Retail Contracting and Grower Prices

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Abstract

Contracting directly between produce shippers and retailers is growing in importance. Retailers seek to obtain reliable supplies, while reducing their reliance on recurring market transactions. Producers seek stable prices and market access. These private transactions diminish spot market liquidity and enhance noncompetitive buying opportunities, raising concerns over the resulting impact on grower prices, whether under contract or not, and the future produce market structure. Primary data are used to test hypotheses on contract participation. Simulations on grower prices reveal that contract prices are generally lower, but less variable, than market prices, suggesting some form of risk sharing.

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Background and Introduction

Structural changes in the retail grocery industry, including consolidation and the growth of sales through supercenter stores, have contributed to the increasing use of contracts for fresh fruit and vegetables directly between retailers and shipper or even growers (*The Packer*, 1998). In fact, in 1997 fully 56% of all produce shippers used retail contracts for at least 10% of their sales (McLaughlin *et al*). This trend towards contracting, reflecting the so-called "Wal-Mart" business model, represents the most significant change in marketing produce in a generation. This change, though, is accompanied by many of the concerns that have arisen in other sectors of agriculture where contracting is now commonplace, including its effect on pricing efficiency and grower returns. The private transactions between retailers and shippers further accentuate the growing void of public price and market information, resulting in the potential for asymmetries in information favoring large retail buyers. Recent consolidations in the grocery retail sector amplify these concerns and give rise to renewed concerns over the potential for oligopsony market power, whether the transactions occur through a contract or not. Presently, growers of many produce commodities are conditioned to expect large, daily fluctuations in price in their respective spot markets. In contrast, contracts are reported to specify minimum shipment quantities over a month, quarter, or marketing season at a fixed, contract-period average price with adjustments for deviations in quality from some standard level. Clearly, there are incentives to enter into such contractual relationships on both the buying and selling side.

Retailers prefer to contract for their fresh produce due to the inability to plan and to maintain stocking levels if produce is purchased daily or weekly on the open market. While such quantity concerns are vital to maintaining the efficient distribution and inventory systems for which Wal-Mart is well known, they also perceive price advantages as well. Traditionally, retailers maintain relatively fixed price points for produce and absorb, albeit imperfectly (see Powers), price fluctuations from the FOB level. Many contracts now in use, however, specify prices over a monthly period (strawberries) or even annually (bananas) (Peterson). Of course, these contracts are subject to myriad contingency and *force majeur* clauses, but the intent is to protect the retailer from undue fluctuations in both margin and availability. On the grower or shipper side, such contracts provide a relatively stable price compared to selling into a wholesale market or directly to retail buyers on an *ad hoc* basis. Obviating the need to negotiate price on a shipment by shipment basis also allows suppliers to allocate more time to servicing accounts and making new sales. Developing formal selling relationships also takes much of the uncertainty of acceptance, payment, or quality verification out of produce transactions. Thus, the potential benefits from contracting, at least for the participating firms, are apparent and may be explained using established theory.

Assuming these firms' owners are risk averse, the typical theoretical result from principal/agent theory holds - that upstream agents derive utility from the insurance provided from a risk neutral downstream contractor. Although these benefits are relatively clear to both participants in the contract, it is less clear what the effects on those not party to these contracts may be. Typically, these are the shippers who are too small to guarantee an uninterrupted supply to the buyer. A better understanding of this issue would make an important contribution to the growing literature on agricultural contracting.

Recent research has sought to characterize contracts between fresh produce shippers and growers (Hueth and Ligon; Goodhue, Rausser, and Simon). However, these contracts are concerned with a fundamentally different problem - how shippers (principals) may design optimal mechanisms that guide growers (agents) to provide produce of consistent quality at a price that maximizes the utility of the principal, while ensuring that growers have the appropriate incentives to adhere to the agreement without requiring costly monitoring. While seemingly a simple problem, the design of these contracts is made non-trivial by the presumed existence of hidden information regarding the inherent skill of the agent - hidden information that can give rise to a moral hazard problem if the contract terms are not designed in a way to cause the agent to internalize the costs of sub-optimal behavior (Holmstrom; Holmstrom and Milgrom). A considerable body of research studies these types of relationships in the context of the broiler (Knoeber and Thurman; Goodhue) and hog industries (Hennessy; Martin). Typically, these studies use contract theory to explain the rise of integrators and industrialization of the white-meat industries. In general, this research finds that when quality is a random variable, and yet monitoring efforts to control quality is costly, contracts can be written that provide incentives to provide consistent quality - contracts that mimic full vertical integration between grower and processor. However, both the motivation for and the implementation of contracts for fresh produce between retailers and shippers differ significantly from these examples.

In this case, the important random variable under partial control of the agent (shipper in this case) is not necessarily produce quality, but rather the ability to provide consistent supplies on a year-round or at least seasonal basis of an acceptable quality. This is the feature that provides retailers incentives to write these contracts. In return for the provision of a continuous supply of produce, the retailer provides a degree of price insurance and guarantee of a market. However, merely because growers have an individual incentive to participate does not necessarily mean that these contracts are optimal from a social perspective. This is particularly true when the terms of the contract are written by a dominant buyer on a take-it-or-leave-it basis.

In fact, industry members fear that the principal outcome of the spread of retail contracting will be a loss of liquidity, the loss of a price formation mechanism, and a greater ability for buyers to fill their remaining needs through non-competitive bidding on terminal markets (Field). While large suppliers may be able to obtain favorable prices or other contract terms with buyers due to their superior bargaining power, smaller shippers fear that they will not have access to the same contract terms as larger suppliers. Ultimately, they predict the demise of the small grower/shipper. Even if smaller growers are able to survive on spot market prices, industry members believe that retail contracting will speed the process of consolidation at the grower/shipper level as sellers attempt to obtain sufficient size and market control to obtain more favorable contract terms from the few, large retail produce buyers. However, many of the projections for this industry are the result of conjecture and subjective analysis and are not products of sound, quantitative research. Therefore, in an effort to address this critical information need, the objectives of this study are to (1) determine how contracting will affect the level of grower prices and (2) determine what types of firms are most amenable to contracting with retailers.

To accomplish these objectives this study first develops a theoretical model of retail produce contracting that generates testable hypotheses on factors influencing contract and open market prices and contract participation. Next, these hypotheses are tested using primary data collected through a national survey of produce shippers. Finally, the impact of contracting on grower returns is evaluated by comparing the prices obtained under a competitive market equilibrium to those obtained by contracting shippers using a stochastic simulation model. This analysis proceeds with the development of the conceptual model in the next section.

Conceptual Economic Model

From interviews with a number of industry professionals, the predominant reasons given for using retail contracts are the price stability provided on the grower side and the supply stability engendered on the buyer side. Through contracts, retailers can separate negotiations over price from the ongoing movement of produce supplies, reducing the demand for large staffs of buyers. These contracts, therefore, effectively describe a form of vertical integration in which the supply function is entirely fulfilled by the intermediary or produce shipper. With this system, a retailer pays the supplier a set price for a quantity of produce over an agreed-upon period of time, but does not vary this price in order to meet daily requirements as in traditional buying practices. With electronic data interchange (EDI) linkages to the retailer's distribution centers, suppliers can improve the likelihood of meeting retailers' daily demand by tailoring their supply-systems in order to achieve a constant stocking level. What is unknown to the retailer prior to offering a contract, however, is the effort each supplier is willing to exert in order to maintain this consistency of supply.

Retailers can observe two different signals of this effort and, through mechanisms embodied in contracts with suppliers, tailor their compensation schemes accordingly. First, retailers can observe effort indirectly through the ability of suppliers to adjust their output in response to periodic demands for more produce. This describes a traditional relationship where buyers offer higher prices when they perceive a period of excess demand in the hope that this will bring forth a greater supply to restock their warehouse. Second, retailers are able to observe supplier efforts directly using EDI systems or simply through better relationships with some of their suppliers. Retailers, therefore, can choose to compensate suppliers either by paying exclusively on a per-unit of output basis, as in the traditional buyer-based business model, or as a combination of per unit prices and compensation relative to their direct observations of effort. This later compensation method may also involve a fixed fee that is independent of either measure of effort, such as a retainer fee. Moving towards more "behavior-based" compensation (Lafontaine and Slade) represents a movement toward this form of vertical integration that we observe as retail contracting in fresh produce. The key determinant of whether "outcome" or behavior-based compensation is used is shown in the model below to be the variability of effort signaled from supplier to retailers.

The formal development of this model follows the franchising model of Lafontaine and Lafontaine and Slade. Suppose that a retailer receives two imperfect signals of a supplier's efforts to deliver a consistent supply, an indirect signal through the amount of supply (1) and a direct signal (2):[1]

$$Q = Q_0 + e + \epsilon_1, \tag{1}$$

and:

$$E = e + \epsilon_2, \quad \epsilon = N(0,\Sigma), \quad \Sigma = [\sigma_{ij}], \quad \sigma_{ii} > \sigma_{ij} \tag{2}$$

Basing the supplier's compensation on these two signals of effort, the supplier's total income under both outcome and behavioral-based compensation is:

$$\bar{M} = w_1 Q + w_2 E + F - \left(\frac{C}{2Q_0}\right) e^2, \tag{3}$$

where M is total income, w_i is compensation for signal i, F is a fixed transaction fee, and $(C/2Q_0)$ cost of effort, assumed to depend upon a parameter C and the size of the supplier, Q_0. Further, the cost of effort is assumed to be strictly increasing and convex in effort, but declining in the size of the supplier. Define $[Q, E]$ as the vector $\boldsymbol{S}$ of signals and $[w_1, w_2]$ as the vector $\boldsymbol{W}$ of compensation rates, and shipper utility as $U(M) = -\exp(-\rho M)$, his certainty-equivalent income becomes:

$$CE(M) = \bar{M} - (\rho/2)\sigma_M^2 = \bar{M} - (\rho/2) W'\Sigma W. \tag{4}$$

[1] Note that, as in Lafontaine and Slade, supply is net of a price effect, so the value of Q_0 measures average shipment size.

Therefore, the retailer's problem becomes one of selecting the terms of the contract (***W***) and the level of supplier effort (***e***) in order to maximize profit, subject to the supplier's incentive compatibility (IC) and participation constraints (PC). Meeting these constraints ensures that contracting with the retailer is in the best interests of the supplier relative to all alternatives (IC) and that the level of utility that results is greater than the supplier's reservation level (PC). Formally, this problem is written as:

$$\max_{W,e}\left[Q - \left(\frac{C}{2Q_0}\right) - (\rho/2)W'\Sigma W\right], \tag{5}$$

subject to:

$$e = \operatorname{argmax}\left[w_1 Q + w_2 E + F - \left(\frac{C}{2Q_0}\right) - (\rho/2)W'\Sigma W\right], \tag{6}$$

and subject to $U(M^*) \geq \bar{U}$, where $\bar{U}$ is the supplier's reservation utility level. Using the first-order solution approach (Holmstrom; Myerson; Jewitt) to find the optimal compensation schemes involves finding the stationary points of (6) in *e*, and substituting the resulting expression for *e* into the objective function in (5). Maximizing this function with respect to the vector ***W*** provides a set of symmetric, simultaneous equations for both types of compensation (Lafontaine and Slade):

$$\left(\frac{Q_0}{C}\right) - \left(\frac{Q_0(w_i + w_j)}{C}\right) - \rho\,(w_j\sigma_{ij} + w_i\sigma_{ii}) = 0, \quad i = 1,2. \tag{7}$$

Solving these equations for the reduced form of each compensation function, and simplifying by assuming $\Phi_{ij} = 0$ gives:

$$w_i^* = \left(\frac{\rho\, Q_0 C \sigma_{jj}}{(Q_0 + \rho C \sigma_{jj})(Q_0 + \rho C \sigma_{ii}) - Q_0^2}\right), \quad i,j = 1,2. \tag{8}$$

Differentiating these expressions with respect to model parameters provide some useful comparative static results. In each case, the derivative suggests a plausible prediction that we are able to test using the empirical model developed in the next section. In particular, these results suggest conditions under which the compensation scheme is more likely to be outcome based (w_1) as compared to behavior-based, or contracted between retailer and supplier (w_2). Table 1 summarizes these results, the details of which are provided in Appendix A.

[insert table 1]

The first result in table 1 indicates that the level of each type of compensation falls in the variance of its signal. For example, the more variable are deliveries, the lower will be outcome-based compensation. On the other hand, the more reliable are the direct measures of effort to maintain consistent supply (lower Φ_{22}), the more likely is compensation to be behavior-based. Therefore, if retailers are better able to assess a supplier's business practices and if the supplier is willing to invest in the retailer's inventory management systems, then contracting will be more likely.[2] The second result implies that compensation i will rise in the variability of signal j. Intuitively, this is very plausible as the two types of compensation are substitute methods of achieving a stable supply. If a retailer cannot tell whether a supplier is willing to adopt the required technologies to participate in an integrated vertical supply system, then he is more likely to pay for delivery performance instead, and vice versa. Third, both types of compensation rise in supplier size. This result is driven by the assumption that the marginal cost of effort falls in the size of the supplier. Clearly, installing information systems and assigning specific personnel to monitor large retail accounts is only feasible for large suppliers. In order for rewarding effort to be in the retailer's best interest, the gains in efficiency that result must outweigh the added cost of paying suppliers. The final result adds greater specificity to this outcome in stating that the rate at which contract compensation rises will be greater than the rate at which outcome compensation (unit purchases) rises only if the signal provided by directly observing effort is less variable than the signal provided by actual deliveries. Again, this will be the case if a firm invests in

[2] In fact, conversations with apple shippers indicate that firms wishing to supply Wal-Mart stores must install computer terminals linked to Wal-Mart's distribution center database.

information technology, personnel and other measures designed to improve their response capability. This model also suggests the form of an econometric model of retail contract-participation that can be used to test each of these hypotheses.

Econometric Model

While the theoretical model provides strong priors for the key economic variables thought to be causing the growth of retail contracting, it is somewhat of a simplification in that it ignores shipper heterogeneity that exists beyond differences in economic size. Consequently, the empirical model modifies the structural framework above to allow the data to reveal both the sign and significance of each element of a grower attribute vector, $\boldsymbol{Z}$. However, least squares estimates of these parameters over the entire sample of shippers will be biased due to the fact that the participation constraint may be non-binding for many growers. Applying either Lee's generalized correction method, or Heckman's two-stage Tobit approach not only corrects this bias, but provides additional information on the factors that explain shippers' willingness to contract as well as the proportion of their sales under contract.

In terms of the economic model developed above, the value of the latent censoring variable is determined by the relative utility derived from each type of compensation. Specifically, a shipper will only contract with a retailer if his utility from doing so is greater than under a traditional system of transaction-by-transaction price and quantity negotiation. Further, the proportion of shipments that are contracted will rise the greater this difference in utility. As shown above, a shipper's utility is assumed to be an exponential function of total income, which is in turn dependent upon each compensation rate, effort, a fixed payment, and the cost of effort. However, because contract terms are proprietary and the elements of E are not observable to parties outside the transaction, direct measures of w_2 and E are not available for this analysis.

Descriptions of typical retail contracts provided by industry members, though, indicate that contract prices are determined as a certain percentage of the retail price, so an observed retail price series is used as a proxy variable for w_2. This behavior-based pricing is compensation for effort that is, perhaps ideally, directly observed. However, effort is more likely not observable, but rather inferred from existing business practices. Consequently, we create an index of supplier (direct) effort (E) that consists of observable variables likely to be indicators of the effort expended by a supplier in meeting retailers' needs.[3] These factors include psychometric, structural, and behavioral measures. Among the psychometric variables, suppliers who responded that they have indeed recognized an increased use of retail contracting and an increase in retail buyer power are more likely to expend effort to meet a retailer's specific needs. Further, an increase in the number of accounts serviced by a firm from 1994 to 1999 enters the index in an inverse manner, whereas the percentage of sales going to a supplier's top four accounts enters directly. These are structural indicators of supplier effort. Finally, the survey includes a number of behavioral questions that are able to elicit directly, on a five-point Likert scale, the relative importance a supplier places on a number of actions undertaken to meet retailers' needs. Actions such as acquiring produce from other growers or suppliers, forming joint ventures, global sourcing, increasing employee numbers, requiring employees to work overtime, redirecting shipments from other accounts, or acquiring additional transportation or storage facilities are felt to be important indicators of (direct) effort expended by suppliers. Each of these elements is defined such that higher values of the index increase the accuracy with which effort may be measured, so the index is expected to be positively correlated with the propensity to contract. On the other hand, factors that cause actual output to be more easily monitored are felt to be negatively correlated with the extent of contracting.

Similar to the effort index, neither output prices nor output variability are directly observable to parties outside the transaction, so we again construct proxy indices for both. Unlike contract prices, direct compensation for output is more likely to be based on market, or FOB prices. Consequently, we use an FOB price series for each commodity as a proxy for w_1.[4] Each element of the proxy for Q is intended to measure the extent to which firms attempt to increase actual output in response to retailer demands, rather than adopt specific managerial practices to smooth output over time. Therefore, higher

[3] Many empirical studies in this field develop proxy variables for this cost from measures of the geographic isolation of the firm (Minkler), the density of outlets (Lafontaine), or survey questions that obtain a subjective measure of the difficulty of performance monitoring (Anderson and Schmittlein; Anderson).

[4] Even in the absence of contracting, most produce transactions now occur directly between a grower/shipper or wholesaler and the retailer, so FOB prices reported by the USDA are not entirely accurate (McLaughlin *et al*). However, in constructing the instrumental variables here, they are likely to be more highly correlated with prices negotiated on a daily basis than are retail prices.

values of Q suggest that retailers receive a more precise signal of actual output, so are less likely to compensate suppliers with long-term contracts. Components of the Q proxy include the number of accounts, the change in account numbers from 1994 to 1999, the change in account concentration (proportion of sales to the top four accounts) between 1994 and 1999, the change in sales over this period, whether or not the firm belongs to a marketing cooperative, and the number of years they have been produce suppliers. Each of these variables is defined such that higher values cause the value of the aggregate Q index to rise. Data for all the variables required to construct these instruments were obtained from a survey of shippers.

With these explanatory variables, a latent variable measuring the propensity to contract is written as:

$$y^{*} = \exp[\alpha_0 \hat{\vartheta}_1 Q + \alpha_1 \hat{\vartheta}_2 E + \alpha_2 F + \alpha_3 \left(\frac{C}{2Q_0}\right) E + u_i], \tag{9}$$

where the percentage of output contracted, y, is only observed if this variable is greater than zero, but not otherwise:

$$y = \begin{bmatrix} y^{*} & if & y^{*} > 0 \\ 0 & if & y^{*} \leq 0 \end{bmatrix},$$

which, after applying a log-transformation to both sides, is estimated in two-stages using Heckman's sample-selection model with the standard errors corrected for the fact that the Mill's ratio used in the second-stage regression is an estimated variable (Greene).[5] By applying this two-stage method to our survey data we are able to test hypotheses regarding the factors that determine the probability that a grower will contract, and, given that he contracts, the factors that determine the intensity of contracting. While these results provide vital information on the growth and composition of firms that contract with

[5] If the error is assumed to be normal, a two-stage Tobit model is appropriate where the first stage consists of a bivariate probit model and the second consists of an OLS regression on only the non-limit observations with the inverse Mill's ratio included as an explanatory variable. If the error is assumed to be logistic, Lee's generalized correction method is used in a similar manner.

retailers, it does not shed light on the likely welfare effects on shippers, or the growers that supply them. Consequently, an empirical simulation model is used to estimate the effect of contracting on market prices for a representative commodity.

Simulation Model

This simulation is conducted for a representative produce market under a competitive price-formation process and under one that follows the contract price mechanism described above. By conducting these simulations under similar stochastic conditions, we compare the effects of supply, demand, and marketing cost changes on grower welfare. The critical difference between a competitive and a contractual price formation process for the purposes of this simulation is the locus of price determination. Whereas retail prices in a competitive market model, such as that found in Gardner, are determined as the outcome of the equilibrium between supply and demand for the farm product and supply and demand for marketing services, retail contracts maintain constant percentage retail margins (Peterson). Any adjustment in price required by unusual events or a periodic adjustment to reflect changes in supply and demand at the FOB level are made simultaneously at the retail and FOB levels such that margins remain constant. More importantly, this structure means that any change in the cost of marketing produce directly impacts packing fees charged to growers, so the grower price is likely to be far more sensitive to changes in cost than in a competitive framework.

Although the market for any of the commodities in this study is quite complex, a simple model of a competitive market equilibrium will be sufficient to illustrate the essential differences between prices received under contract and those determined under a series of negotiated equilibria. In addition to the supply curve defined above, the simulated market equilibrium consists of a retail demand function and a FOB-retail price linkage equation. Assuming marketing services are perfectly elastic in supply, however, this linkage simplifies to a fixed percentage markup.[6] Therefore, the model is written in terms of the supply relationship:

$$Q = \beta P + e + \varepsilon_1, \tag{10}$$

[6] This assumption is consistent with information provided by industry members (Hambleton, Peterson).

and demand:

$$P = \phi_0 - \phi_1 Q, \tag{11}$$

where *P* is the retail price. Solving for the competitive market equilibrium, therefore, gives an expression for the retail price entirely in terms of the model parameters:

$$P = \frac{\phi_0 - \phi_1 e - \phi_1 \epsilon_1}{(1 + \phi_1 \beta)} = \gamma_0 - \gamma_1 \epsilon_1. \tag{12}$$

where the value of *e* is to be constructed using the instrumental variables procedure described above. Under the assumption that marketing services are perfectly elastic in supply, the competitive FOB price then becomes simply a fraction * of the retail price, or:

$$w_1^F = \delta(\gamma_0 + \gamma_1 \epsilon_1), \tag{13}$$

Comparing this price series, simulated over a large number of randomly generated realizations of ,$_1$, to a simulated series of contract prices requires an expression for the contract price variable. Substituting the competitive supply equation into equation (8), and then substituting the reduced-form expression for the retail price from (12) into the result provides the contract FOB series:

$$w_2^C = \delta\left(\frac{\beta(\gamma_0 + \gamma_1 \epsilon_1)\sigma_{11}}{\beta(\gamma_0 + \gamma_1 \epsilon_1(\sigma_{11} + \sigma_{22})) + \rho C \sigma_{11} \sigma_{22}}\right), \tag{14}$$

so it is clear that the difference between these two series is critically dependent upon the relative variability of a firm's direct and indirect signals of its ability to deliver a continuous supply. Using demand and supply parameters taken from the existing literature, a Monte Carlo simulation provides estimates of each price as an average over 1000 random draws of the supply-shift parameter.[7] Values

[7] Because there are no known estimates of risk-aversion coefficients specific to firms similar to our sample data set, the simulations will be conducted over a range of plausible values. This will also serve to demonstrate the sensitivity of the research results to this parameter.

for the baseline parameters are found in table 2. Conducting simulations under a baseline parameter case, with shocks to each of the random components, or with changes to each of the key demand and supply parameters show how prices behave under each scenario.

[insert table 2]

Survey Data

The simulations not only require supply and demand parameters, they also require estimates of the effort intensity index, e, and measures of the variability of a firm's direct and indirect effort signals, F_{11} and F_{22}. The effort index is constructed as an instrumental variable as discussed above. Similarly, the variability of firm effort signals are estimated by the coefficient of variation for each proxy variable for Q and E. Estimation of equation (9) is accomplished using primary data collected through a survey of fruit and vegetable shippers.

The survey of apples, table grapes, oranges, grapefruit, and tomatoes shippers was conducted through a mailed questionnaire between March and June 2000. The sample was developed from the membership listings of various producer organizations, including the California Grape and Tree Fruit League (grapes), the Florida Tomato Exchange (Florida tomatoes), and listings of shippers obtained from the Florida Department of Citrus (Florida grapefruit) and from Vance Publishing's *Red Book Credit Services* (California, Michigan, New York, Pennsylvania, Virginia, and Washington apples; California oranges and tomatoes). These sources were used to identify a total of 1,019 firms, which nearly encompass the universe of shippers in these states for the respective products.

The survey instrument consists of four sections with questions seeking information on the respondents' size and scale of operations, their perception of changes in produce marketing institutions and practices, the extent of their use of contracts with retailers, and the shipper's reasons for contracting. Recognizing that contracts may be construed in a variety of ways, the questionnaire defined contracts for the respondent as follows: "Contracts include both written and verbal negotiated sales arrangements with buyers that cover multiple sales transactions or relationships with retail buyers where your firm might be considered the preferred supplier." This definition was used by the firms in framing their responses on contract use and experience in the survey.

Results and Discussion

Of the 1,109 mailed surveys, 29 were returned due to errors in the address; 19 were returned indicating their refusal to participate; 121 completed questionnaires were returned, yielding a response rate of about 12 percent. Questions on very sensitive business information likely made some firms reluctant to participate.[8] Still, the information obtained from the survey makes a significant contribution to the literature and is based on a sample generally representative of the produce shippers.

In particular, the distribution of firm sizes is comparable to another survey of fruit and vegetable shippers, the *Fresh Tracks* survey conducted by McLaughlin, Park, and Perosio.[9] In each survey, the modal firm size lies in the $5 to $29 million annual firm sales class. The *Fresh Track* survey, though, had proportionally more firms in the $30 to $100 million class and fewer in the less than $5 million class. However, the *Fresh Track* survey included a broader assortment of products, including several high-value nut and fruit crops. Accounting for this difference in products, the distribution of firm sizes in the two survey samples are arguably comparable. Further corroborating evidence on the representation of the industry reflected by each survey is not available, as there are no public statistics on the characteristics of produce shipping firms.[10]

The survey provided new insights on the types of buyers these produce shippers supplied and how supply channels have changed over time. The most notable change is the dramatic increase in sales to mass merchandiser customers (e.g. Wal-Mart), increasing from 3.8 percent of total firm sales in 1994 to 9.6 percent in 1999. This increase was accommodated by declining sales to wholesalers and brokers, reflecting the general movement towards more direct sales between shippers and retail buyers.

[8] Hueth *et al* express similar sentiments about inducing firms to participate in their survey on contracting practices. Their published work was based on responses from about 10% of the first-handlers of produce in California.

[9] The *Fresh Tracks* survey is conducted periodically by researchers at Cornell University under the support of the Produce Marketing Association to establishe benchmarks for industry operations and structure.

[10] The U.S. Census Bureau *Economic Census* only provides information on firm size for all firms storing and transporting all farm products.

This shift in buyer type has also been accompanied by a change in selling methods with 23.7 percent of the produce sales to mass merchandisers in 1999 occurring under a seasonal contract. This compares to only 4.5 percent in 1994. Only 1.3 percent of product sales to mass merchandisers in 1999 were under an annual contract and no sales under multi-year contracts were observed. Other evidence from the survey reveals that the contracts were typically only for three months or less, which would cover a single growing or harvest period. This reliance on shorter time periods in retail contracts is striking compared to other sectors of agriculture, where multi-year contracts between producers and processors are not uncommon, particularly in the broiler and hog sector and processed vegetables. Gains in contracting were also seen in sales to grocery retailers and to food service buyers. Although food service sales account for only about one percent of total firm sales, 21.6% of the sales to these customers occur under contract.

In total, 41 of the responding firms indicate that they have experience with retail contracts. Among the approximately 46 accounts held by a shipper on average, about four customers typically use contracts. However, this ranges from as few as one to as many as 20. Their use of contracts, however, is relatively new, with 1997 and 1999 being the modal year for first entering into contracts. A firm's desire to maintain future relationships with buyers is the strongest factor influencing it to enter into retail contracts (see table 3). The mean response to this question is 4.3 on a five point scale ranging from "not important" at one to "very important" at five. Consistent with prior discussions with produce shippers, other strong motivating factors include desires to assure sales (4.0) and to attain some degree of price stability (3.7). Pressure by retailers only has a modest degree of influence on this decision (3.2). Conversely, most contracting firms appear to have entered into the contracts freely and have benefitted from them. Among the 41 contracting firms, 23 indicate that the use of contracts has in general been beneficial for their firm's operations. Further, their business relationships under contract appear to have been favorable with 31 of the respondents indicating that their contract buyers have generally kept to their contractual commitments.

[insert table 3]

While the use of contracts appears to be beneficial to growers, keeping their contractual commitments with buyers entails some additional costs. Therefore, the survey instrument also includes questions designed to assess shipper efforts and costs in meeting their commitments. Using a five point Likert scale with one denoted as “never” and five denoted as “often,” these firms occasionally require their employees to work overtime (mean value of 3) and sometimes acquire additional transportation or storage facilities (2.9) or assign an employee to a contract account (2.7) in order to meet contract shipping requirements. However, only seldom or rarely, would they buy produce from other shippers (2.5), form joint ventures (2.5), develop global sourcing capabilities (2.0), or redirect shipments from other customers (1.9) in order to meet the provisions specified in their contract. The more frequently exercised options include the use of resources accessible to the shipper on a short-term basis. So while they may be costly, contracting may be a good way of controlling costs. Indeed, if shipments can be planned and additional capacity can be obtained on a short-term basis, it would suggest that further consolidation in the shipping sector is not necessarily required, if contract usage becomes more widespread. Contracts could aid shippers in utilizing their existing capacity in a more consistent manner. Still, growers may be faced with other requirements associated with the contractual agreements, such as certain fees and services.

Contracting firms cited requirements such as special packaging methods, the use of third-party food safety inspection services, and the adoption of electronic data interchange (EDI) systems as special accompanying conditions. There is a concern that some of these requirements are scale-intensive, and would therefore favor awarding the contracts to large shippers. In this case, it may bring more equal trading partners together, but it may also disadvantage smaller suppliers, who could effectively be blocked from the opportunity to trade with certain buyers.

Thus, the type of supplier most likely to contract is an important question. Provided that shipments may be planned and additional short-term facilities and resources are accessible, contracts do not necessarily favor larger firms. However, if the contract specifies the accompanying use or provision of certain scale-intensive services, they may favor larger firms. The resulting balance of power will also ultimately influence the returns captured by the trading partners. Contract usage may also be influenced by certain other firm characteristics, like the number of years in the shipping business, rate of growth in sales, or the number and type of buyers supplied by the firm. Tests on these and other factors influencing contract use are examined next, as part of the first stage estimation of Heckman's two stage sample selection model.

Contracting Firms and Contract Intensity

The estimated parameters of the first stage model are presented in table 4. Since the model was estimated using data pooled across four of the different product surveys, dummy variables were included in the model to account for variation associated with the different product markets with grapes treated as the excluded dummy variable.[11] The null hypothesis that the coefficients on these variables, as well has variables measuring firm size (number of boxes shipped), recent change in sales, concentration in sales or buyer share, and years in business all equal zero is rejected at the one percent level under a P^2 test, providing a strong indicator on the overall performance of the model. Similarly, a McFadden R^2 of 0.23 is generally good for a probit model using cross sectional data on firms.

[insert table 4]

Amongst the firm characteristic variables, firm size, measured by the number of boxes shipped in 1999, is found to have a statistically and economically significant influence on the likelihood of a firm participating in retail contracts; each one million box increase in shipments increases the likelihood of contracting by approximately 15 percent. This is plausible for a sample, where the average number of boxes shipped in 1999 was approximately one million with a range from 400 to over eight million. Retail contracting would, thus, appear to be more attractive to larger firms, who have a real interest in securing stable market access and perhaps have greater resources to service exclusive retail accounts. As seen, firms that serve a fairly exclusive group of clients, as measured by the share of sales to its top four customers, are also more likely to contract. Indeed, a one percent increase in four-firm buyer share results in a 0.3 percent increase in the probability of contracting. Firms experiencing growth in sales are also seen to be more likely to contract. The point estimate for this coefficient suggests that a

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[11] The orange sample only provided one respondent that contracted. However, this observation was lost due to nonresponses to some key model variables. Thus, oranges were excluded from the analysis.

one percent increase in sales between 1994 and 1999 would cause a 0.2 percent increase in the probability of contracting. Although the coefficient on this variable is not significantly different from zero at the 10 percent level, it is significant at the 15 percent level under a two-tailed test or at the 10 percent level under a one-tailed test. A one-tailed test might be appropriate, if growth is construed to be an indicator of progressive management that would be more receptive to contracting or that would be more likely to provide the service and managerial efforts that contract buyers seek from their suppliers.

As discussed earlier, a large share of the supplies destined to mass merchandisers are under contract. Accordingly, the share of firm sales to mass merchandising customers is positively related to the probability of contracting, but the coefficient on this variable is not significantly different from zero. Recall, however, that even though the share of sales to mass merchandisers under contract is relatively high, the total share of firm sales to merchandisers is still less than 10 percent. Further examination of the data also shows that a relatively few, large firms tend to supply mass merchandiser customers. This would cause the firm size variable (number of boxes) to partially mask the influence of the mass merchandiser share variable.

Finally, it is evident that there is a relatively stronger tendency to contract among apple, grapefruit, and tomato growers. Although, about 22 percent of the grape respondents, the excluded category, indicate that they have experience with contracts, contracting is more prevalent amongst apple, grapefruit, and tomato growers, thereby explaining the positive dummy variable coefficient for each of these products in the probit model. While this model provides insight into the types of firms who have a propensity to enter into retail contracts, it is also a necessary step in correcting for the bias that would result if sample selection is not corrected for in testing hypotheses on factors explaining the intensity of contracting in the second stage model.

Specifically, the second stage model provides a test of hypotheses developed above on how signals on firm effort observable indirectly from output supply or directly from shipper actions influences the use, or more accurately the award of contracts, as measured by the share of shipments made under contract. The estimated parameters from this model are presented in table 5. As hypothesized, the more pronounced or easily discernible signals on output (*Q*) are, the lower the contract usage. Thus, increases in the absolute or relative number of accounts, growth and concentration in sales, and increasing firm tenure, as incorporated in the summated scale measuring output signals, tend to decrease the share of sales under contract. This finding is consistent with the conceptual model. Increases in these variables increase the precision of the effort signal inferred from output. Firms that have successfully increased the number of accounts they serve, while at the same time supplying a greater share of their shipments to their largest customers and increasing overall sales, could be viewed as providing clear output signals to its customers. These proven market suppliers would, thus, tend to be compensated for these market actions and would be seen to contract less.

[insert table 5]

Conversely, and as hypothesized, increases in the direct firm effort signal (*E*) results in more contract use. The index measuring direct firm effort was composed of several elements: the sum of the expressed frequency of actions taken by firms in order to meet its contractual commitments, declines in the absolute number of accounts (an increase in the reciprocal measure of number of accounts), an increase in the share of sales held by leading accounts, and indicator variables that express firm beliefs that contracting has been beneficial and that bargaining power with buyers has improved. These measures are posited to be indicators of the directly observable efforts shippers would take to provide a consistent supply to their customers. For instance, firms that have become more selective in the customers they serve could be viewed by a buyer as exerting more effort to support leading buyer sales. Similarly, a firm's preferential attitude towards contracting and the efforts firms take to service contract customers could become apparent through improved relations between buyer and seller. In these instances, the buyer is willing to reward firms for their direct effort. Specifically, a reduction in the variability of the direct effort signal results in an increase in behavioral-based compensation, and, therefore, a greater proportion of sales under contract.

These results suggest that retailers seek contract suppliers that can assure them of more exclusive service or they may stipulate this condition in a contract. This would provide the retailer with some assurances of dedicated firm efforts in providing supplies on a consistent basis. At the same time, the supplier may feel more assured of having a known buyer or buyers for its output under less volatile price conditions. These assurances, though, may be met with some additional service requirements, such as third-party food safety inspections or special packaging. It remains to be seen how the trading partners value the opportunities afforded by the contract. This is evaluated using the proposed simulation model.

Price Simulations

The price simulations were conducted for a representative commodity, Washington Red Delicious apples, using the parameters presented in table 2. The effort index enters through the supply relationship specified in equation (10). The stochastic error term in this same expression was generated through a Monte Carlo simulation, where 1,000 equilibrium market (w_1^F) and contract (w_2^C) prices were determined for each grower in the sample. The prices were then averaged across all growers. Additional simulations were performed by varying the demand and supply equation slopes, the variance on the output and effort signals, and cost of effort. Average prices for each set of parameter assumptions are reported in table 6.

[insert table 6]

Using the base case parameters, the average market grower price ($\bar{w}_1$) is $0.3336 per pound, while the average contract grower price ($\bar{w}_2$) is only $0.2858. Further, the standard deviation for the contract price is appreciably smaller. The source of the smaller variability is readily apparent from an inspection of equations (13) and (14), where it is seen that the stochastic error term entering through the supply relationship has a direct effect on market price, while its influence is partially muted through its interactions with other terms in the numerator and denominator of the expression for the contract price. More importantly, though, this result has a great deal of intuitive appeal. Market prices responding to changing supply conditions would be expected to be more variable than contract prices. The reduction in price variability, though, is accompanied by a lower contract grower price, which would suggest some form of risk sharing. Shippers may be willing to accept a lower price recognizing that the contract will shield them from some variability in price and potential variability in sales. Indeed, this is consistent with the shippers' expressed strong interest in entering into contracts in order to obtain greater price stability and to assure sales, each of which rated higher than a desire to obtain superior prices (see table 3). This pattern in price levels and the variability of prices is seen to hold over a range of plausible demand and supply slopes. Although there are some changes in the prices relative to the base case prices, strong priors on these price movements could not be developed. Perhaps more critical to growers and retailers, though, is information on how price varies in response to variability in effort.

Variability in effort and the cost of effort only affect the contract price, so the discussion focuses on the change in price relative to the base simulation. When variability in the indirect effort signal increases (decreases), the contract price increases (decreases). This is consistent with the comparative static results and suggests that in an environment where output is quite variable, retailers would pay more for more reliable supplies through contractual relationships. This is seen in the rise of the contract price from $0.2858 per pound in the base case to $0.4178 when the variability in the indirect effort signal increases. Under this scenario, not only is the contract price higher, it also less variable than the open market price. Yet, when the variability of the indirect effort signal increases, the contract price falls to $0.1198, suggesting that retailers are not willing to pay a premium for contract deliveries when market transactions are supplied in a reliable manner. These results clearly illustrate the substitute relationship that exists between contract and market transaction, which are further supported in simulations involving the variability of the direct effort signal. As the direct effort signal becomes less (more) variable, the contract price rises (falls), albeit slightly. For example, under the precise direct effort case ($F_{22} = 0.90$ vs. $F_{22} = 1.817$ in the base case), the contract price rises from $0.2858 to $0.2863. Similarly, a relatively small change in the contract price occurs following an increase in the variability of the direct effort signal (from 0.2858 to 0.2863). In both cases, the contract price remains below the market price and has lower variability. The magnitude of contract price changes corresponding to changes in effort costs are similar to those related to changing the variability of the direct effort signal. As would be expected from inspecting (14), an increase (decrease) in effort costs decreases (increases) the contract price. Still, the contract price lies below the market price.

These simulations suggest that contract prices are more responsive to increases in the variability of the indirect effort signal. Facing increased variability in market deliveries, retailers are willing to pay a premium for contract deliveries. However, when the indirect effort signal is relatively precise, suggesting that the retailers can rely on open market transactions, the contract price is heavily discounted. Further, changes in firm efforts under contract, either through attempts to reduce the variability associated with the direct effort signal or measures that would reduce effort costs, have relatively little impact on contract price, which remains below the market price. So while the contracting firms may enjoy lower variability in price, their efforts in supporting these contracts have little incremental affect on the price they receive. The modest increase in contract price associated with lower effort costs, also suggests, to the extent to which effort costs are scale related, that larger firms will not necessarily receive disproportionately higher contract prices. Further, the contracting firms continue to receive less than those trading on the open market.

Conclusions and Implications

It is evident that the use of contracts between shippers and retailers is on the rise, but is still in its infancy with most shippers having only begun using them in 1997 or 1999. For retailers, the contracts enable them to obtain produce on a timely basis, aiding them in reducing storage costs and shrinkage, while presenting the consumer with high quality product. They also help to reduce the retailer's exposure to fluctuations in FOB prices, which are typically absorbed in the margin, while retail prices remain relatively fixed. For shippers, contracts offer them some stability in price and an assured market for their produce. Typically, this market access only extends through a single season or harvest period for fruit and vegetable contracts with retailers. Still, shippers take a longer term perspective when expressing the sentiment that the leading reason they enter into contracts is to maintain future relationships with buyers. The contracts also offer shippers the opportunity to better plan the use of their facilities. Some even indicated that they acquire additional transportation and storage facilities to meet their contract commitments. They are, however, less inclined to undertake longer term activities, such as developing global sourcing capabilities. This may reflect the relatively short-term duration of most contracts. Provided that additional facilities are available, widespread use of contract does not necessarily imply that further consolidation in the produce shipping sector will occur.

However, current contracting firms tend to be larger firms. Further, they are firms that have demonstrated to their customers that they will undertake the steps necessary to fulfill their contract commitments. They are also required to provide additional services in connection with their contracts. These services are scale-intensive, further suggesting that larger firms may be more likely to enter into contracts. If contracting continues to grow, this may leave smaller shippers with fewer marketing options in the future, causing them to rely on an increasingly less liquid spot market. This could lead to further disparities among shippers and concerns over competition at this level of trade. With regard to transactions with retailers, contracting will bring more equal trading partners to the table, but the balance of power still rests with retailers.

Exercising market power, though, does not appear to major factor driving the increased use of contracts. Pressure from retailers only played a modest role in the shipper's decision to enter into contracts. Further, most shippers feel that contracting has been beneficial for their firm. Contracting provides them with the price stability and market assurance they seek. This stability and market access does come with some costs. Beyond the provision of required additional services and additional managerial efforts, the shipper may also receive a slightly lower price. This decline in price, though, is likely due more to a risk sharing mechanism than to the exercise of market power by retailers. Indeed, in an environment where shipper deliveries are highly variable, the retailer is willing to pay a premium to contracting firms, which can provide more consistent deliveries. Aside from its potential impact on the structure of the produce shipping sector, contracting appears to serve the interests of both shippers and retailers.

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Table 1. Comparative Static Results for Compensation Schemes

Comparative Static	Sign	Condition
1. $dw_i/d\sigma_{ii}$	< 0	none
2. $dw_i/d\sigma_{jj}$	> 0	$\rho C Q_0(\sigma_{ii}+\sigma_{jj}) > \rho^2 C^2 Q_0 \sigma_{jj}$
3. dw_i/dQ_0	> 0	none
4. $dw_2/dQ_0 > dw_1/dQ_0$	> 0	$\sigma_{11} > \sigma_{22}$

Table 2. Parameter and Baseline Variable Values Used in Grower Price Simulation

Parameter	Description	Value	Source
N_0	Demand intercept term	$2.79/lb.	IRI retail database[1]
N_1	Slope of market demand	-$0.023/lb.	IRI retail database
$	Slope of market supply	$8.967/lb.	WA Growers Clrng. House
F_{11}	Variability of direct outcome	0.956	Estimated from survey[2]
F_{22}	Variability of effort signal	1.817	Estimated from survey
D	Coefficient of risk aversion	1.0	Plausible estimate
$,_1$	Random supply error term	N(0,10.8)	Generated in SHAZAM
C	Cost of effort ($/lb.)	$0.05/lb.	Plausible estimate
*	Farm share of retail price	0.30	Richards and Patterson (1999)
e	Effort intensity index	N.A.	Estimated from survey

[1] The demand parameters are estimated using weekly retail scanner data obtained from Information Resources Incorporated from Jan. 1998 to Dec. 1999 from 20 chains located in six urban U.S. markets. The supply parameter is estimated using price and movement data from the Washington Growers' Clearing House.

[2] Both measures of variability are calculated as coefficients of variation.

Table 3. Factors Influencing Decision to Use Retail Contracts, Importance Scale.

Decision Factors	**Importance Scale** *1=Not Important ... 5=Very Important*
Price stability	3.7
Assured market or sale	4.0
Maintenance of future relationship with buyer	4.3
Superior price	3.2
Reduction in cost of distribution	2.7
Reduction in cost of sales and marketing	2.9
Pressure from retailers	3.2
Incentives provided by retailers	2.5
Pressure from growers	2.3
Prior experience with food service contracts	2.1

Table 4. First Stage Probit Model: Factors Determining Probability of Participating in Retail Contracts, Marginal Values.

Variable	Coefficient	Asymptotic t-ratio
Constant	-0.574	-3.907
Apples	0.142	1.007
Grapefruit	0.387	1.612
Tomatoes	0.145	0.666
Number of Boxes Shipped, 1999 (1,000 boxes)	0.147E-3**	3.231
Proportional Increase in Sales between 1999 and 1994	0.223	1.544
Share of Sales to Top 4 Buyers (Proportion)	0.301*	1.856
Share of Sales to Mass Merchandisers (Proportion)	0.742	0.898
Years in Shipping Business	-0.246E-2	-1.277
N	96	
McFadden R^2	0.2297	
P^2	27.400**	

Two and one asterisks denote significance at the five and ten percent levels, respectively. P^2 tests explanatory power of the model by imposing the restriction that all explanatory variable coefficients are equal to zero.

Table 5. Second Stage OLS Model: Output Signal (*Q*) and Effort Signal (*E*) Influence on Contract Use.

Variable	Coefficient	t-ratio
$\hat{w}_1 Q$	-0.073**	-2.310
$\hat{w}_2 E$	0.051**	2.328
8, Inverse Mill's Ratio	0.217**	3.643
R^2	0.4424	
N	30	

Two asterisks denote significance at the five percent level.

Table 6. Price Simulation Model: Sensitivity Analysis

Scenario	Parameter	$\bar{w}_1$	σ_{w_1}	$\bar{w}_2$	σ_{w_2}
		.... *$ per pound*			....
Base Case	no change	0.3336	1.840e-04	0.2858	4.820e-05
Elastic Demand	N_1 = -0.01	0.3359	1.630e-05	0.2857	4.230e-06
Inelastic Demand	N_1 = -0.03	0.3153	1.534e-03	0.2869	4.380e-04
Elastic supply	$ = 13.50	0.3315	1.830e-04	0.2863	4.840e-05
Inelastic supply	$ = 4.50	0.3349	1.850e-04	0.2846	4.770e-05
Variable output	F_{11} = 1.40	0.3336	1.840e-04	0.4178	8.790e-05
Precise output	F_{11} = 0.40	0.3336	1.840e-04	0.1198	1.390e-05
Variable effort	F_{22} = 2.70	0.3336	1.840e-04	0.2853	7.200e-05
Precise effort	F_{22} = 0.90	0.3336	1.840e-04	0.2863	2.340e-05
High effort cost	*C* = 0.075	0.3336	1.840e-04	0.2852	4.800e-05
Low effort cost	*C* = 0.025	0.3336	1.840e-04	0.2863	4.840e-05

Appendix A: Comparative Static Derivations

This appendix provides expressions for each of the comparative static results provided in table 1. First, simplify the expression for compensation method i such that:

$$w_i^* = \left(\frac{\rho Q_o C \sigma_{jj}}{(Q_0 + \rho C \sigma_{jj})(Q_0 + \rho C \sigma_{ii}) - Q_0^2} \right) = \left(\frac{\rho Q_0 C \sigma_{jj}}{\Omega} \right), \; i,j = 1,2, \; \Omega > 0. \quad \textbf{(15)}$$

With the denominator of this expression always positive, the comparative static derivatives are:

1. $$\frac{dw_i}{d\sigma_{ii}} = \frac{-\rho C (Q_0 + \rho C \sigma_{jj}) \rho Q_0 C \sigma_{jj}}{\Omega^2} < 0;$$

2. $$\frac{dw_i}{d\sigma_{jj}} = -\frac{(\rho Q_0 C \Omega - \rho Q_0 C \sigma_{jj} \rho C (Q_0 + \rho C \sigma_{ii})}{\Omega^2} > 0;$$

3. $$\frac{dw_i}{dQ_0} = \frac{\rho C \sigma_{jj} \Omega - \rho C \sigma_{jj} (\rho Q_0 C \sigma_{ii} + \rho Q_0 C \sigma_{jj})}{\Omega^2} > 0;$$

4. $$\frac{dw_j}{dQ_0} - \frac{dw_i}{dQ_0} > 0 \text{ if } \sigma_{ii} > \sigma_{jj}.$$