Contracts, Quality, and Industrialization in Agriculture: Hypotheses and Empirical Analysis of the California Winegrape Industry

Rachael E. Goodhue, Dale M. Heien, Hyunok Lee and Daniel A. Sumner*

University of California, Davis

Revised December 25, 2000

*Rachael Goodhue is an assistant professor, Dale Heien a professor, Hyunok Lee a research economist, and Daniel Sumner a professor all in the Department of Agricultural and Resource Economics at the University of California, Davis. Sumner is also the director of the University of California Agricultural Issues Center (AIC). Goodhue, Heien, and Sumner are members of the Giannini Foundation of Agricultural Economics.

The authors thank Barry Bedwell, past president, Allied Grape Growers, for valuable information regarding the structure of winegrape contracts. James Tippett and his staff at CASS (California Agricultural Statistics Service) were very helpful in preparing the survey mailing. The authors thank the survey respondents for their cooperation, which made contract information available and this publication possible. The survey was supported by the AIC and descriptions of the data appeared in Goodhue, Heien and Lee.

Introduction

A perceived change in the organizational focus of American agriculture has given rise to the increased use of the term industrialization. Essentially, this change is viewed as a movement from a homogeneous commodity system to one emphasizing product differentiation (Urban, (1991)). Movement toward increased product differentiation is associated with greater vertical integration which relies on improved information. Often drawing contrasts between the 'old' agriculture and 'new', the industrialization literature is largely descriptive (Drabenstott, 1994; Hurt; Boehlje, 1995; Boehlje, 1996). Rather than developing explicit testable hypotheses, the literature discusses outcomes informally and links them with possible motivating factors using frameworks drawn from economics and management (Barkema, Drabenstott and Cook; Boehlje and Schrader; Sporleder). With the exception of Hennessy, explicit linkages are left undeveloped. In their place are a number of implicit hypotheses regarding the relationships among vertical integration, information and other changes in agriculture.

This paper focuses on contract provisions and product quality in a quality differentiated product system: the California winegrape industry. Contracts provide a vehicle to encourage and monitor cultural practices, provide bonuses or penalties for product attributes, and facilitate product control. We explicitly identify hypotheses regarding the nature of information and the change in this relationship that seem to be implicit in the industrialization literature. Analyzing data from a survey of California winegrape growers, it is demonstrated that these implicit hypotheses often do not hold.

Explicit evaluation of the factors underlying the design of agricultural contracts is particularly important now. Contracting is increasingly important as a means of organizing farmgate transactions. Concern regarding the impacts of these arrangements on participant risk and returns, and on-farm control of farm resources is widespread (ERS). In order to assess these impacts correctly, it is essential to test theories underlying existing explanations of these contracts. Here we test a specific set of

theoretical hypotheses and conclusions for an important industry, California winegrapes, that has highly sophisticated production and marketing.

Agricultural Industrialization, Information and Coordination

It is always difficult to capture a large literature in a few sentences. This is particularly true for a descriptive and diffuse set of ideas, such as those represented by "industrialization of agriculture." Nonetheless, we must attempt that now. The industrialization storyline regarding quality information and vertical integration may be summarized as follows. Differentiated markets need (more differentiated) information on product characteristics, in order to determine whether or not the product meets market demand. This demand for information is much less important in undifferentiated commodity markets. For example, Barkema suggests that government-administered grading systems will be too broad to serve markets with product differentiation. He suggests that grades will be replaced by internal standards enforced through contracts, integration, or other vertical coordination measures. Similarly, Boehlje and Schrader suggest that contracts and integration will allow quality standards to be met more easily. Implicitly, this step in the argument is based on one of the following two hypotheses: either, markets will not provide the necessary quality information, so that closer integration is necessary to serve the differentiated markets, or it is less costly to obtain quality information in an integrated system than in a market-based system.

In the industrialization framework the shift to differentiated markets involves a shift from symmetric to asymmetric quality information. That is, quality information in a commodity market is cheap and easily available to both buyers and sellers. In differentiated markets, the relevant information is costly or difficult to acquire for the buyer. (Cook; Barry, Sonka and Lajili; Barkema and Cook; Barkema; Hennessy). Thus, the information that is most valuable in differentiated markets differs from that in commodity markets. The idea that differentiated markets have more demand for

costly and asymmetric information remains largely unexamined, and, to the best of our knowledge, has not been explicitly tested.

The patterns of information costs are vital determinants of vertical coordination. In turn, models with different motivations imply different distributions of returns across the marketing chain. By imposing a specific set of hypotheses regarding the information costs in differentiated markets, models may imply a distribution of returns that does not reflect reality. In turn, this will distort any evaluation of the implications of a transition to differentiated markets.

A related literature analyzing agricultural contracts has developed recently. This literature focuses on evaluating the design of a specific vertical coordination measure. Consistent with the assumptions of the broader industrialization literature, economists have explained contact design using transaction costs (Knoeber), moral hazard (Knoeber and Thurman; Tsoulouhas and Vukina; Hueth and Ligon), and adverse selection (Goodhue, 2000). While this approach would appear fruitful for developing testable hypotheses related to industrialization, unfortunately there are two problems. First, models of contracts generate few testable predictions that distinguish one explanation from another. This is particularly true in cases for which an actual contract, or observations on contract provisions, are the only forms of available empirical evidence (Goodhue, 1999). Second, the industrialization literature largely neglects the *design* of vertical coordination measures, in favor of simply delineating degrees of coordination. This approach supports the contracting literature's use of industrialization's implicit assumption of costly, asymmetric information to explain specific vertical coordination measures, even when this explanation is observationally equivalent to other theoretical explanations (Goodhue, 1999). Here, we test the hypothesis regarding the importance of asymmetric information and an alternative, symmetric information explanation. We are able to develop an observationally distinct hypothesis for this comparison.

The neglect of issues related to the design of vertical coordination measures in favor of the degree of coordination suggests a second, perhaps more provocative, implicit hypothesis of the

industrialization literature: the features of a specific vertical coordination measure are not yet an important consideration within the paradigm. More simply, vertical coordination measures are substitutes, rather than complements. Here we test whether various approaches to vertical coordination are substitutes.[1]

We conclude by testing the most fundamental implicit hypothesis of the industrialization literature, contained in the definition of industrialization: vertical integration provides the means by which food system members communicate the product attribute information that is necessary to meet consumers' desires for differentiated products. To do so, we accept the nested implicit hypothesis of costly, asymmetric information. We examine the importance of two alternatives to vertical coordination: bonding and efficiency pricing (in the sense of efficiency wages in the labor literature).

Information and coordination in California winegrapes

We analyze vertical coordination and integration in the California winegrape industry, and use our analysis to critique the industrialization paradigm, particularly the relationship between information and vertical integration/coordination. The California winegrape industry fits most, perhaps all, of the identified characteristics of an industrialized agricultural sector. Wine is a highly differentiated commodity. A significant share of this differentiation is due to differentiation in the raw material originated at the farm level: region, variety, etc. According to our 1999 survey of winegrape growers, more than 90 percent contract with wineries for the sale of grapes. There is no state-mandated grading process for winegrapes; rather, wineries use internal standards that may be specified in contracts.

[1] Readers familiar with the industrialization literature may argue that the use of the marketing-production-resource provision contract distinction developed by Mighell and Jones refutes our identification of this implicit hypothesis. However, it is possible to obtain a desired outcome by providing incentives (e.g. price incentives in a marketing contract) *or* by monitoring (e.g. production specifications, resource provision) (Maskin and Riley). Mighell and Jones themselves recognized this point: "The three-way grouping suggested above is convenient for some purposes. However, it needs to be recognized that strategic control[,] virtually equivalent to control under vertical integration[,] may be achieved under any of the groups." (p. 14).

Although the winegrape industry as a whole could be considered an industrialized farm industry serving differentiated markets, there are significant differences within the industry regarding the components of product quality. Product quality is largely based on observable characteristics, especially sugar content or brix, in the Central Valley, while important quality characteristics, other than acid, variety and appellation, are harder to measure in the premium wine-producing areas of the coastal regions. We argue that the different nature of the information necessary for serving specific differentiated product markets affects the nature of vertical coordination.

Explicit empirical hypotheses from the industrialization paradigm

Our task here is to make the industrialization framework operational. In general, the key idea is that differentiated products and markets imply vertical coordination through contracts that influence farmer production decisions using input control measures or price incentives. We list two initial specific hypotheses about vertical coordination applied to the winegrape industry that are consistent with the industrialization paradigm. Both hypotheses attempt to capture the notion from the industrialization literature that the degree of vertical coordination is the important organizational feature associated with differentiated product markets.

Hypotheses 1 and 2 start with the simplification that all winegrape regions and producers are equally industrialized. Clearly, there is room to debate any interpretation of the industrialization literature through testable hypotheses.[2] We offer a second, more nuanced, set of hypotheses that are also consistent with the general industrialization framework. These hypotheses are based on the observation that within the wine and wine grape industry, premium grape production and winemaking,

[2] In particular, readers familiar with the industrialization literature may note that we offer no hypotheses regarding the effect of farm size on the producer's involvement in industrialized agriculture. We do so for two reasons. First, due to the relatively high per acre value of grapes grown in the premium production areas and the nature of our data set, acres is not a useful measure of size, and even gross revenue does not capture the most appropriate concept of farm size. Second, the industrialization literature does not have a consensus on this relationship. Some authors predict that industrialization will eliminate small farms (e.g. C-FARE; Boehlje, 1999). Others take a more nuanced view, and predict that industrialization will

which take place in regions with higher priced grapes, are more specialized and differentiated. For example, there were 285 wineries in Napa County for 102,000 tons of grapes in 1999. In the southern San Joaquin Valley crush district (Stanislaus, San Joaquin and Merced counties), there were 27 wineries and 293,000 tons of grapes in 1999. Using a different measure, in Napa County the ratio of the range of prices to the mean price for Cabernet Sauvignon grapes in 1999 was 1.89, while for the southern San Joaquin Valley the equivalent ratio was only 1.18. For Chardonnay grapes, the Napa ratio was 1.5 and the southern San Joaquin ratio was 1.18. For Merlot grapes, the pattern is less striking: the Napa ratio was 1.32, and the southern San Joaquin ratio was 1.29. The overall pattern suggests greater differentiation in premium grape regions. If premium production is more industrialized, then it should display closer vertical coordination.

Hypotheses 1a, 2a, and 2b follow from this argument. Our formal statements of the hypotheses obtained from the two applications of the industrialization framework to the California winegrape industry follow.

Hypothesis 1: **The winegrape industry as a whole is fully industrialized, so the proportion of winegrape growers who contract will not vary by region or by farm characteristics.**

Hypothesis 2: **The frequency of price incentives and involvement of wineries with farm production decisions will not vary by region or by farm characteristics.**

Hypothesis 1a: **There will be a higher degree of contracting in the premium wine growing regions.**

Hypothesis 2a: **Price incentives for meeting specifications are more likely to be included in contracts in premium grape areas.**

Hypothesis 2b: **Clauses establishing winery involvement with farm production are more likely to be included in contracts in premium grape areas.**

---

reduce the number of small commercial farms, so that any bimodal nature of the farm size distribution will become more pronounced (Barry). However, with respect to the bimodality hypothesis itself see Wolf and Sumner.

Information and coordination characteristics

To contrast with the industrialization literature, we develop additional testable hypotheses regarding relationships between information and vertical coordination in the California winegrape industry. We know that a significant percentage of growers reported coordination with buyers through a contract in all winegrape production areas. Based on differences in the observability of key product characteristics, however, we hypothesize that the nature of this coordination will differ by the quality of grapes and other regional characteristics. In contrast with the industrialization literature, we develop a model of costly but symmetric information in order to obtain our testable hypotheses.

Consider a winery that is interested in obtaining grapes that meet its quality specifications.[3] Let us develop a simple model of this decision. There are two pre-crush indicators of grape quality for wine: production practices followed during the growing season and grape characteristics at the time of harvest.[4] Each of these indicators is an imperfect, but unbiased, indicator of quality. Wineries can evaluate grape juice after harvest, but this is not a perfect measure of the quality of the wine that is ultimately produced. Indeed, in some cases fuller knowledge about where and how the grapes are grown can be more revealing than information about the observable grape characteristics at harvest. We assume, for simplicity and emphasis on our main concerns, that it is equally costly for the winery to use either of these indicators.[5] We assume first that the vintner may use only one of the two assessment methods.[6]

[3] Clearly, this problem is only part of the winery's optimization problem, which involves selecting the profit-maximizing quality specifications. Here, rather than considering this broader profit maximization choice, we are concerned only with the assessment methods supporting that decision.

[4] In addition, the rootstock, the clone, and the vineyard's soil and microclimate are all indicators of winegrape quality. Once chosen, these factors remain constant and known, so we do not incorporate them explicitly in our model.

[5] Relaxing this assumption will not substantially alter our theoretical findings for the purpose of analyzing the winegrape industry. Theoretically, rather than the relative variance of the two indicators alone determining their desirability, the relative costs, benefits, and accuracy of the two measures will jointly determine their desirability.

Formally, we model grape quality in wine production, W, as a function of harvest time characteristics, H, and production practices, G. A set of production practices, given the weather and vineyard location, results in a set of harvest-time characteristics that creates a set of wine quality attributes, so that there is a one to one mapping between the sets. The taste characteristics of the wine, for example, may be represented by W. Sugar content, or brix, of the grapes may be represented by H. Irrigation timing and amounts of water that were applied during the growing season may be represented by G. For analytical convenience, we assume units can be defined such that W=H=G. Since winemaking is costly, vintner j would like to minimize deviations from his ideal wine attributes, W_j*. We assume that increasing deviations are increasingly costly.[7] The vintner observes H_k or G_k for grower k with error, and rejects grapes that do not meet his specifications W_j*.[8] More formally, the vintner's objective is

$$\text{Min}_{Hk,Gk} \; E[(W_{jk}-W_j^*)]^2.$$

He has two assessment methods at his disposal. The accuracy of the two methods depends on his ideal attributes, W_j*. His harvest-time technology results in a quality report of h_{jk}, where

$$h_{jk}=H_k+e(W_j^*)$$

$$E[e(W_j^*)]=0, \text{ and}$$

$$\text{var}(e(W_j^*))>0.$$

However, in winegrapes, the costliness of observing production practices is greater than that of testing sugars at harvest time, while the benefits of either method are larger in the premium wine areas. Hence, the relative cost-benefit ratios of the assessment methods results in the same qualitative predictions across growing areas as does the relative accuracy of the assessment methods in the different areas alone.

[6] This approach is similar to the structure of a principal-agent model where the winery is specified to be the principal and the grower to be the agent. We do not, however, require a relationship of principal-agent or agent-agent in order to develop our hypotheses.

[7] We abstract from aggregation issues, although clearly a vintner is concerned with the average quality of all the grapes he intends to crush and eventually bottle together. Aggregation can complicate the incentive problem, as in Goodhue (2000). Control over production practice can be used to reduce information rents when agents are heterogeneous, as well as to affect product quality.

[8] In practice grapes are almost never rejected; the price is renegotiated instead. Since we abstract from aggregation considerations (discussed in the previous footnote) and the possibility that the winery may produce multiple wines with varying quality levels, we model a simple rejection of grapes, rather than a price renegotiation based on such considerations.

His growing practices assessment method results in a quality report of g_{jk}, where

$$g_{jk}=G_k+f(W_j^*)$$

$$E[f(W_j^*)]=0, \text{ and}$$

$$var(f(W_j^*))>0.$$

The random variables e and f are independent. Of course, since $H_k= W_j^*$, the realized mean of the harvest assessment method, $E[h_{jk}]$ will equal the vintner's desired attributes, W_j^*, since he will reject any grapes that do not meet his specifications. Again, since $H_k= W_j^*$, the variance of the harvest assessment method, $var(h_{jk})=E([h_{jk}-E[h_{jk}])^2$, equals the variance of realized quality, W_j, around its expected value of W_j^*. The variance of h_{jk} equals $var(e(W_j^*))$. Thus, the variance in realized grape quality is a function of the desired attributes. An identical set of arguments applies to the production practice assessment method. Therefore, a vintner minimizes costs by choosing the assessment method with the lowest error variance.

Proposition One: When the assessment methods are equally costly, vintner j will choose his assessment method according to the following rule:

a. When $var(e(W_j^*)) < var(f(W_j^*))$, i.e. at-harvest testing has a lower variance, the vintner will choose to test quality at harvest.

b. When $var(e(W_j^*)) > var(f(W_j^*))$, i.e. growing-condition observation has a lower variance, the vintner will choose to monitor grower production practices.

c. When $var(e(W_j^*))=var(f(W_j^*))$ he will be indifferent between the two methods.

In order to operationalize this proposition, we must characterize the accuracy of these assessment methods for different sets of grape attributes. Regarding the monitoring of production practices, there is no reason to believe that its accuracy differs substantially across W* choices. It seems likely that vintners in all regions can obtain a somewhat accurate idea of the quality of grapes to be delivered through monitoring the fields. This consistency is unlikely to be the case, however, with assessment of grapes at harvest. According to viticulture and enology experts, sugar content is the

most important product characteristic for lower-priced grapes and in regions that generally produce lower quality wine. Sugar content is easily measured at harvest, when the winery purchases the grapes. However, in the premium grape regions and for grapes used to make the more expensive wines, sugar and similar easily measured characteristics are not the most important factors that distinguish quality. The specific location of the vineyard, which is of course known to all in advance, and more subtle grape characteristics affect the relative values of grapes. These additional desired characteristics of premium winegrapes are generally difficult to measure at the time of purchase. This suggests that the accuracy of the harvest-time assessment for the quality attributes that matter most is high for Central Valley vintners, and low for premium vintners in the coastal regions. This results in three possible cases: one, where even the premium area-harvest assessment is more accurate than observing production practices; two, where even the low price-harvest assessment is inaccurate relative to observing production practices; and three, where the premium harvest method is less accurate than monitoring production practices, which in turn is less accurate than the low price harvest method. Based on knowledge of the winegrape industry, the third case is the most relevant.

Interpreting Proposition One based on our discussion on assessibility, we obtain predictions regarding hypotheses 2a and 2b: we predict that 2a will be rejected and 2b will be accepted. Price incentives are more likely to be used when important product characteristics can be accurately observed at harvest. Price incentives for grape characteristics observed at harvest are more likely to be used in the lower-priced regions that emphasize sugar content. This suggests a rejection of Hypothesis 2a, in contrast to the industrialization hypothesis. Based on Proposition One, winery involvement in specifying farm production behavior in contracts is more likely when important product characteristics cannot be observed accurately at harvest (purchase). Contract specification of production practices is more likely to be used in premium winegrapes regions, which suggests an acceptance of Hypothesis 2b. This prediction is the same as that obtained from the refined version of the industrialization paradigm.

These two hypotheses regard the likelihood of specific provisions, given that the grower and winery choose to enter a contract. As we discussed above, the industrialization literature does not distinguish effectively within a given form of vertical coordination. More broadly, the literature does not appear to recognize that there are a number of ways for a processor to provide incentives to growers to induce them to produce raw materials that are likely to have the unobservable characteristics desired by the processor, as discussed in footnote 1. The industrialization literature views coordination and integration as the only way to deal with this asymmetric information. Coordination may allow the winery to monitor or control portions of the production process, while integration provides the winery with complete control.

Information and incentives: Alternatives to coordination

In this section, we accept the maintained hypothesis of costly, asymmetric information in order to focus on the usefulness of means other than vertical coordination for conveying information about grape quality. Two alternative mechanisms would provide growers with the appropriate incentives, but are not addressed in the industrialization literature: efficiency incentive pricing and implicit bonding (see, for example, Ritter and Taylor, or Bar-Ilan). If a winery pays a relatively high price for grapes that is associated only, in part, with field location, and, in part, contributes to the grower's producer surplus, the grower will have an incentive to provide grapes of the appropriate quality. The wine vintage will eventually reveal these attributes to the winery (albeit imperfectly, due to multiple growers selling grapes), and the grower wishes to continue to receive a high price for future harvests. Similarly, a grower's up front investment in the land, equipment and vines necessary for growing grapes may be viewed as a bond guaranteeing his performance, to the extent that his costs cannot be recovered through resale if his farm's reputation suffered. His investment can only be recovered through growing winegrapes with the desired attributes. Both of these mechanisms are consistent with the use of a market for transactions between growers and vintners that provide incentives for quality.

In practice, with repeated interactions parties to transactions accumulate information about each other over time. Increased information and, perhaps, the development of trust between the parties, may reduce the use of formal contracting.[9] This discussion provides us with a number of hypotheses regarding who within a region will coordinate formally through a contract. We contrast these alternative explanations with agricultural industrialization by developing comparable hypotheses from the agricultural industrialization literature.

Based on the efficiency pricing argument, we develop the following hypothesis:

Hypothesis 3: **Growers who obtain a higher price relative to others within a region-variety group are less likely to use a contract.**

Similarly, the efficiency pricing argument suggests that even if growers do use a contract, the contract is less likely to specify coordination mechanisms, such as requiring certain viticultural practices.

Hypothesis 3a: **Growers who obtain a higher price relative to other within a region-variety group and use a contract are less likely to have production practice requirements in such contracts.**

The bonding argument suggests another hypothesis. New growers will not have had sufficient time in the business to recoup their investment, and perforce are effectively bonded.

Hypothesis 4: **Within a region, new growers are less likely to have a contract.**

While new growers are effectively bonded, and hence less likely to have a contract, by definition they have less experience and knowledge regarding grape production, so that this prediction does not readily extend to the degree of control given that a contract is signed.

Finally, learning and the accumulation of information over time suggest the following:

Hypothesis 5: **Within a region, growers who have a longer-term relationship with their buyer *relative to their years growing grapes* are less likely to use a contract.** [10]

[9] One North Coast grower, for example, said that after 20 years of dealing with the same winery, it would be an insult if the winery exhibited a lack of trust by requiring a written contract.

[10] One large, experienced Suisun Valley grower said that if a winery tried to specify his production practices he would shift to another buyer. He claimed his reputation demonstrated his ability.

Like Hypothesis 3, Hypothesis 5 extends naturally to the degree of control within a contract, given that a contract is used.

Hypothesis 5a: **Within a region, growers who have a longer-term relationship with their buyer *relative to their years growing grapes* will have less buyer control of production, given that a contract is used.**

The broad brush approach of the industrialization literature obscures the potential importance of heterogeneity within a sector, and how it will affect organizational and technical choices. In this particular case, the industrialization literature's focus on vertical coordination as the means of information transmission obscures the potentially important role of these more informal means of information transmission. For comparison, we develop the parallel predictions from the industrialization paradigm for hypotheses 4 and 5, based on the implicit assumption that different forms of vertical coordination are substitutes. (Hypothesis 3 does not have an easily justifiable parallel within the paradigm.) In particular, the paradigm suggests that formal and informal vertical coordination measures are substitutes, leading us to predict a rejection of Hypothesis 4 and acceptance of Hypothesis 5. The predicted rejection of Hypothesis 4 reverses the relationship predicted by the bonding approach. The predicted acceptance of Hypothesis 5 is the same as predicted by learning and trust. Table 1 summarizes our hypotheses, and the predictions from each framework for each hypothesis.

Survey and Data Description

In June 1999, the authors conducted a survey of contract usage in the California winegrape industry that was sponsored by the Agricultural Issues Center at the University of California. The survey was based on a questionnaire mailed to about 12,000 growers statewide (see the Appendix insert for a copy of the questionnaire). The CASS (California Agricultural Statistics Service) grape acreage database was used for this mailing. This database included all known grape growers and

wineries. About 10 percent of the total are engaged in winemaking, either as a winery-grower or as a winery alone. The Center received more than 2,000 total responses, a nearly 20 percent response rate. Since a grower's time is valuable, we kept the questionnaire simple and short—one page, asking mostly yes or no answers.

Table 2 compares our survey coverage to the overall CASS data, based on 1362 usable grower responses. The percentage response from each region closely matches the grower population percentage (CASS) in that region. This is one indication that the survey is representative of the population of growers. Survey respondents were generally operators of larger vineyards. However, the relative sizes of CASS acres per grower versus survey acres per grower in each region are similar. This is important since there are difficulties in ascribing average size to intervals (see survey question 15).

The survey included questions on contract use, contract provisions, and grower characteristics. Growers were asked the varieties they produced, their total acreage, the length of their current buyer/seller relationship, and the length of their time in the grape business. Contract use was reported for written contracts, oral contracts, both, and neither. Contract provisions included questions on price incentives, evergreen clauses, best viticultural practices clauses and specification of specific viticultural practices, among others.

Contract usage is widespread in the California winegrape industry. Table 3 shows that 90 percent of respondents have contracts with wineries and most of those are written. Further, overall about 10 percent of contracts were made before vines were planted (planting contracts). This percentage is highest in the Central Valley where the share of new winegrape acreage is high. Table 3 also shows that contracts with evergreen (renewal) clauses are common, accounting for 30 percent of all contracts and as much as 45 percent on the North Coast.

Table 4 presents statistics on farm characteristics by region for survey respondents. Among the values, acres and regional ton price show a distinct pattern: farm size becomes smaller as regional

price increases. Most sellers have been in the grape growing business for many years — the average was 20.6 years, with little variation by region. The average time with the same buyer was 9.7 years, again with little regional variation.

Contract provisions are summarized in Table 5. In this paper, we focus on provisions concerning cultural practices and bonuses and penalties. While contracts commonly suggest specific practices, requiring specific practices is uncommon. Reporting of chemical use before and after is routine. In California, it is also true that chemical application on a farm is controlled; farmers are required to report chemical applications to the county office. The extent of bonuses and penalties for sugar, acids, MOG (material other than grapes) and defects (rot, mildew, etc.) are also important contract features. As shown in Table 5, penalties are more prevalent than bonuses, although 33 percent of contracts in the San Joaquin South/Other region do provide for a sugar bonus. Overall, only about 10 percent of contracts have bonus provisions, while over 35 percent of contracts have penalty provisions.

Tests of Hypotheses

We now turn to testing the above hypotheses using logistic regressions on the data set described above. We examine factors that influence whether or not a grower has a contract and factors that influence the choice of contract terms, specifically, the factors associated with the use of price incentives and winery involvement in the production process.[11]

First we must select or construct empirical variables for our hypothesis tests. Three types of variables bear particular interest: price incentives, production practices, and average expected quality of winegrapes (indicated by the average price received in the region where the grapes are produced).

[11] Clearly it would be preferable to have data on the characteristics of both the grower and the winery, matched to each transaction. However, other studies have examined information-based problems using data based on characteristics of only one party. (See, for example, Lemmon, Schallheim and Zender's study of executive compensation.)

Regarding production practices, our survey asked whether the contract has provisions on: 1) specific viticultural practices (required or suggested), 2) the report of chemical use prior to the use, and 3) the report of chemical use after they have been applied. We used information on these three variables to reflect the winery's involvement in production. Price incentive variables mainly include bonuses and penalties. These incentives are used for quality characteristics such as sugar, acids, material other than grapes (MOG) and defects, all of which are observable and verifiable at the time of harvest.

Our survey did not ask for price information directly from growers because growers are often particularly sensitive to such questions. Instead we traced the locality of the farm, matched the locality with the crush district, and used average crush district price. The price we assign to each observation therefore reflects an area-average price rather than the price caused by the bargaining skill or luck or farming skill of the individual respondent. While this price information is only approximate, for our purposes here one advantage of using this district price is that we avoid a simultaneity bias. We use the regional price variable as an indication of winegrape quality in the region. In the context of the industrialization literature, winegrapes of different varieties and quality can be viewed as differentiated products. The specific location of vineyard is also a major factor regarding product differentiation and thus in determining quality.[12] Given this close relationship between region and quality, our regional average price conveys a reasonable indication of the quality of winegrapes.

To test our hypotheses, we ran three basic sets of regressions that involve three broadly defined relationships: 1) the patterns of contract use and farm characteristics, 2) production specifications in the contract and farm characteristics and 3) grower price incentives in the contract and farm characteristics. In each relationship category, we analyze multiple specifications using different binomial dependent variables. In the specifications, the variables that are used to represent farm or farmer characteristics are acres of the vineyard, years in business as a grape grower, years with the

[12] Variety is a secondary factor compared to region. For instance, chardonnay grapes from the Central Coast garner only half of the price as those in Napa and the Central Valley chardonnay are far lower priced yet.

current buyer, and regional price. While our hypotheses focus on farm characteristic variables, we also include other explanatory variables on contract characteristics, such as the inclusion of planting contract and/or evergreen clauses, and contract length.

We recognize that, over some horizon, almost any farmer or farm characteristic may be considered a choice variable and hence jointly determined with contract provisions. The same is true of contract length and other contract characteristics that may capture aspects of the contracting relationship, particularly planting contract and evergreen clauses. Unfortunately, data are not available on clearly exogenous instruments for a full simultaneous equation model, nor are we able to test for endogeneity using, for example, a Hausman-Wu test. Our results are conditional on the maintained hypothesis that right-hand-side variables are predetermined relative to the dependent variable in each specification. The lack of sensitivity to alternative model specifications gives us some confidence that our results are robust to these concerns.

Table 6 reports the regression results on contract use. Results for three alternative dependent variables are reported in each of the three columns. In column 1, oral and written contracts are grouped together and no-contract is a separate category. In column 2, we group oral contracts with no contracts, and specify written contracts as the separate category. Then, in column 3 we leave out observations claiming the oral contracts and examine how the explanatory variables account for sorting the observations into written contracts versus no contract. In every case, the effects of all four explanatory variables are positive; in columns 1 and 3 they are all strongly significant in explaining the likelihood of a farmer engaging in a contract. That is, farms engaging in more years with the specific buyer, more business experience, larger vineyards, and producing higher-value winegrapes per unit are more likely to have a contract whether oral or written. Only if we attempt to group oral contracts with no contract do we get less significant effects. These results in Table 6 allow us to reject Hypothesis 1 that predicts there is no significant variation in contract usage across grower characteristic or average quality or differentiation. Our findings on regional price indicate that we fail to reject Hypothesis 1a

that a higher degree of contracting would be found in the premium wine growing regions. Growers in those regions with the highest grape prices, where quality is highest and where differentiation is most prevalent, are significantly more likely to have contracts. This is true holding constant size of grape acreage, and two measures of farm tenure.

Our results in table 6 also allow us to test Hypotheses 4 and 5. Our findings on years in business indicate that newer growers are less likely to have a contract, holding regional price constant. This result is consistent with bonding, so we fail to reject Hypothesis 4. This is counter to industrialization but consistent with bonding. Based on learning and development of trust, Hypothesis 5 predicts that contracts are less likely for those who have been dealing with their buyers for a longer period of time. This also rejects the implication of industrialization which predicted the same sign as learning. Our data indicate clearly that the longer the relationship with the buyer the more likely there is a contract, even holding constant total years in the business. Thus, given the positive sign of the years-with-buyer variable, our results reject Hypothesis 5. (We acknowledge here a concern that to some degree contracts could lead to long-term relationships, and thus some causation could run in the opposite direction. This is a subject for further research with richer data.) We have insufficient information to test Hypothesis 3 regarding a lower likelihood of a written contract for farms with higher grape prices within a region. We do not have price information within regions. We hope to collect such data in our follow-up survey.

Our empirical tests of the hypotheses about information, quality and contracting are contained in Tables 7a and 7b. Table 7a provides the results on three contract provisions by which wineries attempt to control grape farm production practices, while Table 7b reports the results on the use of price incentives for grape quality characteristics. The first column of Table 7a measures the effects of contract or grower characteristics on the likelihood that a contract suggests or requires specific grower practices. About half of the contracts had such a provision. The next two columns of Table 7a measure the relationship of grower characteristics and other contract provisions on the likelihood of

contract provisions related to chemical use. In Table 7b, the dependent variable in the first column is whether the contract specifies any bonuses or penalties for grape quality attributes. The next four columns provide analysis of bonuses or penalties for four specific quality attributes. In what follows, our discussion on hypothesis tests will be based mainly on the results on the first equations of Tables 7a and 7b. Results on other equations will be used as supplemental information.

Results reported in Tables 7a and 7b clearly reject Hypothesis 2 that predicts no link between the likelihood of contract price incentives or production restrictions and farm characteristics. In particular, column one in both Table 7a and Table 7b show a strong pattern of significant relationships between farm and farmer characteristics and whether the contracts provided for either production practice restrictions (Table 7a) or price incentives (Table 7b). Every one of the farm characteristic variables is strongly significant in one or the other of these two specifications. Regional price and years in the winegrape business have significantly positive effects on both the likelihood of winery control provisions and price incentive provisions.

Hypotheses 2a and 2b concern the relationship between the contract provisions and the price of winegrapes. Our data reject Hypothesis 2a and fail to reject Hypothesis 2b. As predicted by Hypothesis 2b, the regional price has a strongly positive effect on the likelihood of specific practices being included in the contract (Table 7a). But, counter to Hypothesis 2a, Column 1 of Table 7b shows that growers in regions with higher priced grapes (and where the industry is more differentiated) are less likely to have quality-based price incentives included in the contract (two equations of the attributes also support this).

Table 7a also allows us to test Hypothesis 5a that predicts less buyer control of production with a longer-term buyer-seller relationship. Our results indicate the opposite—more production control is associated with longer-term relationships, resulting in the rejection of Hypothesis 5a. Bonuses and penalties are also more likely for those that have more years in the business. Our data suggest that a

longer-term relationship (and thus more learning), among the written contract users, does not substitute for formal contract provisions.

Our data support the important finding that contracts in those parts of the winegrape industry with higher quality and more differentiation are less likely to contain bonus or penalty provisions. Price incentives for any of the measurable quality characteristics are less likely to be found in the regions with higher priced, higher quality grapes. This is also true for the specific MOG and defects quality attributes. This finding contrasts with the industrialization hypothesis that more product quality differentiation leads to contract provisions specifically rewarding quality. Our results suggest that we would expect more use of price incentives in those regions where quality attributes are more easily measured and less use of these contract provisions where the most important quality attributes cannot be measured well at the point of delivery. This finding suggests that broad generalizations about industrialization need to be replaced by careful industry specific knowledge about the pattern of information costs.

For all the models in Tables 7a and 7b, we ran the models excluding the three contract characteristics control variables. In every case, the signs and significance of the farm characteristic variables are unchanged. This provides some reassurance that our results are reasonably robust.

Conclusion

The agricultural industrialization literature has developed in a largely descriptive fashion. The hypotheses underlying its arguments are often implicit and untested. Here, we offer explicit statements of some of these hypotheses, and test them using data from the California winegrape industry. Table 1 summarizes the predictions of the industrialization approach and our test results from the California winegrape industry. Our analysis of the California winegrape industry illustrates that asymmetric information is not a necessary condition for an agricultural sector devoted to supplying differentiated markets. Hence, the industrialization literature's discussion of the relationship between the degree of

vertical integration and product specialization is often misleading in this case. The relationship is critically dependent on the observability and verifiability of information regarding product characteristics. Some undifferentiated markets may have asymmetric information regarding product characteristics, while, as appears to be the case here, some differentiated markets may have symmetric information. This suggests that there is no reason to expect the relationships described in the industrialization literature to hold.

We tested implicit hypotheses regarding the substitutability of different means of vertical coordination and the importance of vertical coordination as a means of addressing asymmetric information problems. Our results largely refute these aspects of agricultural industrialization as well. The results provide support for bonding as an explanation of contracting choices, but do not support learning or the development of trust as an explanation for observed behavior. Table 1 summarizes the predictions and our test results drawn from alternative economic explanations. Other hypotheses do better, but not all of these are supported either. Overall, we find very little support for the agricultural industrialization framework as an explanation of the development of the California winegrape industry.

As the first systematic empirical analysis of contract usage in the winegrape industry, we believe that our findings regarding contract provisions will be of interest to those examining industries where the use of contracts is less developed. More broadly, our systematic testing of the implicit assumptions underlying the agricultural industrialization framework will be of interest to those interested in the future development of American agriculture.

Table 1: Hypotheses, Predictions and Results

Hypothesis	Framework	Prediction	Result
1. No differences in contracting	Industrialization	Accept	Reject
1a. More contracting in premium regions	Industrialization	Accept	Accept
2. No differences in provisions	Industrialization	Accept	Reject
2a. More price incentives in premium regions	Industrialization Symmetric information	Accept Reject	Reject
2b. More winery involvement in premium regions	Industrialization Symmetric information	Accept Accept	Accept
3, 3a.Higher within-group price less likely to contract, use coordination provisions	Efficiency pricing	Accept	N/A
4. New growers less likely to contract	Industrialization Bonding	Reject Accept	Accept
5. Long-term relationships less likely to contract	Industrialization Learning/trust	Accept Accept	Reject
5a. Long-term relationships less likely to include coordination provisions	Industrialization Learning/trust	Accept Accept	Reject

Table 2: Regional Distributions and Average Farm Size of California Grape Growers: Survey and Population[a]

Region		All	North Coast	Central Coast	San Joaquin Central	San Joaquin South/Other
Acreage (acres)	CASS*	752,000	96,000	65,000	103,000	488,000
Number of Growers	CASS	11,726	3430	1018	1834	5444
% of Growers	CASS	100	29%	9%	16%	46%
% of Respondents	Survey	100	26%	12%	25%	37%
Acres/grower	CASS	64	28	64	56	90
Acres/grower	Survey	120	64	99	104	165

a. The regions used in Tables 2-5 include the following counties:
North Coast: Napa, Sonoma, Mendocino, Lake, and Solano.
Central Coast: Monterey, San Luis Obispo, Santa Barbara, San Benito, Santa Clara, Santa Cruz, San Mateo, Contra Costa and Alameda.
San Joaquin Central: Sacramento, San Joaquin, Yolo (south of Interstate 80), Stanislaus, Merced, and foothills.
San Joaquin South: Fresno, Tulare, Kings, Madera and all other.

Table 3: Contract Types and Provisions Used by Region

	All	North Coast	Central Coast	Central	South & Other
			%		
Written, Oral vs No contract					
No contract	10	4	11	6	18
Written Only	70	71	56	68	74
Oral only	11	13	20	15	4
Both	9	12	13	11	4
Planting contract	10	9	13	21	8
Evergreen clause	30	45	34	13	9

Table 4: Farm Characteristics and Years of Contract by Region

	All	North Coast	Central Coast	Central	South and other
			Averages		
Farm Characteristics					
Years with buyer (years)	9.7	7.9	7.5	12.3	9.6
Years in business (years)	20.6	18.3	15.8	21.1	23.6
Acres (acres)	118	59	107	109	179
Regional price ($/ton)	787	1710	1256	477	276
Years of contract (years)	3.7	4.0	4.5	4.8	2.5

Table 5: Cultural Practices and Price Incentive Provisions in Contracts by Region

	All	North Coast	Central Coast	Central	South and other
			%		
Cutural Practices					
Specific practices					
Required	16	15	8	15	21
Suggested	37	44	56	32	30
Inform of chemical use					
Before use	45	39	31	45	55
After use	71	62	53	76	83
Bonues and Penalties					
Bonus					
Sugar	18	11	7	17	33
Acids	4	3	3	3	6
MOG*	9	7	5	10	13
Defects	10	8	10	10	15
Penalty					
Sugar	42	13	40	57	34
Acids	10	11	9	12	7
MOG*	43	39	37	59	48
Defects	47	45	41	60	48

*Material other than grapes

Table 6: Logit Analysis of the Effects of Farm Characteristics on Contract Choice

	Contract in the form of (Dependent variable)		
	Coefficient (t-ratio)		
	(Written +Oral) vs. (No contract)	(Written) vs. (Oral+No contact)	(Written) vs. (No contract)
	Written or Oral=1	Written=1	Written=1
Independent variable	Equation 1	Equation 2	Equation 3
Years with Buyer	0.18*** (3.83)	0.012 (0.72)	0.18*** (3.73)
Years in Business	0.047*** (3.49)	0.057*** (6.79)	0.052*** (3.82)
Acres (100 acres)	2.61*** (3.99)	1.25*** (5.513)	3.08*** (4.40)
Regional Price ($1000/ton)	1.02*** (5.01)	0.23* (1.87)	0.82*** (4.04)
Sample Size	Those with written only, oral only, or no contract 1277	Those with written only, oral only, or no contract 1277	Those with written contracts only or oral contracts only 1122

Equation 1: Binomial estimate=0.88, Log Likelihood Function = -307.95, McFadden R^2 = 0.348
Equation 2: Binomial estimate=0.76, Log Likelihood Function = -552.6, McFadden R^2 = 0.208
Equation 3: Binomial estimate=0.86, Log Likelihood Function = -275.0, McFadden R^2 = 0.392

*significant at 10% level. **significant at 5% level. ***significant at 1% level.

- **Table 7a: Logit Analysis of the Use of Production Specifications in Contract**

	Type of production practice provision (Dependent variable)		
	Coefficient (t-ratio)		
Independent variable	Specific Practices[1]	Chem. Use before[2]	Chem. Use after[3]
Contract characteristic	Equation 1	Equation 2	Equation 3
Planting Contract	0.353* (1.60)	0.027 (0.11)	0.311 (1.34)
Evergreen Contract	0.432*** (2.86)	-0.178 (-1.04)	0.520*** (3.32)
Years of Contract	0.024 (1.24)	0.010 (0.47)	0.040** (1.97)
Grower characteristic			
Years with Buyer	0.0147* (1.83)	0.015 (0.47)	0.014* (1.68)
Years in Business	0.011** (2.10)	0.015 (1.75)	0.012** (2.20)
Acres (100 acres)	-0.027 (-0.75)	-0.070* (-1.65)	0.235*** (5.67)
Regional Price ($1000)	0.281** (2.44)	-0.012 (-0.10)	-0.094 (-0.79)

N=1002 (written contracts only). Logit analysis,
Equation 1: binomial estimate = .48, Log likelihood function=-669.0, Mcfadden R^2 =0.035
Equation 2: binomial estimate = .27, Log likelihood function=-563.58, Mcfadden R^2 =0.030
Equation 3: binomial estimate = .50, Log likelihood function=-643.09, Mcfadden R^2 =0.074
*significant at 10% level. **significant at 5% level. ***significant at 1% level.

Footnote
1. Specific Practices: Winery requires/suggests specific viticultural practices
2. Chem Use before: Winery informed of chemical use before application
3. Chem Use after: Winery informed of chemical use after application

Table 7b: Logit Analysis of the Use of Bonuses and Penalties for Quality Characteristics in the Contract

	Bonus or penalty for quality characteristics (Dependent variable)				
	Coefficient (t-ratio)				
Independent variable	Any[1]	Sugar[2]	Acid[3]	MOG[4]	Defects[5]
	Equation 1	Equation 2	Equation 3	Equation 4	Equation 5
Contract characteristic					
Planting Contract	0.796** (2.03)	0.664** (2.32)	0.160 (0.56)	0.561** (1.99)	0.086 (0.33)
Evergreen Contract	0.490** (2.27)	0.254 (1.47)	0.208 (1.01)	0.636*** (3.62)	0.473*** (2.71)
Years of Contract	0.063** (2.05)	0.041* (1.76)	0.039 (1.58)	0.068*** (2.90)	0.053** (2.27)
Grower characteristic					
Years with Buyer	0.020 (1.42)	0.025** (2.50)	0.0025 (0.21)	0.0093 (1.00)	0.0049 (0.50)
Years in Business	0.042*** (5.27)	0.012** (2.18)	-0.0057 (-0.76)	0.015*** (2.65)	0.032*** (5.26)
Acres (100 acres)	0.449*** (4.10)	0.30*** (5.01)	-0.041 (-0.79)	0.357*** (5.63)	0.252*** (4.60)
Regional Price ($1,000)	-0.442*** (-3.00)	-0.187 (-1.51)	0.00095 (0.006)	-0.627*** (-4.98)	-0.487*** (-3.89)

N=1002 (written contracts only). Logit analysis,
Equation 1: binomial estimate = .80, Log likelihood function=-427.38, Mcfadden R^2 =0.16
Equation 2: binomial estimate = .68, Log likelihood function=-577.82, Mcfadden R^2 =0.085
Equation 3: binomial estimate = .14, Log likelihood function=-410.49, Mcfadden R^2 =0.009
Equation 4: binomial estimate = .64, Log likelihood function=-574.85, Mcfadden R^2 =0.121
Equation 5: binomial estimate = .67, Log likelihood function=-572.82, Mcfadden R^2 =0.10

*significant at 10% level. **significant at 5% level. ***significant at 1% level.

Footnote
1. Bonus or penalty for any attribute
2. Bonus or penalty for sugar
3. Bonus or penalty for acid
4. Bonus or penalty for material other than grapes
5. Bonus or penalty for defects

APPENDIX: SURVEY INSTRUMENT

University of California **Grape Contract Survey**
Agricultural Issues Center **May 1999**

If you do not use a winegrape contract, please answer questions 1-3 and return. If you have more than one contract, choose the most representative. If you are both a grape grower and a winery, answer as most appropriate for you, or return two surveys (one for each operation).

1 Are you a grower or a winery? Grower (Seller) Winery (Buyer)

2 Do you use a written contract? Yes No

3 Do you use an oral contract? Yes No

4 Is your contract for one year? Yes No, how many years? _____

5 Is it a planting contract? Yes No

6 Does your contract have an evergreen clause? Yes No

7 How is price determined? *Check more than one if needed.*

- Fixed price stated in contract
- Price based on some reference price (Crush district average, etc.)
- Specified max and/or min price (circle one)
- Fair market price, e.g. negotiated yearly
- Per acre price
- Other, please describe (use back)

8 Does your contract specify tonnage? Yes No
Acreage? Yes No
Maximum tonnage? Yes No

9 Bonuses/Penalties

	Bonuses		Penalties	
For sugar?	Yes	No	Yes	No
For acids?	Yes	No	Yes	No
Material Other Than Grapes (MOG)	Yes	No	Yes	No
Defects (mold, rot, mildew)?	Yes	No	Yes	No

10 Was your contract brokered by a third party? Yes No

11 Is there a clause for disagreement resolution? Yes No

12 Contract requires/suggests specific viticultural practices? Requires Suggests Neither

13 Contract includes a best viticultural practices clause? Yes No

14 Contract requires winery be informed of chemicals used? **Before use** Yes No **After use** Yes No

15 What varieties do you market/buy? [up to 3]

16 Total Acres (circle): 0-10 11- 25 26-49 50-99 100-199 200-499 500+

17 How many years have you dealt with your current buyer/seller?

18 How many years have you been in the grape/wine business?

Additional Comments: (Please use back of this sheet.) Thank You

Bibliography

Bar-Ilan, Avner. 1991. "Monitoring Workers as a Screening Device." *Canadian Journal of Economics*. 24(2):460-9. May.

Barkema, Alan. 1994. "New Roles and Alliances in the U.S. Food System." Chapter 6 in *Food and Agricultural Markets: The Quiet Revolution.* Lyle P. Schertz and Lynn M. Daft, editors. National Planning Association (Washington).

Barkema, Alan and Michael Cook. 1993. "The Changing U.S. Pork Industry: A Dilemma for Public Policy." *Economic Review*. 78(2):49-65. Second Quarter.

Barkema, Alan, Mark Drabenstott and Michael Cook.. 1993. "The Industrialization of the U.S. Food System." *Food and Agricultural Marketing Issues for the 21st Century.* Daniel I. Padberg, editor. Food and Agricultural Marketing Consortium 93-1. Texas A&M University, College Station, Texas. P.3-20.

Barry, Peter. 1995. "Industrialization of U.S. Agriculture: Policy, Research and Education Needs." *Agricultural and Resource Economics Review*. 128-35. April.

Barry, Peter, Steven Sonka and Kaouthar Lajili. 1992. "Vertical Coordination, Financial Structure, and the Changing Theory of the Firm." *American Journal of Agricultural Economics*. 74(5):1219-25. December.

Boehlje, Michael. 1996. "Industrialization of Agriculture: What Are the Implications?" *Choices*. First Quarter. P.30-33.

Boehlje, Michael. 1995. "The 'New' Agriculture." *Choices*. Fourth Quarter. P. 34-5.

Boehlje, Michael. 1999. "Structural Changes in the Agricultural Industries: How Do We Measure, Analyze and Understand Them?" *American Journal of Agricultural Economics.* 81(5):1028-41. December.

Boehlje, Michael and Lee Schrader. 1998. "The Industrialization of Agriculture: Questions of Coordination." Chapter One in *The Industrialization of Agriculture: Vertical Coordination in the U.S. Food System.* Jeffrey Royer and Richard Rogers, editors. P.3-26.

Cook, Michael. 1994. "Structural Changes in the U.S. Grain and Oilseed Sector." in *Food and Agricultural Markets: The Quiet Revolution.* Lyle P. Schertz and Lynn M. Daft, editors. National Planning Association (Washington).

C-FARE. 1994. "The Industrialization of Agriculture: Policy, Research, and Education Needs. A Symposium." Council on Food, Agricultural and Resource Economics. 8 pages. July.

Drabenstott, Mark. 1995. "Agricultural Industrialization: Implications for Economic Development and Public Policy." *Journal Agricultural and Applied Economics.* 27(1):13-20. July.

Drabenstott, Mark. 1994. "Industrialization: Steady Current or Tidal Wave?" *Choices*. Fourth Quarter. P. 4-8.

Economic Research Service, 2000. "Contracting in Agriculture: An Overview of the Issues." August 28. Accessed October 26, 2000. http://www.ers.usda.gov/whatsnew/issues/contracting/

Goodhue, Rachael E. 1999. "Input Control in Agricultural Production Contracts." *American Journal of Agricultural Economics.* 81(3):616-620. August.

Goodhue, Rachael E. 2000. "Broiler Production Contracts as a Multi-Agent Problem: Incentives, Common Risk and Heterogeneity." *American Journal of Agricultural Economics.* 82(3):606-622. August, 2000.

Goodhue, Rachael, Dale Heien and Hyunok Lee. 1999. "Contract Use in the California Winegrape Economy." AIC Issues Brief No. 11. University of California, Agricultural Issues Center (December).

Hennessy, David.A. 1996. "Information Asymmetry as a Reason for Food Industry Vertical Integration." *American Journal of Agricultural Economics*. 78(November 1996):1034-43.

Hueth, Brent and Ethan Ligon. 1999. "Producer Price Risk and Quality Measurement." *American Journal of Agricultural Economics*. 81(3):512-24. August.

Hurt, Chris. 1994. "Industrialization in the Pork Industry." *Choices*. Fourth Quarter. P.9-13.

Knoeber, C.R. "A Real Game of Chicken: Contracts, Tournaments, and the Production of Broilers." 1989 *Journal of Law, Economics and Organization* 5(Fall):271-92.

Knoeber C.R. and W.N. Thurman. 1994. "Testing the Theory of Tournaments: An Empirical Analysis of Broiler Production." *Journal of Labor Economics* 12(April):155-79.

Lemmon, Michael L., James S. Schallheim and Jaime F. Zender. 2000. "Do Incentives Matter? Managerial Contracts for Dual-Purpose Funds." *Journal of Political Economy*. 108(2):273-299.

Maskin, Eric and John Riley. 1985. "Input versus Output Incentive Schemes." Journal of Public Economics. 28(1) (October): 139-57.

Mighell, Ronald L.and Lawrence A. Jones. 1963. "Vertical Coordination in Agriculture." Agricultural Economic Report No. 19. Economic Research Service, United States Department of Agriculture. February. 90 pages.

Motto Kryla and Fisher, LLP. Economic Impact of California Wine, St. Helena, CA. January 2000. MKF Research Report.

Ritter, Joseph A. and Lowell J. Taylor.1994. "Workers as Creditors: Performance Bonds and Efficiency Wages." *American Economic Review*. 83(3):694-704. June.

Sporleder, Thomas L. 1992. "Managerial Economics of Vertically Coordinated Firms." *American Journal of Agricultural Economics*. 7(5):1226-31. December.

Tsoulouhas, Theofanis and Tomislav Vukina. 1999. "Integrator Contracts with Many Agents and Bankruptcy." *American Journal of Agricultural Economics*. 81(1):61-74. February.

Urban, Thomas. 1991. "Agricultural Industrialization: It's Inevitable." *Choices*. Fourth Quarter. Pages 4-6.

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

Wolf, Christopher and Daniel A. Sumner. 2001. "Are Farm Size Distributions Bimodal? Evidence from Kernel Density Estimates of Dairy Farm Size Distributions." *American Journal of Agricultural Economics*. 83(1):77-88. February.