INTERACTIONS BETWEEN EXPLICIT AND IMPLICIT CONTRACTING: EVIDENCE FROM CALIFORNIA AGRICULTURE

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ABSTRACT. We examine interactions among explicit and implicit contracting practices for a sample of 385 intermediaries in California fruit and vegetable markets. *Explicit* practices are measured with an indicator for the existence of a formal contract, and with indicators for various contract specifications (e.g., target delivery date, volume, acreage). *Implicit* practices are measured directly with a question about the existence of an "implicit understanding," and indirectly with questions about the extent of informal involvement in farm-level decision making. Firms that manufacture processed foods, and that grow in house a portion of their total farm input, are significantly more likely to report use of explicit *and* implicit contracting practices. Additionally, unobserved factors that influence the use of explicit and implicit contracting are positively correlated. These findings suggest a complementary relationship between formal and informal contracts.

INTRODUCTION

A number of scholars, including economists, lawyers, management scientists, and sociologists have all observed that formal statements of contractual obligation often differ substantially from the *real* terms of exchange. Llewellyn (1931, p. 736) was among the first legal scholars to make this point, arguing that, "The major importance of a legal contract is to provide a framework... a framework highly adjustable, a framework which almost never accurately indicates real working relations, but which affords a rough indication around which such relations vary, an occasional guide in case of doubt, and a norm of ultimate appeal when the relations cease in fact to work." It is relatively recent, however, that economists have focused their efforts on modeling interactions between explicit and implicit contracts. This work has, for the most part, found that the two can either substitute or complement, depending on the context, and empirical confirmation of this ambiguity has begun to emerge (we review the relevant literature below).

The issue has become less one of, "do explicit and implicit contracts interact?" and more how do they interact? We examine this question in the context of contracts for farm output that are used by first-level intermediaries of fruit, nut, and vegetable commodities in California. We conducted a survey of 385 of these intermediaries to ask about their contracting practices. We describe the survey protocol and data below, but Figure 1 summarizes key findings for the purpose of this paper. Firms who process, rather than merely broker or market fresh produce, and firms who grow some portion of their farm input in house, are significantly more likely to report use of formal contracts *and* to claim that their farmers' actions are influenced to some degree by an "implicit understanding." This finding suggests a complementary relationship between explicit and implicit contracting practices. The factors that are motivating particular kinds of intermediaries to use formal contracting practices

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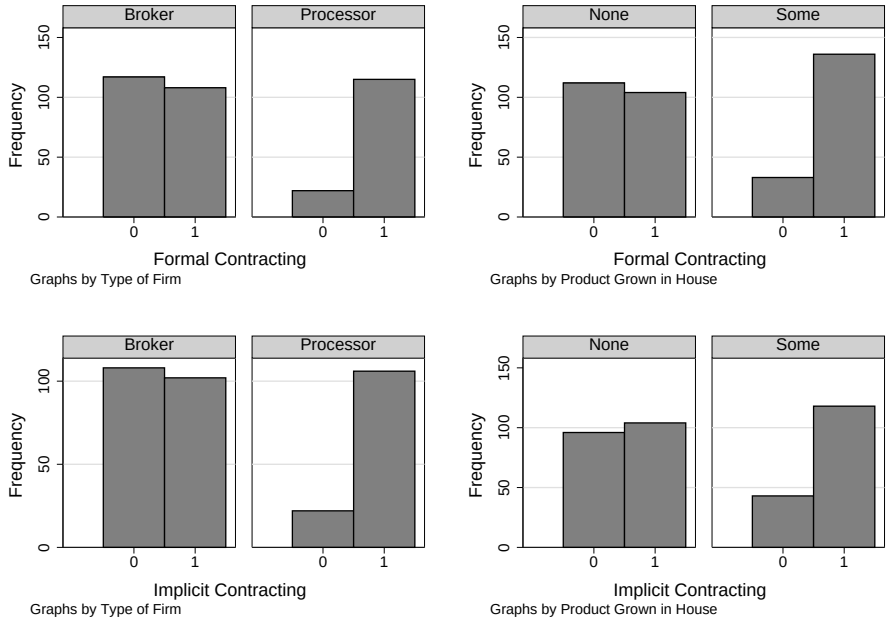

FIGURE 1. Explicit and implicit contracting practices by firms who broker and market fresh produce versus those that manufacture processed foods, and by firms that do not grow any portion of their farm input in house versus those who do.

are also driving them to use informal contracting practices. Below, we explore, and confirm, the robustness of our results by considering other measures of explicit and implicit contracting practices, and by controlling for various sources of heterogeneity.

Our data do not permit formal testing of *why* processors and firms who produce in house are so much more inclined to combine formal and informal contracting practices, but we identify a number of hypotheses. In particular, we argue that processors are able to identify relatively easy-to-measure performance indicators on which a formal contract can be based, and that firms who grow in house know better the production environment of their contractees. It is reasonable to expect that both these characteristics serve to reduce the cost of writing a formal contract. Similarly, processing firms arguably face greater costs from a coordination failure, and thus may benefit more from investing in a formal contractual apparatus. Our findings are therefore consistent with the notion that firms adopt formal contracting in response to a cost-benefit calculus from doing so, and that for those who do, formal contracts then provide a foundation on which informal, or relational, incentives can more easily be built.

In what follows, we briefly review and summarize the relevant extant literature on formal and informal contracting. We then provide more detail on the specific environment where we study this issue and present data and results.

Related Literature

Preliminaries. A number of economists and management scientists have examined the rational, calculative origins of relational governance, with expectations of future interactions enforcing cooperation in the present. These economic models focus on cooperation that is driven purely by monetary benefits from future interactions rather than by social norms (such as reciprocity and genuine trustworthiness). In these models, implicit or informal or relational contracts are self-enforced through rewards and punishments in a repeated interaction (Bull, 1987; Macleod and Malcomson, 1989; Baker et al., 1994; Pearce and Stacchetti, 1998; Schmidt and Schnitzer, 1995; Levin, 2003; Macleod, 2006). The self-enforcement is usually via trigger strategies, where reneging on the implicit agreement by one of the contracting parties results in the other party breaking off the relational contract with the party who reneged. For a relational contract to be self-enforcing the value of the future relationship must be sufficiently large to outweigh the short-run benefits from reneging. In contrast to formal contracts that are conditioned on objective measures, relational contracts can be conditioned on contingencies that are observed only by the contracting parties and can specify actions that are prohibitively costly to specify in a formal contract. A relational contract thus allows the parties to utilize new and non-contractible information as it becomes available.

By contrast to these selfish motivations, some economists have emphasized intrinsic motivations such as good will and reciprocity. Fehr et al. (1997) emphasize the tendency of people to reciprocate favors and punish unfair behavior as the main contributing factors to the enforcement of contracts. Fehr et al. (1997, p. 836) present experimental data that suggests that "reciprocal motivations have a robust and very powerful impact on the enforcement of contracts."

Chen (2000) emphasizes that people have a tendency to keep promises that are a result of "social conventions, norms, rules of thumb, or any mutually understood signals," and demonstrates that when contracting parties have some desire to keep promises they may choose to write an incomplete contract even though complete contracts are available.

The sociology literature (e.g., Macaulay, 1963; Bradach and Eccles, 1989) identifies socially derived norms and social ties, that emerge from prior transactions, as the main forces shaping repeated exchanges. These studies point out that firms are embedded in a network of social relations with other parties and that firms form such relations in response to marker failures. Trust is considered a trait that becomes embedded in a particular exchange relation. Using social processes, such as mutuality and cooperation, and the resulting norms, relational governance may mitigate various exchange hazards. These social aspects of repeated interactions have also been addressed by the management literature. The latter identifies and examines norms of flexibility, information sharing, and commitment as factors that may mitigate exchange hazards (e.g., Adler, 2001; Blumberg, 2001).

Formalizing Interaction Between Explicit and Implicit Contracts. Interactions between formal contracts and relational governance has been at the center stage of the economics, management, and sociology literatures on relational governance. Some empirical studies and formal treatments of the subject point toward complementarity between formal contracts and relational governance, i.e. the two re-enforce each other making their joint use more effective. Other studies support the substitution view by demonstrating that the mere feasibility of formal contracts may

hinder the use of implicit self-enforcing arrangements or social norms. Finally, the third category of studies generates mixed results with formal contracts and relational governance being complementary under some circumstances and substitutable under others. In what follows we begin with an overview of selected (formal and informal) treatments of the interaction between formal contracts and relational governance in the economics literature. This is followed by the contributions in the management and sociology literatures.

Baker et al. (1994), Pearce and Stacchetti (1998), and Schmidt and Schnitzer (1995) independently study interactions between explicit and implicit contracts and demonstrate that when available objective performance measures are imperfect implicit contracts may be valuable. Implicit contracts can be sustained when the principal's net benefits from abiding by the informal agreement outweigh the short-run gains from reneging on the implicit contract. Explicit contract affects the principal's net benefits from sticking to the informal agreement through two channels; it alters the long-run gross benefits from abiding by the informal agreement and it changes the principal's fallback position. When the objective performance measure is sufficiently close to perfect, the firm's fallback position after reneging on an implicit contract is very attractive. As a result, the use of implicit contracts, either in addition or instead of explicit contracts, becomes infeasible. Thus, explicit and implicit contracts are substitutes when "almost perfect" objective performance measures are available (Baker et al., 1994). On the other hand, when an option of writing a formal contract does not affect the worst possible punishment equilibrium and reduces the agent's gain from a deviation, feasibility of an explicit contract enlarges the set of actions implementable via an implicit contract (Schmidt and Schnitzer, 1995). Thus, explicit and implicit contracts can be complementary.

Itoh and Morita (2006) formalize arguments in Klein and Murphy (1988,1997) and Klein (1996,2000) by examining a hold-up problem in a repeated buyer-seller relationship where in each period the seller makes a relationship-specific investment that affects both the good's value to the buyer and the good's value in the alternative use.2 Itoh and Morita (2006) find that under certain condition "formal contracting plays a complementary role of relaxing the self-enforceability condition for informal agreements." As a result, formal contracts may improve efficiency even in situations where they don't have value in a static setting. Under alternative conditions, it is optimal not to write a formal contract but rely entirely on a relational contract.

Baker et al. (2006) develop a model of repeated contracts that move decision rights across firm boundaries. In their model, governance structure (or allocation of decision rights) affects adaptation as uncertainty of the economic environment is resolved. Allocation of decision rights via explicit contracts also affects the set of self-enforceable arrangements. The authors find that the decision rights should be allocated to the firm that has the smallest maximum temptation to renege on the implicit contract.

A number of authors have suggested that formal contracts that rely on incentives and punishments may signal absence of expectations of reciprocity (e.g., Frey, 1997; Fehr and Gächter, 2001). Some argue that explicit incentives may transform a good-will based relationship into a monetized relationship which is governed by selfish considerations rather than good will, reciprocity and other

intrinsic motivations (Frey and Jegen, 2001). Formal contracts may also signal distrust of the contracting counterpart and by undermining trust discourage voluntary cooperation (Fehr and Gächter, 2001; Falk and Kosfeld, 2004). This substitution effect, which has been coined in the economics literature as "motivation crowding out" (Frey, 1997), has received a considerable amount of support from experimental data (see below).

The interaction between relational governance and formal contracts has also received considerable attention in the field of management. A number of authors view formal contracts as a more costly substitute for relational governance. Gulati (1995, p. 93) argues that contracts and trust function as substitutes: "...trust avoids contracting costs, lowers the need for monitoring, and facilitates contractual adaptation. Trust counteracts fears of opportunistic behavior and as a result, is likely to limit the transaction costs associated with an exchange... In other words, trust can substitute for hierarchical contracts in many exchanges..." Similarly, Dyer and Singh (1998) argue that informal self-enforcing agreements which rely on trust and reputation 'often supplant' the formal controls characteristic of formal contracts. Sitkin and Roth (1993) argue that legalistic remedies often undermine the "interpersonal foundations of a relationship" because they result in substitution of formal requirements for an individual's 'good will'. In contrast, Poppo and Zenger (2002) write, "Rather than hindering or substituting for relational governance, well-specified contracts may actually promote more cooperative, long-term, trusting exchange relationships. Well-specified contracts narrow the domain and severity of risk to which an exchange is exposed and thereby encourage cooperation and trust. ...This complementary relationship may also function in reverse. The continuity and cooperation encouraged by relational governance may generate contractual refinements that further support greater cooperation."

The sociology literature has strongly argued that repeated interactions build up trust and decrease reliance on formal contracts (e.g., Macaulay, 1963; Bradach and Eccles, 1989). These studies suggest that trust and other social norms are frequently more effective in achieving preferred outcomes than formal contracts. They argue that relational governance is based mainly on trust. By signaling distrust of a contractual partner formal contracts frequently undermine the contracting parties' ability to develop relational governance. Thus, this literature postulates that social norms and formal contracts are substitutes. Either relational governance eliminates the need for formal contracts and vice versa, or formal contracts directly hinder the formation of relational governance. For example, Macaulay (1963, p. 64) writes that "detailed negotiated contracts can get in the way of creating good exchange relationships between business units." He further argues that some firms may be reluctant to use a complex contract because it "...indicates a lack of trust and blunts the demands of friendship, turning a cooperative venture into an antagonistic horse trade."

Empirical Study of Interactions between Explicit and Implicit Contracts. Recently, a number of researchers have used naturally occurring data and surveys to examine the relationship between repeated interactions, the form of formal contractual arrangements and relational governance. Rather than presenting an exhaustive review of this literature we focus on the papers that are most pertinent to the present study.

Gulati (1995) examines factors that explain the choice between equity and non-equity inter-firm strategic alliances involving exchange, sharing, and co-development in the biopharmaceutical, new materials, and automotive economic sectors in the United States, Europe, and Japan during the period of 1970-1989. He presents evidence that repeated interactions breed trust through familiarity and make reliance on formal equity based alliances less likely. The author argues that firms "substitute trust for contractual safeguards in their repeated alliances." Similarly, Gulati and Singh (1998) find that repeated interactions diminish the use of hierarchical controls in alliances.

Banerjee and Duflo (2000) examine the Indian customized software industry and find that repeated contracting does not have a significant effect on the choice between fixed-price and cost-plus contracts. In contrast, the contracting firm's age plays an important role in determining the contractual outcome; young firms are significantly more likely to enter fixed-price contracts.

Poppo and Zenger (2002) use survey data on outsourcing relationships in information services to test whether relational governance3 and formal contracts are complements or substitutes. The authors find that increases in the level of relational governance were associated with greater levels of complexity in formal contracts. They also find strong evidence that reliance on relational norms is increasing in the longevity of the relationship between the contracting parties.

Corts and Singh (2004) use data from the offshore oil-drilling industry to examine the relationship between repeated interactions and the form of contractual arrangements between oil and gas companies and independent drillers.4 The oil and gas companies tend to rely on two types of contracts with independent drillers; detailed fixed-price contracts and simpler and more flexible cost-plus contracts.5 The authors argue that the effects of repeated interaction on incentive problems and contracting costs are key determinants of the relationship between the prior history of interactions and the optimal contract form. Repeated interactions mitigate incentive problems and lower contracting costs. When the former effect dominates, repeated interaction favors low-powered cost-plus contracts. In the opposite case (when improvement in incentives is relatively unimportant compared to the savings in contracting costs), the contracting parties prefer high-powered and more detailed fixed price contracts. The authors present empirical evidence that companies with a longer history of interactions are more likely to use cost-plus contracts, i.e. repeated interaction and formal high-powered contracts are substitutes. The authors also find that cost-plus contracts are more likely when there is relatively large ex ante uncertainty about the economic environment ("complex" projects), when the oil-company is relatively large, and when the driller is relatively small.

Kalnins and Mayer (2004) examine contractual relationships of a U.S. information technology (IT) services firm. They analyze choice between three types of contracts; fixed-price, cost-plus and cost-plus with a cap contracts. Similarly to Corts and Singh (2004), Kalnins and Mayer (2004) find that the IT services firm tends to enter into lower-powered cost-plus contracts with contracting partners that have a relatively more extensive history of procuring services from the IT services firm. That is, they discover that repeated interaction and formal fixed-price contracts are substitutes. The authors also find that the firm was more likely to enter into low-powered contracts when ex ante uncertainty regarding costs and specifications of the project ("complexity" of the project) was relatively large

and when costs of measuring ex post quality (measured by the availability of an inexpensive test to verify ex post quality) were relatively large.

Ryall and Sampson (2003) analyze joint technology contracts in the telecommunications equipment industry. They examine how contract detail, formal monitoring provisions and formal penalties vary according to whether firms have prior exchange experience. They find strong empirical evidence for complementarity between formal and relational contracts; contracts become more detailed and use penalty clauses more frequently when at least one of the firms has prior deal experience. These effects are stronger when the contracting firms have prior experience with each other.

Fehr and Gächter (2001) present experimental evidence indicating that incentive contracts may undermine voluntary cooperation. In their experiments, "the undermining effect is so strong that the incentive contracts are less efficient than contracts without any incentives." In the experiments conducted by Gächter et al. (2007) experiencing incentive contracts reduces voluntary cooperation even after incentives are abandoned. Their experimental evidence also indicates that implicit incentives considerably increase voluntary cooperation and make explicit incentives redundant. In contrast, Lazzarini et al. (2004) demonstrate with experimental data that incomplete contracts facilitate the self-enforcement of noncontractible dimensions. They find evidence of reciprocity as an enforcement mechanism. However, they find no evidence that contracts crowd out the reciprocity effect and hence substitute for social norms. The authors conclude that "low-cost contracts are important mechanisms to support cooperation when it is not very likely that parties will continue transacting in future periods" Lazzarini et al. (2004, p. 290).

Malhotra and Murnighan (2002) present experimental evidence on the negative effect of contracts on trust. Bohnet et al. (2001) provide theoretical arguments and experimental evidence that demonstrates that legal rules have a nonmonotonic effect on behavior. Trustworthiness is "crowded in" with weak and "crowded out" with medium enforcement probabilities.

Repeated Contractual Relations and Learning. In addition to the factors outlined above there is another channel through which repeated interactions affect the contractual form. Mayer and Argyres (2004) and Argyres et al. (2007) argue that through repeated interactions firms gain experience in drafting more effective contracts which, in turn, changes the form of optimal contracts. Mayer and Argyres (2004) examine evolution of contract terms between the same two partners in the personal computer industry. They find that the structure of these contracts has been becoming more "complete" over time and that these changes are mainly attributable to the learning by the parties of how to efficiently govern the projects through contracts. The authors also find that the contracting parties have relied on formal contracts "as their main repository for learning, rather than relying exclusively on oral communications or memos that are much less enforceable, legally" and interpret this result as evidence that contracts "continued to play a central governance role in the relationship, independent of whether other relationship-support mechanisms (such as trust or reputation effects) became more important in the relationship, over time". The authors also present evidence that trust between the contracting parties has increased over time. Their results, thus, suggest that through the effect of learning formal contracts and trust are complementary.

Similarly to Mayer and Argyres (2004), Argyres et al. (2007) find that learning leads to a positive relationship between repeated interaction and more detailed contracts. The authors focus on two groups of contractual terms; deal description and contingency planning. They demonstrate that a more extensive prior interaction leads to richer formal contracts in terms of contingency planning. Contractual task description is not, however, affected by prior relationships with a specific partner.

In the next section, we describe our data and approaches for measuring explicit and implicit contracting practices. The subsequent section

Data

Our data come from a 1999 survey of first-level handlers of fruit, vegetable, and nut commodities in California. Data from a pilot study for our survey instrument are reported in Hueth et al. (1999).[1] The California Department of Food and Agriculture's Market Enforcement Branch licenses all parties who contract for, handle, or purchase agricultural commodities (for details see http://www.cdfa.ca.gov/mkt/meb/). In 1999 there were 6,660 licensees. We sampled randomly from the licensee population and phone screened 1,738 potential survey respondents. Our screening instrument elicited the commodities handled, ordered by volume marketed, and asked respondents to verify that they work with independent growers. This information allowed us to select survey respondents that both handled fruit, vegetable, or nut commodities, and that contracted with or purchased from independent growers. Of the screened firms, 36 percent were in our population of interest, 5 percent were second handlers, 9 percent grew their own product and did not procure any commodity from external growers, and the remainder either did not handle fruit, vegetables, or nuts (25 percent), refused to respond (4 percent), or could not be contacted (20 percent). Of the 630 firms in our population, each was sent a mail survey asking for information about their contracting practices for their largest-volume product (identified from the initial phone screen). We received 385 completed surveys, or a 61 percent response rate.

Table 1 summarizes the unique commodities represented in our sample and defines commodity groups that are used to control for heterogeneity in contracting practices that is specific to a given crop type. There are a variety of ways potentially to group specific commodities. This grouping reflects differences in planning horizon with respect to crop choice.

In our survey, we asked contractors the location(s) of their contract growers for the given commodity, allowing multiple selections among the Sacramento, San Joaquin, and Imperial Vallyes; the Central Coast, Mexico, "elsewhere in California," and "Other." Table 2 aggregates responses into those who claimed to contract only with growers in the Central Valley (San Joaquin and Sacramento Valleys), only with growers in either the San Joaquin, Sacramento, or Imperial Valleys, only with growers in Mexico, with growers in three or more locations (Multiple Locations), and Other.

There are at least three ways in which our data differ from data used in previous studies of contract choice. First, much of the previous empirical work has focused on settings with well-defined discrete contract types (e.g., cost-plus vs. fixed price; share-rent vs. cash rent). There

[1]The survey instrument, variable descriptions, and data are available for public use at http://www.aae.wisc.edu/hueth/calag.zip.

is not a well established taxonomy of agricultural contracts that offers this kind of discreteness.[2] Instead, we measure a number of contract attributes that arguably have a relation to theoretical constructs used by social scientists who study contracts. Second, unlike many previous studies of contracting practices, we did not ask contractors about a *specific* contract. We collected data only from the contracting side of the relationship and asked respondents either to report a statistic on the distribution of contracts for the given commodity, or to focus on the "typical" relationship for the given commodity. Third, we were careful to avoid asking about just about "contracts" so as to avoid nonresponse from individuals with no written or formal contract. We instead asked respondents to "please answer the following questions for the contract (whether it be formal or informal) or advance arrangement which is most widely used for procuring this single commodity from outside growers."

Table 3 defines two sets of variables, one relating to characteristics of contracts and another relating to characteristics of contracting firms. In one question, firms are asked to indicate the

[2]Hueth et al. (2007) discuss shortcomings, for the purpose of conducting research on agricultural contracting, with the distinction between "production" and "marketing" contracts that is used by the USDA for tracking farm costs and returns.

TABLE 1. **Commodities and Commodity Groups**

Commodity Group	**Commodities**
Annual	Anise, Asparagus, Broccoli, Cabbage, Carrot, Celery, Corn, Cucumber, Drybean, Eggplant, Garlic, Ginger, Greenonion, Jailan, Lettuce, Melon, Mushroom, Okra, Onchoy, Onion, Pea, Pepper, Potato, Pumpkin, Squash, Sweetpotato, Tomato, Yam, Zucchini
Tree	Apple, Apricot, Avocado, Banana, Cherry, Grapefruit, Lemon, Lime, Nectarine, Nut, Olive, Orange, Peach, Pear, Plum, Prune, Tangerine
Vine	Grape, Kiwi, Winegrape
Other	Alfalfa, Strawberry, Strawberryplant

TABLE 2. **Frequency Tabulation: Grower Location(s) by Commodity Group**

	Commodity Group				
Location(s)	Annual	Vine	Tree	Other	Total
Central Coast	13	27	4	3	47
Central Valley[1]	9	4	8	0	21
Imperial Valley	2	0	1	0	3
Mexico	4	0	6	0	2
Multiple Locations[2]	43	12	9	1	65
Sacramento	6	4	4	1	15
San Joaquin	19	19	45	0	83
Other	39	79	20	7	145
Total	135	145	93	12	385

[1]Defined as Sacramento and San Joaquin Valleys.

[2]Defined as 3 or more locations.

proportion of total farm input that is obtained via each of the following arrangements: "grown by my firm", "formal contract with outside growers," "informal contract or advance arrangement with outside growers (e.g., handshake, or mutual understanding), or "other (please specify)." We construct three variables from this question. First, the percentage of total farm input that is grown in house (prctinhouse) is the response to the first part of this question. One important consequence of this measure in what follows is that if conveys information about the knowledge that contractors have of the production environment of contractees. Second, we compute the ratio of the proportion that is formally contracted to the sum of proportions of all externally procured farm input (formal, informal, and other) and call this variable "formality." This variable therefore measures the extent to which the firm uses formal contracting among all contract growers. As it turns out, this variable is strongly bi-modal. Nearly 40% of respondents report no use of formal contracting, and over 35% report only use of formal contracts. As an alternative specification, and to simplify multivariate estimation of a non-linear discrete choice model, we therefore also define an indicator (formal) that takes on the value 1, if the firm reports some use of formal contracts, and 0 otherwise. Asking firms whether their contracs are formal is one way to assess contractual formality. We also ask whether the firm contracts on specific measurable variables and record responses as indicators taking the value 1 if the firm reports that it contracts on the given variable, and 0 otherwise. From these indicators, we construct a measure of formal contractual complexity (complexity) by summing up coded responses.

We similarly, measure informal contracting in two different ways. First, we ask firms to report whether there is an "implicit understanding" that affects the typical grower's behavior. Firms can respond by indicating that (i) there is an implicit understanding, but it does not affect grower behavior; (ii)-(iv) there is an implicit understanding that affects grower behavior to a small, moderate, or large extent, respectively; or (v) that no explicit understanding exists because everything is communicated explicitly. We code an indicator variable (implicit) that takes the value 1 if the firm responds either of (ii)-(iv), and 0 otherwise. In other words, the variable "implicit" takes the value 1 if the firm responds that there is an implicit understanding that affects grower behavior in *some* way, and 0 otherwise.

Second, we ask about the degree to which the firm is "involved" in scheduling harvest. We see "involvement" as evidence of implicit contracting. Harvest timing is a key determinant of product quantity and quality. The formal right to select harvest timing is typically left with the farmer. There is good reason to suppose that the objectives of farmer and intermediary are not always congruent with respect to this decision. For a given set of performance incentives, and for given decisions made during the course of the growing season, a farmer will choose the harvest date that maximizes his return. An intermediary who possibly faces a capacity constraint (e.g., because the crops of many contract growers happen to have matured on more or less the same date), may wish to alter the "optimal" harvest dates of one or more of its growers. If the farmer is explicitly granted authority over harvest timing, then any harvest adjustments from the farmer's optimal date will require that the farmer be compensated for associated losses. In practice, compensating for losses requires a fairly precise method of determining the magnitude of yield and quality reductions

TABLE 3. **Variable definitions.**

Variable	Description
Contract Attributes	
prctformal	Fraction of grower contracts that are formal
formal	=1 if firm uses a formal contract with some growers, =0 otherwise
contractacres	=1 if typical formal contract specifies acres, =0 otherwise
contractvolume	=1 if typical formal contract specifies volume, =0 otherwise
contractdate	=1 if typical formal contract specifies target delivery date, =0 otherwise
contractquality	=1 if typical formal contract adjusts payment for quality, =0 otherwise
complexity	=contactacres+contractvolume+contractdate+contractquality
implicit	=1 if an implicit understanding exists that affects growers' farming practices to some extent, 0 otherwise
oharvest	=1 (low), 2, 3, 4, or 5 (high) measuring level of involvment by buyer in scheduling harvest
harvest	=1 if buyer is involved in scheduling harvest, 0 otherwise
Firm Attributes	
fimtype	=1 if firm "obtains California farm products for the purpose of processing or manufacturing the same and sells them in dried, canned, extracted, fermented, distilled, frozen, or other preserved or processed form," 0 otherwise
prctinhouse	= fraction of farm input that is grown in house
firmage	= years in business (1e+2)
ngrowers	= number of growers (1e+2)
prctlongterm	= fraction of delivering growers who have contracted with the firm for 6 or more years
tonsbought	= total tons purchased in last crop year (1e+6)

associated with suboptimal harvest timing. In most contexts, such a method does not exist.[3] Although both parties to a contract may be able provide reasonable *estimates* of losses, it's unlikely that such estimates will be verifiable. As a result, whenever the parties' assessments do not coincide and an adjustment is desired, some form of bargaining will determine actual compensation paid. To the extent that grower-intermediary relationships are on-going and exhibit "involvement" of this sort, the relationships are "self-enforcing." That is, there are important outcomes and adjustments that that are not supported by third-party enforcement.

We have already identified one firm characteristic in the percentage of farm input that is grown in house. The other firm characteristic that is key in our analysis is whether the firm manufactures processed food products, or whether instead the firm brokers and markets fresh produce.[4] Firms

[3]The authors are aware of at least one agricultural contract in which the right to choose harvest timing allocated to the buyer, and where a specialized instrument is used to calibrate and measure losses associated with a "suboptimal" harvest date from the grower's perspective. This contract is an exception, however; more often *ex post* bargaining is used to adjust harvest dates.

[4]In some instances firms reported doing both, in which case we asked firms to report on the contracts they use for product that is marketed as fresh.

that process face a qualitatively different coordination problem with growers than their fresh-market counterparts. First, processors arguably have a much larger fixed-cost component in handling farm produce, and face a greater cost from coordination failure. Second, processors are concerned with a different set of quality indicators than fresh-market intermediaries. In particular, processing firms are interested in the "processibility" of product for which their are indicators (e.g., size, % sugar content, % damage) that lend themselves more easily to mechanical measurement. Fresh-market intermediaries are interested principally in eating quality (e.g., flavor, texture). As a result, fresh-market intermediaries tend to use downstream customers' assessment of quality to adjust grower payments, while processors tend to use *ex ante* measures of product integrity.[5]

The firm's age, and the percent of growers that have long-term contracts are used to measure variation in the potential for use of implicit contracting. It seems reasonable to think that the cost of formal contracting has an important fixed-cost component. Increases in the number of growers that a firm contracts with may make this investment worthwhile. Finally, tons bought is intended to capture firm size. Relatively large firms may face lower contracting costs if they have in-house lawyers, for example.

Table 4 provides summary statistics on key variables in aggregate and across locations and firm types. Firms report a degree of formality that averages slightly higher than 0.5. Recall that many firms report either all or no formal contracts with growers. Processors and producers of vine crops report much higher use of formal contracting, the former being consistent with the aggregate numbers reported in Figure 1. The same pattern is present for each additional measure of explicit and implicit contracting. Processors and vine-crop producers use "heavier" contracts both in terms of their explicit and implicit provisions. Fresh-market brokers, however, have slightly higher levels of in-house production, and vine-crop producers are among the youngest firms. Firms average about 26 growers for the given commodity, and for over half of these have relatively long-term relationships of 6 or more years.

Results. Todo.

Conclusions. Todo.

[5]For examples of each, see Hueth and Ligon (1999) and Hueth and Ligon 2002, which examine fresh-market and processing tomato contracts, respectively. Processors may also have stronger incentive to invest in quality measurement because they are unable to use residual claimancy to motivate growers. Identity preservation during processing is generally not economically viable.

TABLE 4. **Mean (S.D.) for Selected Variables by Commodity Group and Firm Type.**

	Commodity Group				Firm Type		
Variable	Annual	Tree	Vine	Other	Broker	Processor	Total
prctformal	0.341	0.47	0.691	0.23	0.356	0.714	0.52
	(0.441)	(0.468)	(0.42)	(0.389)	(0.445)	(0.389)	(0.459)
complexity	1.815	1.548	2.041	1.417	1.604	2.168	1.823
	(1.141)	(1.147)	(1.073)	(0.793)	(1.077)	(1.102)	(1.123)
implicit	0.424	0.554	0.824	0.545	0.486	0.828	0.615
	(0.496)	(0.5)	(0.382)	(0.522)	(0.501)	(0.379)	(0.487)
oharvest	2.417	2.879	4.162	1.3	2.674	3.955	3.16
	(1.73)	(1.712)	(1.476)	(0.949)	(1.783)	(1.575)	(1.812)
prctinhouse	0.176	0.177	0.194	0.099	0.184	0.171	0.181
	(0.316)	(0.287)	(0.256)	(0.3)	(0.309)	(0.25)	(0.287)
firmage	0.25	0.288	0.234	0.327	0.239	0.281	0.256
	(0.239)	(0.259)	(0.241)	(0.245)	(0.234)	(0.265)	(0.245)
ngrowers	0.176	0.453	0.244	0.13	0.249	0.283	0.264
	(0.28)	(0.837)	(0.536)	(0.139)	(0.56)	(0.546)	(0.555)
prctlongtrm	0.581	0.568	0.462	0.529	0.543	0.505	0.53
	(0.378)	(0.362)	(0.341)	(0.399)	(0.387)	(0.333)	(0.363)
tonsbought	0.088	0.147	0.003	0.185	0.082	0.064	0.071
	(0.532)	(0.801)	(0.014)	(0.573)	(0.559)	(0.464)	(0.507)

TABLE 5. Coefficient Estimates, Base SUR Model.

	Equation			
Regressors	formality	complexity	implicit	oharvest
constant	0.450**	1.583***	0.476**	2.738***
	(3.20)	(4.51)	(3.07)	(5.05)
firmtype	0.365***	0.466***	0.344***	1.300***
	(7.49)	(3.81)	(6.40)	(6.91)
firmage	-0.0430	-0.588*	0.0314	-0.381
	(-0.43)	(-2.34)	(0.28)	(-0.98)
prctinhouse	0.275**	0.340	0.216*	2.171***
	(2.98)	(1.47)	(2.12)	(6.11)
ngrowers	0.0889*	0.369***	0.0486	0.271
	(2.15)	(3.57)	(1.07)	(1.70)
prctlongtrm	-0.0642	-0.231	-0.0789	-0.495
	(-0.97)	(-1.39)	(-1.08)	(-1.93)
qualitymeasurement	-0.0303	0.0664	-0.00109	-0.0207
	(-0.91)	(0.80)	(-0.03)	(-0.16)
N	306			

t statistics in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

TABLE 6. Coefficient Estimates, SUR Model with Commodity-Group and Location Controls.

	Equation			
Regressors	formality	complexity	implicit	oharvest
constant	0.374*	1.653***	0.374*	2.578***
	(2.45)	(4.30)	(2.24)	(4.54)
firmtype	0.340***	0.637***	0.189**	0.654**
	(5.63)	(4.18)	(2.85)	(2.91)
firmage	-0.0445	-0.606*	0.0506	-0.0908
	(-0.44)	(-2.40)	(0.46)	(-0.24)
prctinhouse	0.318***	0.325	0.212*	2.084***
	(3.46)	(1.40)	(2.11)	(6.09)
ngrowers	0.0703	0.406***	0.0534	0.254
	(1.69)	(3.86)	(1.17)	(1.63)
prctlongtrm	-0.0887	-0.242	-0.0379	-0.482
	(-1.32)	(-1.42)	(-0.51)	(-1.92)
qualitymeasurement	-0.0228	0.0904	0.00616	0.0588
	(-0.69)	(1.08)	(0.17)	(0.48)
Commodity Group Indicators				
vine	0.0900	-0.291	0.261***	1.104***
	(1.32)	(-1.68)	(3.49)	(4.33)
tree	0.0214	-0.454**	0.0547	0.474
	(0.31)	(-2.58)	(0.72)	(1.82)
other	-0.0972	-0.463	0.0403	-1.435*
	(-0.57)	(-1.07)	(0.22)	(-2.26)
Location Indicators				
central valley	0.150	0.0113	-0.0259	-0.785
	(1.25)	(0.04)	(-0.20)	(-1.75)
imperial valley	-0.428	-0.000589	-0.520	-1.323
	(-1.46)	(-0.00)	(-1.62)	(-1.21)
mexico	-0.0577	0.0632	-0.102	-0.280
	(-0.33)	(0.14)	(-0.53)	(-0.42)
multiple locations	0.0566	0.0645	-0.0428	-0.636
	(0.65)	(0.29)	(-0.45)	(-1.95)
sacramento valley	-0.227	0.254	0.207	-0.834
	(-1.75)	(0.77)	(1.45)	(-1.72)
san joaquin valley	0.134	0.0782	0.00501	-0.414
	(1.55)	(0.36)	(0.05)	(-1.29)
other	-0.0126	-0.127	-0.0157	-0.518
	(-0.17)	(-0.68)	(-0.19)	(-1.88)
N	306			

t statistics in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

TABLE 7. Correlation Matrix of Residuals from SUR Model with Commodity-Group and Location Controls.

	formality	complexity	implicit	oharvest
formality	1.0000			
complexity	0.1767***	1.0000		
implicit	0.1520**	0.0755	1.0000	
oharvest	0.3183***	0.1183*	0.3574***	1.0000

Breusch-Pagan test of independence: chi2(6) = 92.760, p < 0.0001

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

TABLE 8. Univariate Non-Linear Models.[1]

	formal	complexity	implicit	harvest
constant	-0.567	0.455	-0.107	-0.390
	(-1.09)	(1.68)	(-0.20)	(-0.75)
firmtype	0.954***	0.354***	0.576**	0.566**
	(4.54)	(3.32)	(2.84)	(2.80)
firmage	-0.665	-0.323	0.123	-0.00706
	(-1.93)	(-1.69)	(0.36)	(-0.02)
prctinhouse	1.252***	0.142	0.394	1.430***
	(4.06)	(0.91)	(1.36)	(4.66)
ngrowers	0.433*	0.180**	0.136	0.193
	(2.24)	(2.81)	(0.97)	(1.32)
prctlongtrm	-0.121	-0.177	-0.159	-0.346
	(-0.53)	(-1.44)	(-0.70)	(-1.49)
qualitymeasurement	0.0384	0.0448	-0.0218	0.113
	(0.34)	(0.79)	(-0.19)	(1.04)
N	324	327	315	327

t statistics in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

The complexity equation is estimated as a poisson model. All other equations are estimated as probit models. Controls for commodity groups and locations are included in each estimation, but are surpressed for reporting.

TABLE 9. Multivariate Model.[1]

	(1) formal	(2) implicit	(3) harvest
constant	-0.475	-0.0463	-0.243
	(-0.88)	(-0.09)	(-0.45)
firmtype	1.018***	0.586**	0.589**
	(4.71)	(2.88)	(2.85)
firmage	-0.619	0.122	-0.163
	(-1.76)	(0.36)	(-0.48)
prctinhouse	1.208***	0.411	1.482***
	(3.93)	(1.42)	(4.78)
ngrowers	0.395*	0.161	0.207
	(2.14)	(1.13)	(1.36)
prctlongtrm	-0.163	-0.148	-0.346
	(-0.71)	(-0.65)	(-1.47)
qualitymeasurement	0.0405	-0.0363	0.0748
	(0.35)	(-0.32)	(0.67)
σ_{12}	0.187*	(2.03)	
σ_{13}	0.337***	(3.70)	
σ_{23}	0.485***	(5.81)	
N	317		

t statistics in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

[1]Commodity-Group and Location Controls Surpressed.

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