Coordination of the California Wine-Grape Supply Chain

Jason R.V. Franken*

Wine-Grape Supply Chain Coordination

*Franken is assistant professor in the School of Agriculture, Western Illinois University.

Please direct correspondence to Jason Franken at jr-franken@wiu.edu.

Coordination of the California Wine-Grape Supply Chain

Abstract

This study investigates factors influencing coordination of the California grape and wine supply chain. Results corroborate prior findings that quality considerations and needs to protect investments in specialized or durable assets significantly increase usage of more formal coordination mechanisms like formal contracts and vertical integration or ownership. Consistent with findings for other industries, such investments are associated with greater contract complexity and inclusion of enforcement provisions, while trade partners' prior experience working together decreases contract complexity. Furthermore, our results suggest that quality considerations extend to greater use of formal contracts further downstream.

Keywords:contract, grapes, vertical integration, wine

Quality Considerations for Coordination of the California Wine-Grape Supply Chain

Quality is a key competitive factor in the wine industry, and numerous approaches for organizing and managing the supply chain for wine grapes and wines are employed, ranging from simple oral agreements, to formal written contracts, to common ownership and management of neighboring stages in the supply chain. Such vertical coordination decisions are considerations of organizational economics (Grossman and Hart, 1986; Williamson, 1975; 1979), which has been applied to explain wine grape marketing by growers in California (Goodhue, Heien, Lee, and Sumner, 2003) and procurement decisions by wineries in Spain (Fernández-Olmos, Rosell-Martínez, and Espitia-Escuer, 2009).These studies suggest that uncertainty, for instance regarding grape quality, and differences in investments in assets to support wine grape and wine production play integral roles in the decisions. Furthermore, contract terms regarding production practices and quality attributes are related to size and experience of the grower and the duration of the relationship with buyers.

This study revisits vertical coordination of the California wine grape industry for 98 handlers of wine grapes, which contributes to a broader, more comprehensive perspective of the industry. The California grape and wine industry is an ideal sector for studying vertical coordination for several reasons (Goodhue, Heien, Lee, and Sumner, 2003). Wine grapes are a perishable product, requiring close coordination between growers and wineries at harvest time. Grape quality is critical to a winery's reputation for wine making, which is an important aspect of competition in the industry.[1] Additionally, there is considerable product differentiation along with variation in types of grapes and wines, size of businesses, and vertical coordination mechanisms employed. Factor analytic methods (Hair, Anderson, Tanham, and Black, 1995) are used to develop measures of growth input and harvest input factors or categories of contract

terms, which yield modeling efficiencies in terms of degrees of freedom in regression analysis of procurement and marketing methods. The results are generally corroborative of previous findings that concern for quality is a common motivation for tighter coordination of the wine grape supply chain.

The paper proceeds as follows. Literature on vertical coordination in the wine grape supply chain and organizational theory are reviewed in the next section, followed by the research design, including data, measures, and empirical methods employed. The results are then presented and discussed, and the paper concludes with implications and suggestions for further research.

Relevant Literature and Hypothesis Development

Extant literature on the organization of wine-grape supply chains draws heavily on organizational economics and transaction cost economics in particular (Goodhue, Heien, Lee, and Sumner, 2003; Fernández-Olmos, Rosell-Martínez, and Espitia-Escuer, 2009).

Goodhue, Heien, Lee, and Sumner (2003) find that use of written contracts by winegrape growers in California is significantly more likely for producers of high quality grapes, as approximated by price, years in business and years working with buyers, and acreage. For larger producers and those raising higher quality grapes, the value of potentially appropriable quasi-rents is large enough to justify the costs of contracting. Notably, written contracts for higher quality grapes are more likely to include provisions regarding the production process, while written contracts for lower quality grapes are more likely to include financial incentives for particular attributes, like sugar content.

Fernández-Olmos, Rosell-Martínez, and Espitia-Escuer (2009) find that Spanish wineries' choices to make rather than buy most grapes are positively related to wine quality (i.e., wine differentiation of *reserva* and *crianza* wines from *guarantee of origin* wines),growers' investment in dedicated and specialized assets,and the level of behavioral and environmental uncertainty involved. The authors suggest that a lack of statistical significance for wineries' specialized investments reflects that their revenues are increasingly not just from winemaking but alsofrom wine tourism.Vertical integration is negatively related to size, as proxied by average capacity from 2002 to 2004, perhaps due to a need to source large amounts of grapes. The authors conclude calling for more comprehensive research across the full spectrum of modes of exchange.

Wineries, like other businesses, seek to grow sales via product differentiation, which leads to heterogeneity of input needs across wineries. Such businesses may then implement their own grading standards and corresponding quality premiums to source inputs with quality attributes that support their differentiation strategy (Jang and Sykuta, 2008; Jang and Olson, 2010) or alternatively may produce inputs in-house. External suppliers may require having these terms in writing to serve specific winery needs. Therefore, we hypothesize:

H1 Buyer measurement of quality is positively associated with sophistication of procurement mechanism.

H2 Quality premiums are positively associated with use of formal contracts.

Financial incentives may adequately ensure performance on objectively measurable or quantifiable attributes, like sugar (i.e., degree brix) or acidity, but other quality attributes, such as appearance or color and taste or flavor may be more subjective (Table 1). According to the organizational economics literature (Mahoney 1992), if quality is imperfectly measurable, or

measurable only at high cost, then contract provisions can stipulate *best practices* known to exact/deliver quality, presuming their use is easily verified (i.e., the task is highly programmable). If both, quality is difficult to measure and production practices do not correlate with quality orare not easily verified, in-house production may be necessary. We hypothesize:

H3 Measurement difficulty is positively associated with usage of formal contracts.

Thus, specification or provision of specific production inputs may assist in ensuring quality. Gergaud and Ginsburgh (2007) show that technological choices (i.e., grape varieties, picking and fermenting technologies) affect quality much more than natural endowments (i.e., land characteristics and exposures of vineyards). Hence, we expect:

H4 Buyer specification or provision of inputs for growing and harvesting grapes is positively associated with sophistication of exchange mechanism.

Input specification or provision may ensure quality, but also may entail investment in specialized or durable assets by either, the supplier, the buyer, or both. In particular, specification of production inputs requires such investments on the part of the supplier, whereas provision of inputs implies investments on the part of the buyer.

Reuer and Arino (2007) found that the complexity (i.e., number of provisions) of alliance contracts across several industries in Spain is significantly greater in the presence of such investments and significantly lower when prior ties exist among contracting parties. The costs of writing more complex contracts that cover dispute resolution procedures and consequences of breach and termination become worthwhile to protect the potentially appropriable quasi-rents stemming from these investments. In contrast, prior experience working together engenders trust and development of inter-organizational routines and a better understanding of each other's

needs, procedures, management systems, cultures, etc. Looking more closely at the type of provisions included in contracts, Reuer and Arino (2007) identify that asset specificity significantly increases the use of enforcement provisions designed to safeguard quasi-rents, while prior ties significantly decrease the need for basic coordination provisions but not enforcement provisions. Hence, we hypothesize:

H5 Buyer specification or provision of inputs for growing and harvesting grapes is positively associated contract complexity and enforcement provisions in particular.

H6 Duration of trade relationship in years is negatively associated with contract complexity and coordination provisions in particular.

These hypotheses are empirically tested as described in the research design section.

Research Design

Research Context

We analyze a data on the proportion of grapes produced in-house or procured via formal or informal contracts by 98 wine grape handlers. The data are from a 1999 survey of 385 handlers of fruit, vegetable, and nut commodities in California (Hueth, Ligon, and Dimitri 2007). Data from a pilot study for the survey instrument are reported in Hueth and Ligon (1999). Responses to an open-ended question about the firms' activities reveal that at least 70% are involved with grape production and 43% make wine. Whereas previous studies have focused on exchange of grapes between grower and winery, the available data allow us to also examine subsequent downstream transactions (i.e., how survey respondents sell grapes or wine).

Measures

Procurement and marketing methods (i.e., *In-House Production*, *Formal Written Contract*, *Informal Oral Contract*) are measured as the percentage of grapes traded via that method. Indices are also developed to capture the degree of formality involved.*Grower Formality* is computed by multiplying percentages of grapes procured via in-house production by three, via formal contracts by two, via informal contracts by one, via other methods (e.g., cash or cooperative) by zero. Correspondingly, *Buyer Formality* is computed by multiplying percentages of grapes or wine marketed via formal contracts by two, via informal contracts by one, and via cash sales by zero.

Following Reuer and Arino (2007), *Contract Complexity* is the number of provisions in the contract or arrangement, as selected by survey respondents from a predefined list including: number of acres, adjustment for quality, provisions governing quality measurement, target date of delivery, provisions for governing contract renewal, compensation (e.g., method of calculating payment to grower, volume (e.g., tons, bushels or other production units), means of negotiating disputes (e.g., appeal procedure). Hence, contract complexity may range in value from one provision to eight provisions.

Factor analysis (Bollen 1989; Hair, et al. 1995; Thompson 2004) of survey items is used to limit error in measurement of variables representing certain types of contractual provisions and buyer requirements for grape production inputs. (Survey respondents selected inputs they provided or required growers to use from a predefined list including: fertilizer, pesticides, plants, labor, and equipment.) Relationships between relevant itemsare summarized as a smaller set of more parsimonious variables (eigenvectors called factors) that conserve degrees of freedom and improve power against Type II error in subsequent regression analyses (Thompson 2004).

Following the conventional "K1"rule, we identify notable factors possessing characteristic roots (eigenvalues) greater than one (Thompson 2004). Survey items loading nearly evenly on multiple factors were eliminated to preserve unidimensionality of factors. (Complete results available from authors upon request.) The analysis yields two factors pertaining to input requirements—*Growth Inputs* comprising fertilizers, pesticides, and plants and *Harvesting Inputs* consisting of equipment and labor—and two factors regarding contract stipulations—*Enforcement Provisions* comprising contract renewal and dispute resolution and basic *Coordination Provisions* comprising delivery date and quality adjustments. Cronbach's (1951) alphas of 0.70 and 0.67, respectively, indicate that measures of harvesting inputs and enforcement provisions are fairly reliable, while values of 0.57 and 0.39 indicate relatively less reliable measurement of growth inputs and coordination provisions, respectively (Streiner and Norman 1995).

Several explanatory variables are measured directly by survey items. *Years* is how long the respondent's company has been in business and approximates experience or tenure. *Duration* is the years of experience with growers, on average. *Sales%* is the percentage of revenues coming from grape or wine sales, and represents the importance of this activity to the company. *Tons Bought* (of grapes) is a reflection of company size. *Measurement Difficulty* is survey participants' responses on a Likert scale of one (poorly) through five (perfectly) to the question, "How well does what you measure capture all relevant quality attributes (for grapes)?" Finally, several binary variables (equal to one if yes and zero if no) indicate region of operation, the types of buyers (retail, wholesale, institutional, direct, export, etc.) that the respondent supplies, whether grower compensation is conditional on quality (i.e., *Premium*), and who measures quality (i.e., respondent, government, or another third party).

Modeling Marketing Behavior

The proportion of a crop procured or marketed by a particular method, say formal written contracts, may be estimated using Tobit regressions. The log-likelihood for the Tobit model contains probabilities of nonuse of contracts from a Probit regression in the first term and a classical regression for positive amounts contracted in the second term:

$$\ln L = \sum_{\alpha_i=0} \ln \Phi\left(-\frac{\beta_\alpha' x_i}{\sigma}\right) + \sum_{\alpha_i>0} \ln\left[\frac{1}{\sigma}\phi\left(\frac{\alpha_i - \beta_\alpha' x_i}{\sigma}\right)\right], \tag{1}$$

where $\Phi(\bullet)$ is the standard normal probability density function, $\mathbf{x}_i$ and β_α are vectors of independent variables and coefficients, σ is the standard deviation, and α_i denotes the proportion contracted.[2] Following Katchova and Miranda (2004), α_i is not constrained from above since a producer conceivably may contract more than the actual *ex post* production. Under the Tobit formulation, the independent variables and associated coefficients are constrained to be the same for the contract adoption and proportion contracted decisions. Cragg's (1971) less restrictive hurdle or two-step model does not require the variables and coefficients for both decisions to be the same. The log-likelihood is the sum of the log-likelihood of a Probit regression (the first two terms) and the log-likelihood of a truncated regression (the second two terms) and is given by

$$\ln L = \sum_{c_i=0} \ln \Phi(-\gamma' z_i) + \sum_{\alpha_i>0} \left\{ \ln \Phi(\gamma' z_i) + \ln\left[\frac{1}{\sigma}\phi\left(\frac{\alpha_i - \beta_\alpha' x_i}{\sigma}\right)\right] - \ln \Phi\left(\frac{\beta_\alpha' x_i}{\sigma}\right) \right\}, \tag{2}$$

where$\mathbf{z}_i$ andγ are vectors of independent variables and coefficients pertaining to contract adoption and, and as before, $\mathbf{x}_i$ and β_i are vectors of independent variables and coefficients pertaining to the proportion contracted. When $\mathbf{z}_i = \mathbf{x}_i$ and $\gamma = \beta_\alpha/\sigma$, equations (1) and (2) are equivalent. From a practical standpoint, Tobit models seem particularly appropriate

when(nearly) all observations in the sample are indicative of use or adoption. The hurdle model is intuitive for cases where choices of adoption and proportional use are made sequentially.

Results

Grape Procurement Methods

Marginal effects of Tobit, probit, and truncated ordinary least squares (OLS) regressions of grape procurement method use are presented in Table 2. Recall that the hurdle model (i.e., probit followed by truncated OLS) corresponds to sequentially made adoption and proportional usage decisions, and unlike Tobit models, does not restrict any particular explanatory variable to have the same effect on both decisions (Katchova and Miranda, 2004). Tobit regressions, however, are particularly appropriate for modeling indices representing the overall formality of portfolio of procurement and marketing arrangements employed (i.e., *Grower Formality* and *Buyer Formality*). Thus, except for regressions of these indices, we will place more confidence in and focus discussion on the hurdle model results. Regressions were run in STATA, which automatically dropped some binary dummy variables from binary probit regressions due to statistical issues identified by the program. Fortunately, most of the variables of interest remain intact in the regression results presented here.

Several of the results for grape procurement methods are consistent with previous research (Table 2). Goodhue, et. al (2003) find that more experienced wine grape growers in California are significantly more likely to sell through formal contracts as opposed to informal contracts. Here, *Years* in business also significantly increases usage of more formal procurement methods (i.e., Tobit results), reflecting greater use of in-house production and less use of formal contracts. Specifically, ten additional years in business, on average,increases the probability of

in-house production by 11% (i.e., probit results) and its proportionaluse by 8% (i.e., truncated OLS results), while decreasing the probability of using formal contracts by 2% and their proportion use by 3%. Although *Years* does not influence adoption of informal contracting methods, it does increase their proportional use among those handlers using this informal procurement method. Apparently, with time and experience, those that use informal contracts become comfortable relying more heavily on them. Interestingly, as sales of grapes and wine become an increasingly important component of the business (i.e., *Sales%*), proportional use of formal contracts decreases significantly, but a lack of significant effects in other regressions provides no indication of which procurement methods are used in its place.

Regional dummies indicate greater use of in-house production and less proportional use of formal contracts with growers in the Sacramento Valley (Table 2). In-house production and informal contracts are used proportionally less and formal contracts proportionally more with growers in the San Joaquin Valley. With relatively fewer wineries in the San Joaquin region than in other regions in California (Goodhue, et. al, 2003), few alternative buyers pose a small numbers problem for growers as a motivation for formal contract use (Williamson, 1975). That is, with fewer buyers of perishable grapes, a winery could potentially renege on an informal agreement with a grower or accept delivery only at a lower price than previously agreed upon.

Relative to the baseline of an institutional buyer (i.e., food service or restaurants), having a retail buyer (i.e., supermarket or grocer) significantly increasesproportional use of formal contracts and decreases adoption of informal contracts (Table 2). None of the other binary dummy variables for buyer type are statistically significant. The result is somewhat surprising for the export buyer dummy, in particular, as evidence from the French wine industry (Crozet, Head, and Mayer, 2009) suggests a positive relationship between wine quality and exporting

(i.e., producers of high quality wine export to more markets). If quality control requires tighter coordination, exporting wineries may be expected to utilize such practicesmore sothan those selling only domestically. Another binary dummy variable indicates that use of formal contracts with buyers makes grape handlers 21% more likely to use formal contracts and 43% less likely to use informal contracts with growers. This result may reflect use formal arrangements to coordinate exchange of higher quality products along the entire supply chain.

Relative to the baseline of quality measurement by government entities like the USDA, those grape handlers that that ascertain the quality of growers' grapes themselves are 54% more likely to also produce their own grapes and rely 84% more on their own production (Table 2). This finding directly supports hypothesis H1 (Buyer, i.e., grape handler, measurement of quality is positively associated with sophistication of procurement mechanism). Grape handlers that offer growers financial incentives for quality source about 13% more of their grapes using formal contracts than those not offering quality premiums, which is consistent with hypothesis H2 (Quality premiums are positively associated with use of formal contracts). The degree to which grape handlers' quality measurement procedures can capture all of relevant characteristics (i.e., measurement difficulty) is also significantly related to use of formal and informal contracts. Specifically, greater measurement difficulty decreases the probability of using informal contracts by 28% and increases proportional use of formal contracts 13%, which supports hypothesis H3 (Measurement difficulty is positively associated with usage of formal contracts). When accurately measuring quality is difficult, stipulation of *best practices* may help to ensure quality (Mahoney 1992). Such terms may require specific investments by either of the parties to the exchange, prompting employment of formal contractual safeguards or vertical integration (i.e., ownership) of both stages of the supply chain to protect the value of these investments.[3] While

grape handler specification or provision of *Harvest Inputs* (i.e., labor and equipment) is positively related to proportional use of informal contracts, specification or provision of *Growth Inputs* (i.e., fertilizer, pesticides, and plants) has a negative impact. Additionally, *Growth Inputs* significantly increases the probability of using formal contracts 7% and of using in-house grape production 18%. In the latter case, the statistic implies that those grape handlers who stipulate the use of certain growth inputs in contracts with growers are also more likely to produce at least some grapes themselves.[4] These findings are consistent with hypothesis H4 (Buyer specification or provision of inputs for growing and harvesting grapes is positively associated with sophistication of exchange mechanism).

Grape Procurement Contract Provisions

Grape handler provision or specification of *Growth Inputs* also significantly increases the complexity of contracts (i.e., number of contract provisions) and the types of provisions or contract terms included (Table 3).[5] Such terms may require specific investments by either of the other parties to the contract, and hence may be expected to increase the number of contract provisions and the use of enforcement provisions like procedures for dispute resolution and terms of contract renewal, in particular. The low explanatory power (R^2) of regressions in Table 3 suggests opportunities for future research to better explain the variation in contract complexity and use of such provisions. Still, the results for *Growth Inputs* are generally consistent with Reuer and Arino's (2007) findings across several industries and lend some support to hypothesis H5 (Buyer specification or provision of inputs for growing and harvesting grapes is positively associated contract complexity and enforcement provisions in particular). One inconsistency is that specialized investments did not significantly influence use of coordination provisions in

Reuer and Arino's (2007) study. Here, the positive relationship between *Growth Inputs* and provisions related to coordination of quality, likely reflect these investments in inputs are also intended to help ensure quality.

Reuer and Arino (2007) suggest that their finding of lower use of coordination provisions among trade partners with prior ties reflects development of trust and knowledge of each other's needs and procedures over time, which reduces the need for some contract terms. Here, *Duration of Trade Relationship* significantly decreases the complexity of contracts, in partial support of hypothesis H6 (Duration of trade relationship in years is negatively associated with contract complexity and coordination provisions in particular.) Like Reuer and Arino (2007), we also find that firm size (i.e., *Tons Bought*) significantly increases the complexity of contracts, which may reflect greater use of contractual safeguards among large firms and those that rely heavily on formal contracts.

Grape and Wine Marketing Methods

Regression results explaining the methods used by grape handlers to market grapes or wine are presented in Table 4. To our knowledge, prior research has not addressed this segment of the grape/wine supply chain. Again, except in the case of the index *Buyer Formality*, discussion is focused on the result of the more intuitive hurdle model (i.e., binary probit followed by truncated OLS). The most interesting results are related to buyer type, procurement method, and quality considerations. Specifically, grape handlers who sell to retail (e.g., supermarkets) or wholesale (e.g., brokers, processors, shippers) buyers use formal contracts for over 40% more of their sales. Those that grow their own grapes or procure them via formal contracts, use informal contracts less and more formal mechanisms more when marketing. Quality appears to be relevant to

organization across the entire supply chain, as the use of quality premiums with growers significantly increases the adoption of formal contracts by 20%, and correspondingly, causes a nearly statistically significant 22% decrease (p-value=0.107) in adoption of informal contracts.

Conclusions

This study investigates factors influencing use of alternative approaches to coordinating exchange within the California grape and wine supply chain. Prior research has examined Spanish wineries' decisions to make or buy grapes (Fernández-Olmos, Rosell-Martínez, and Espitia-Escuer, 2009) and California grape growers' use of formal and informal contracts (Goodhue, Heien, Lee, and Sumner, 2003). We offer a more comprehensive analysis of the supply chain from vineyards to wineries' customers. In particular, we are the first study, to our knowledge, to examine the use of formal and informal contracts between wineries and their customers.

At other stages of the supply chain, our results corroborate prior findings that quality considerations and needs to protect investments in specialized or durable assets significantly increase usage of more formal coordination mechanisms (i.e., formal contracts and vertical integration or ownership of successive stages of the supply chain). Consistent with findings for other industries (Reuer and Arino, 2007), such investments are associated with greater contract complexity (i.e., number of contract provisions or terms) and inclusion of enforcement (i.e., dispute resolution and renewal) provisions, while trade partners' prior experience working together decreases contract complexity. Furthermore, our results suggest that quality considerations extend to greater use of formal contracts further downstream. As much of the variation in the contract provisions was unexplained by our models, there are opportunities to

enhance our understanding of the factors influencing their use. Future research may examine if these findings hold in other grape and wine production regions, for instance, in Midwestern U.S. regions of expanding winery tourism.

References

Ashenfelter, O., 2007, "Predicting the Quality and Prices of Bordeaux Wines," AAWE Working Paper No. 4.

Bollen, K.A. 1989. *Structural Equations with Latent Variables*. New York: John Wiley.

Castriota, S. and M. Delmastro, 2009, "The Economics of Collective Reputation: Minimum Quality Standards, Vertical Differentiation, and Optimal Group Size," AAWE Working Paper No. 50.

Cragg J.G. 1971. "Some Statistical Models for Limited Dependent variables with Application to the Demand for Durable Goods."*Econometrica* 39,5(September):829-844.

Cronbach, L.J. 1951. "Coefficient Alpha and the Internal Structure of Tests." *Psychometrika* 16,3:297-334.

Crozet, M., K. Head and T. Mayer, 2009, "Quality Sorting and Trade: Firm-Level Evidence for French Wine," AAWE Working Paper No. 40.

Dubois, P. and C. Nauges, 2007, "Identifying the Effect of Unobserved Quality and Expert Reviews in the Pricing of Experience Goods: Empirical Application on Bordeaux Wine," AAWE Working Paper No. 10.

Fernández-Olmos, M., J. Rosell-Martínez, and M.A., Espitia-Escuer, 2009, "Vertical Integration in the Wine Industry: A Transaction Costs Analysis on the Rioja DOCa." *Agribusiness* 25,2: 231-250.

Gergaud, O. and V. Ginsburgh, 2007, "Natural Endowments, Production Technologies and The Quality of Wines in Bordeaux. Is it Possible to Produce Wine on Paved Roads?" AAWE Working Paper No. 2.

Goodhue, R.E., D.M. Heien, H. Lee, and D.A. Sumner, 2003, "Contracts and Quality in the California Winegrape Industry," *Review of Industrial Organization* 23:267-282.

Grossman, S., andO. Hart. 1986. "The Costs and Benefits of Ownership: A Theory of Lateral Integration."*Journal of Political Economy* 94: 694-719.

Hair, J.F., R.E. Anderson, R.L. Tanham, and W.C. Black. 1995. *Multivariate Data Analysis*. Englewood Cliffs, NJ: Prentice Hall, Inc.

Hueth, B., and E. Ligon. 1999. "Producer Price Risk and Quality Measurement." *American Journal of Agricultural Economics* 81:512–24.

Hueth, B., E. Ligon, and C. Dimitri. 2007. "Agricultural Contracts: Data and Research Needs." *American Journal of Agricultural Economics* 89,5:1276-1281.

Jang, J. and F. Olson. 2010. "The Role of Product Differentiation for Contract Choice in the Agro-Food Sector." *European Review of Agricultural Economics* 37,2:251-273.

Jang J., and M. Sykuta. 2008. "Contracting for Consistency: Hog Quality and the Use of Marketing Contracts." Selected Paper presented at the American Agricultural Economics Association Annual Meeting, Orlando, FL, July 27-29, 2008.

Katchova, A.L., and M.J. Miranda. 2004. "Two-Step Econometric Estimation of Farm Characteristics Affecting Marketing Contract Decisions."*American Journal of Agricultural Economics* 86,1(February):88-102.

Landon, S. and Smith, C. (1998), "Quality Expectations, Reputation, and Price", *Southern Economic Journal*, Vol. 64, No. 3. (January), pp. 628-647.

Mahoney, J.T. "The Choice of Organizational Form: Vertical Financial Ownership Versus Other Methods of Vertical Integration."*Strategic Management Journal* 13,8(November 10, 1992):559-584.

Reuer, J.J., and A. Arino. 2007. “Strategic Alliance Contracts: Dimensions and Determinants of Contractual Complexity.” *Strategic Management Journal* 28:313-330.

Thompson, Bruce. 2004. *Exploratory and Confirmatory Factor Analysis: Understanding Concepts and Applications*. Washington, DC: American Psychological Association.

Williamson, Oliver. 1975.*Markets and Hierarchies: Analysis and Antitrust Implications*, New York, NY: The Free Press.

Williamson, O.E. 1979. “Transaction-Cost Economics: The Governance of Contractual Relations.”*Journal of Law and Economics* 22: 233-262.

Endnotes

[1] The relevance of quality for reputation and competitive advantage is well-documented for the wine industry in general (Landon and Smith, 1998; Dubois and Nauges, 2007; Ashenfelter, 2007; Castriota and Delmastro, 2009).

[2] The proportion contracted α_i equals the latent variable α_i^* for $\alpha_i^* = \beta_\alpha' X_i + \varepsilon_{\alpha i} > 0$ and equals zero otherwise, where $\varepsilon_{\alpha i}$ are independently and normally distributed residuals with mean zero and variance σ^2.

[3]Fernández-Olmos, Rosell-Martínez, and Espitia-Escuer (2009) find that growers' but not wineries' investments in dedicated and specialized assets significantly increase the probability of vertical integration of vineyard and winery stages of the supply chain. Our data does not allow us to distinguish whether such investments were made by growers or buyers.

[4] The marginal effect from the Tobit regression of in-house production confounds this adoption effect as 9% greater use of in-house grape production by such handlers, since the corresponding marginal effect from the truncated regression is statistically insignificant.

[5] A count regression, assuming a poisson distribution, yields qualitatively similar results as the Tobit regressions of contract complexity presented here.

Table 1. Respondents' Rankings of Top Four Quality Attributes Measured.

Quality Attribute	Most Important	2nd	3rd	4th
Sugar content (brix)	41%	17%	15%	4%
Ripeness/Maturity	10%	7%	1%	0%
Rot/Mold	3%	15%	12%	10%
Visual/Color	4%	7%	4%	9%
Flavor/Taste	20%	6%	1%	5%
Acidity (ph)	0%	21%	40%	30%
MOG	0%	2%	6%	8%

$N = 98$.

Table 2. Regression Results for Grape Handler Procurement Method

	Grow Formal	In-House Production			Formal Contract			Informal Contract		
	Tobit	Tobit	Probit	Truncreg	Tobit	Probit	Truncreg	Tobit	Probit	Truncreg
Years	0.005*	0.007***	0.011**	0.008***	-0.007***	-0.002*	-0.003**	-0.001	-0.003	0.010**
	(0.002)	(0.002)	(0.004)	(0.003)	(0.002)	(0.001)	(0.002)	(0.003)	(0.003)	(0.004)
Sales%	-0.477	0.232	0.266	-0.560	-0.907**	-0.180	-0.430*	0.856	0.782	-0.765
	(0.417)	(0.398)	(0.561)	(0.982)	(0.419)	(0.215)	(0.243)	(0.579)	(0.575)	(0.873)
Buyer:										
Retail	0.354	-0.286	-0.465	-0.356	0.764**	0.156	0.487**	-1.021**	-1.038**	-0.094
	(0.375)	(0.285)	(0.478)	(0.515)	(0.321)	(0.245)	(0.215)	(0.492)	(0.515)	(0.385)
Wholesale	0.223	0.004	-0.264	0.279	0.185	0.019	0.175	-0.500	-0.655*	0.140
	(0.247)	(0.184)	(0.325)	(0.335)	(0.210)	(0.157)	(0.146)	(0.317)	(0.354)	(0.211)
Direct	-0.042	0.046	-0.106	0.252	-0.231	-0.101	-0.130	-0.139	-0.167	0.076
	(0.285)	(0.210)	(0.385)	(0.319)	(0.245)	(0.184)	(0.186)	(0.413)	(0.481)	(0.270)
Export	0.881	0.102	-0.453	2.066	0.820	-	-0.506	-1.385	-0.648	-1.901
	(1.100)	(0.808)	(1.272)	(1.439)	(0.957)		(0.619)	(1.678)	(1.578)	(1.475)
Region:										
Sacramento	-0.055	0.276**	0.259**	0.324	-0.319**	-	-0.343***	0.050	0.028	0.008
	(0.175)	(0.132)	(0.113)	(0.223)	(0.150)		(0.101)	(0.239)	(0.233)	(0.249)
San Joaquin	-0.206	-0.281**	-0.277	-0.567**	0.345**	0.047	0.307***	-0.010	0.209	-0.993***
	(0.170)	(0.126)	(0.257)	(0.249)	(0.148)	(0.068)	(0.095)	(0.250)	(0.219)	(0.356)
Central Coast	0.001	-0.079	-0.148	-0.005	0.030	0.028	0.011	0.041	0.057	0.200*
	(0.103)	(0.078)	(0.133)	(0.126)	(0.088)	(0.058)	(0.061)	(0.133)	(0.141)	(0.118)
Buyer Contract	0.408***	0.163*	0.189	0.203	0.244**	0.205***	0.113	-0.657***	-0.433**	-0.754***
	(0.120)	(0.088)	(0.148)	(0.145)	(0.102)	(0.080)	(0.072)	(0.168)	(0.172)	(0.154)
Growth Inputs	0.167***	0.088**	0.181**	-0.002	0.056	0.073*	-0.007	-0.170**	-0.070	-0.307***
	(0.055)	(0.041)	(0.077)	(0.064)	(0.048)	(0.039)	(0.034)	(0.074)	(0.072)	(0.083)
Harvest Inputs	-0.041	-0.002	0.081	-0.031	-0.013	0.015	-0.005	-0.003	-0.054	0.109**
	(0.059)	(0.044)	(0.079)	(0.075)	(0.050)	(0.034)	(0.037)	(0.076)	(0.082)	(0.050)
Self Measure	0.155	0.451**	0.539**	0.842**	-0.412**	–	-0.293	0.005	0.009	0.285
	(0.212)	(0.184)	(0.253)	(0.398)	(0.190)		(0.117)	(0.306)	(0.291)	(0.353)
3rd Party	-0.019	-0.175	-0.342	-0.042	0.163	–	-0.013	-0.072	0.081	-0.188
Measure	(0.151)	(0.121)	(0.217)	(0.221)	(0.130)		(0.087)	(0.208)	(0.206)	(0.181)
Measurement	0.109	-0.013	0.129	-0.157*	0.172***	0.034	0.125***	-0.294***	-0.276**	0.098
Difficulty	(0.070)	(0.051)	(0.097)	(0.083)	(0.059)	(0.043)	(0.040)	(0.107)	(0.110)	(0.115)
Quality Premium	-0.030	-0.044	-0.079	0.030	0.026	-0.075	0.130**	-0.032	-0.078	0.062
	(0.101)	(0.075)	(0.121)	(0.119)	(0.087)	(0.065)	(0.062)	(0.132)	(0.138)	(0.106)
Sigma:	0.412	0.285	–	0.263***	0.342	–	0.222***	0.448	–	0.206***
Constant	(0.033)	(0.029)		(0.044)	(0.033)		(0.020)	(0.059)		(0.028)
R^2	0.2331	0.3329	0.2164	-	0.3401	0.2614	-	0.2747	0.2085	-
N	80	54	83	56	61	92	71	36	83	41
truncated				27 at 0			12 at 0			42 at 0
left censored	1 at 0.959	27 at 0			12 at 0			42 at 0		
right censored	2 at 2.900	2 at 0.89			10 at 1			5 at 1		

*,**,*** denote statistical significance at the 10%, 5%, 1% level.

Table 3. Regressions of Contractual Provisions

Variable	Complexity Tobit	Enforcement Tobit	Quality Coordination Tobit	Dispute Probit	Renewal Probit	Quality Probit	Delivery Probit
GrowthInputs	0.800***	0.282**	0.210*	0.133**	0.126**	0.169**	0.015
	(0.247)	(0.140)	(0.125)	(0.065)	(0.064)	(0.067)	(0.047)
HarvestInputs	0.070	0.112	-0.141	0.075	-0.014	-0.034	-0.059
	(0.249)	(0.142)	(0.127)	(0.063)	(0.059)	(0.058)	(0.058)
Duration of	-0.019**	-0.007	-0.004	-0.003	-0.003*	-0.001	-0.002
Relationship	(0.008)	(0.004)	(0.004)	(0.002)	(0.002)	(0.002)	(0.001)
Years	0.002	-0.002	0.001	0.000	-0.003	-0.001	0.001
	(0.009)	(0.005)	(0.005)	(0.002)	(0.002)	(0.002)	(0.002)
Sales%	1.204	1.273	0.116	0.459	0.409	0.067	0.021
	(1.506)	(0.854)	(0.774)	(0.447)	(0.337)	(0.339)	(0.308)
Tons Bought	3.390×10^{-5}*	1.690×10^{-5}*	2.560×10^{-6}	7.130×10^{-5}**	3.960×10^{-5}	4.260×10^{-5}	-3.540×10^{-6}
	(1.710×10^{-5})	(9.700×10^{-6})	(8.800×10^{-6})	(3.000×10^{-5})	(3.000×10^{-5})	(3.000×10^{-5})	(1.000×10^{-5})
Sigma:	1.983	1.114	0.146				
	(0.153)	(0.092)	(0.739)				
R^2	0.0448	0.0351	0.0177	0.1141	0.0867	0.0923	0.0372
N	89	80	93	98	98	98	98
left censored	3 at 0	6 at -1.441	2 at -1.211				
right censored	6 at 8	12 at 1.103	3 at 1.877				

*,**,*** denote statistical significance at the 10%, 5%, 1% level.

Table 4. Regression Results for Grape Handler Marketing Method

	Buyer Formality	Formal Contract			Informal Contract		
	Tobit	Tobit	Probit	Truncreg	Tobit	Probit	Truncreg
Years	0.003	0.005	0.006	0.001	-0.008*	-0.005	-0.005
	(0.005)	(0.005)	(0.004)	(0.002)	(0.005)	(0.004)	(0.005)
Sales%	2.234*	1.436	0.782	0.882	0.495	-0.046	2.318*
	(1.330)	(1.099)	(0.581)	(0.777)	(1.061)	(0.662)	(1.335)
Buyer:							
Retail	0.116	-0.172	-0.508	0.469*	0.143	-0.603	0.862*
	(0.720)	(0.648)	(0.443)	(0.270)	(0.567)	(0.566)	(0.490)
Wholesale	0.151	0.160	-0.294	0.427**	-0.214	-0.689*	0.339
	(0.470)	(0.426)	(0.292)	(0.180)	(0.378)	(0.406)	(0.315)
Direct	-0.487	-0.141	-0.097	-0.305	-0.465	-0.780	0.378
	(0.545)	(0.503)	(0.329)	(0.205)	(0.477)	(0.525)	(0.396)
Export	0.338	-0.584	-1.595	0.320	1.413	-0.425	3.392**
	(2.401)	(1.990)	(1.343)	(0.714)	(1.834)	(1.548)	(1.727)
Region:							
Sacramento	0.024	-0.089	-0.149	0.016	0.204	0.273	0.038
	(0.295)	(0.262)	(0.206)	(0.105)	(0.231)	(0.167)	(0.180)
San Joaquin	0.112	-0.041	0.118	-0.180	0.341	0.370**	-0.229
	(0.346)	(0.298)	(0.184)	(0.122)	(0.277)	(0.145)	(0.240)
Central Coast	-0.161	0.011	0.008	0.024	-0.251	-0.217	-0.008
	(0.202)	(0.175)	(0.119)	(0.072)	(0.166)	(0.145)	(0.139)
Grow Ourselves	0.783**	1.283***	0.614**	0.348*	-1.155***	-0.973***	-0.392
	(0.418)	(0.410)	(0.251)	(0.190)	(0.348)	(0.347)	(0.255)
Grow Contract	0.327	1.106***	0.544***	0.411***	-1.536***	-1.296***	-0.468**
	(0.318)	(0.323)	(0.195)	(0.161)	(0.295)	(0.303)	(0.212)
Quality Premium	0.154	0.247	0.204*	-0.014	-0.165	-0.224	-0.056
	(0.191)	(0.174)	(0.115)	(0.073)	(0.154)	(0.139)	(0.116)
Sigma: Constant	0.803	0.683	–	0.247	0.572	–	0.313***
	(0.079)	(0.087)		(0.025)	(0.078)		(0.045)
R^2	0.0755	0.0469	0.1848		0.0898	0.3203	
N	61	41	88	58	35	87	45
Truncated				30			42
left censored	9 at 0	30 at 0			42 at 0		
right censored	17 at 2	17 at 100%			10 at 100%		

*,**,*** denote statistical significance at the 10%, 5%, 1% level.