ	+4.0800		+7.8959		+21.9051							
DMNPLUS												
DMNGOLD	+5.6201			+4.5987								
DMNSILV		+4.9081					+4.8837					
DMNBRNZ	+1.8690							+8.1766				
SACPLUS		+11.2593										
SACGOLD												
SACSILV							+4.5419					
SACBRNZ										+3.1591		
NWIPLUS												
NWIGOLD	+2.8217							+19.5867			+6.1184	
NWISILV	-1.6310											
NWIBRNZ			-4.7454									
WCPLUS												
WCGOLD		+3.2954							-3.0188		-6.8617	
WCSILV												
WCBRNZ												
SDPLUS							-9.3034					
SDGOLD												
SDSILV				+3.6675			+4.6975		+4.6045			
SDBRNZ												

Table 3

Log-linear Form	Overall (806)	Char-donnay (145)	Cabernet Sauvignon (158)	Gewurz-traminer (23)	Johannis-berg Riesling (28)	Merlot (71)	Pinot Noir (55)	Red Meritage (29)	Sauvignon Blanc (72)	Semillon (9)	Sparkling Wine (42)	Zinfandel (91)
LAPLUS	+0.3508											
LAGOLD												
LASILV							+0.3686	-0.5019				
LABRNZ											-0.4115	
OCPLUS									+0.4180			
OCGOLD	+0.1039	+0.2779										
OCSILV	+0.0916						+0.2599					
OCBRNZ												
RIVPLUS		-0.6082										
RIVGOLD												
RIVSILV				+0.2872				-0.3140				
RIVBRNZ	-0.0932		-0.2060					-0.5715				
SFPLUS												
SFGOLD	+0.4887	+0.4718	+1.1100					+0.6298				
SFSILV	+0.2007	+0.1806	+0.2644									
SFBRNZ	+0.2305		+0.2731		+1.1435							
DMNPLUS												
DMNGOLD	+0.3018											
DMNSILV		+0.2958				+0.1941	+0.4050					
DMNBRNZ	+0.1224							+0.2820				
SACPLUS												
SACGOLD					+0.6121							
SACSILV							+0.2512					
SACBRNZ				-0.2502	-0.2974					+0.4175		
NWIPLUS												
NWIGOLD	+0.1755				+0.7752			+0.7746				
NWISILV												
NWIBRNZ			-0.2007					-0.6347				+0.1954
WCPLUS												
WCGOLD	-0.1317								-0.4149			
WCSILV	-0.0965											
WCBRNZ					+0.4635					-0.2419		
SDPLUS												
SDGOLD				-0.4376								
SDSILV	+0.0982						+0.3539		+0.4150			
SDBRNZ		+0.1331										

Table 4

Conclusion

We can safely say that the San Francisco competition is the best predictor of quality (given the way we have defined quality). In the linear form, the San Francisco tasting has 9 significant coefficients,all of which are positive. Second is the Dallas Morning News tasting with 6 significant coefficients, also all positive. The California State Fair, New World International, and San Diego have 3 significant positive coefficients each, but NWI and San Diego have 2 and 1 negative respectively.

In the log-linear form, San Francisco again leads the way with 10 significant coefficients (none negative.). Dallas Morning News is second with 6 positive. While the Farmers Fair (Riverside) has 6 significant coefficients, 5 of them are negative, perhaps indicating this is a competition that tends to reward wines that the market believes are of lower quality.[46] New World International has 5 significant coefficients (2 negative) and the California State Fair (Sacramento) has 3 (all positive).

It has been suggested that timing may play a role in these results. In fact, the San Francisco competition is scheduled seventh of the nine tastings. As noted earlier, some wines (particularly those from smaller wineries) may have sold out by the time of this tasting and therefore not be included in the sample. This imposes a supply constraint on the model that is not reflected in the statistical results presented. In fact, what we may be seeing in these results is simply the fact that wines that are available for the San Francisco competition are available for the competition simply because their price is high, reducing demand and allowing enough wine to remain in stock to enter the competition.[47]

Yet another interpretation involves market signalling. Perhaps a wine that wins a medal in a particular tasting is valued more highly by consumers because of the medal. Visit any wine shop and you'll see shelf tags with some wines advertising the medal(s) won in various tasting(s). It is entirely possible that the large number of positive coefficients for the San Francisco Fair and Dallas Morning News competition are caused by consumers placing a high value on those results, rather than using the

[46] It's also possible that this tasting simply attracts lower priced wines.
[47] I am indebted to the Seminar in Economic Research, California State University Hayward for suggesting this line of reasoning.

results as a signal of wine quality. To say that it would be difficult to separate cause and effect in this case would be a gross understatement of the difficulties presented by this possibility. And, in some sense, it does not matter whether consumers value the wine or the medal. We can safely say that winning a medal in San Francisco or Dallas is associated with a higher price and quality for that wine. We leave separating cause and effect to future research.[48]

We would really like a measure of excess demand in this market since it appears that some wineries are pricing their wine below the level warranted by its quality. If we could obtain a measure of flow demand, that would be a good start in the indicated direction. That will have to wait for future research.

Notes

[48] One possible direction for future research is adding another source of wine quality such as the *Wine Spectator's* point rating of each wine.

Bibliography

Ashenfelter, Orley, David Ashmore, and Robert Lalonde. "Wine Vintage Quality and the Weather: Bordeaux." Paper presented at the Second International Conference of the Vineyard Data Quantification Society, Verona, Italy, February 18 - 19, 1993.

Borenstein, S., "Price Discrimination in Free Entry Markets." *Rand Journal of Economics* 16, no. 3 (Autumn, 1985): 380-97.

Cappoza, Dennis R., and Robert Van Order, "A Generalized Model of Spatial Competition." *American Economic Review* 68. no. 5 (December, 1978): 896-908.

Chamberlin, Edward H., *The Theory of Monopolistic Competition*. Cambridge, Mass.: Harvard University Press, 1933.

Combris, Pierre, Sébastein Lecocq, and Michael Visser. "Estimation of a Hedonic Price Equation for Bordeaux Wine: Does Quality Matter?" *Economic Journal* 107 (March, 1997), pp. 390-402.

Demsetz, Harold "The Inconsistencies of Monopolistic Competition." *Journal of Political Economy* 80, no. 3 (June, 1972): 592-97.

Devine, Trudy and J.T. Devine (editors). *California Wine Winners, 1996*. Varietal Fair, Sebastopol, CA, 1996.

Dixit, Avinash K., and Joseph E. Stiglitz. "Monopolistic Competition and Optimum Product Diversity." *American Economic Review* 67, no. 3 (June, 1977): 297-308.

Draper, Norman R. and H. Smith. *Applied Regression Analysis*. John Wiley & Sons, 1966.

Houthakker, H.S. "Compensated Changes in Quantities and Qualities Consumed." *Review of Economic Studies* 19, no. 3 (1952): 155-64.

Katz, M.L. "Price Discrimination and Monopolistic Competition." *Econometrica* 56, no. 6 (November, 1984): 1453-71.

Koenker, Roger W., and Martin K. Perry. "Product Differentiation, Monopolistic Competition, and Public Policy." *Bell Journal of Economics* 12, no. 1 (Spring, 1981): 217-31.

Lancaster, Kelvin. "A New Approach to Consumer Theory." *Journal of Political Economy* 74, no. 2 (April, 1966). 132-157.

Noble, Ann C., "The Flavor Wheel" available at http://wineserver.ucdavis.edu/VEN7.html

Norman, George. "Spatial Competition and Spatial Price Discrimination." *Review of Economic Studies* 48:151 (January, 1981): 97-111.

Oczkowski, Edward. "A Hedonic Price Function for Australian Premium Table Wine." *Australian Journal of Agricultural Economics*, 38:1 (April, 1994): 93-110.

Perry, Motty. "Sustainable Positive Profit Multiple-Price Strategies in Contestable Markets." *Journal of Economic Theory* 32 (1984): 246-65.

Philips, Louis. *The Economics of Price Discrimination*. Cambridge: Cambridge University Press, 1983.

Rosen, S.M. "Hedonic Prices and Implicit Markets: Product Differentiation in Pure Competition." Journal of Political Economy 82 (1974) pp. 34-55.

Salop, S.C. "Monopolistic Competition with Outside Goods." *Bell Journal of Economics* 10, no. 1 (Spring, 1979): 141-56.

Shmanske, Stephen. Public Goods, Mixed Goods, and Monopolistic Competition. Texas A&M University Press, College Station, Texas (1991).

Spence, Michael. "Multi-Product Quantity-Dependent Prices and Profitability Constraints." *Review of Economic Studies* 47, no. 150 (October, 1980): 821-41.

_____. "Product Selection, Fixed Costs and Monopolistic Competition." *Review of Economic Studies* 43, no. 133 (Ju-ne, 1976): 217-35.