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Information Sharing and Oligopoly in Agricultural Markets: The Role of Bargaining Associations

Brent Hueth and Philippe Marcoul

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Center for Agricultural and Rural Development
Iowa State University
Ames, Iowa 50011-1070
www.card.iastate.edu

Brent Hueth and Philippe Marcoul are assistant professors of economics at Iowa State University.
Brent Hueth may be contacted by e-mail at bhueth@iastate.edu, or by telephone at 515-294-1085.
Philippe Marcoul may be contacted by e-mail at marcoul@iastate.edu, or by telephone at 515-294-6311.

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Abstract

We study incentives for information sharing (about uncertain future demand for final output) among firms in imperfectly competitive markets for farm output. Information sharing generally leads to increases in expected total welfare but may reduce expected firm profits. Even when expected firm profits increase, information sharing does not represent equilibrium behavior because firms face a prisoner's dilemma in which it is privately rational for each firm to withhold information, given that other firms report truthfully. This equilibrium can be overcome if firms commit to simultaneously reporting their information and if reports are verifiable. We argue that agricultural bargaining associations serve both these roles.

Keywords: agricultural markets, bargaining, imperfect competition, information sharing

INFORMATION SHARING AND OLIGOPOLY IN AGRICULTURAL MARKETS: THE ROLE OF BARGAINING ASSOCIATIONS

Introduction

Many markets for farm output are plausibly characterized by some degree of imperfect competition. This is certainly true in most fruit and vegetable markets where growers are numerous, and where intermediation (e.g., processing or shipping/packing) is relatively concentrated. Processing or packing cooperatives, and cooperative bargaining among farmers, may in some instances be institutional responses to these market imperfections—in both cases, farmers can enhance their bargaining position in price negotiations with noncooperative intermediaries (e.g., Sexton 1990). This perspective emphasizes the effect of cooperation on the distribution of surplus among participants in agricultural markets. An alternative view—the one we explore in this paper—is that cooperation is an institutional response affecting the efficiency of market transactions and hence indirectly the distribution of surplus among parties.

Briefly, we consider an imperfectly competitive market for farm output in which information sharing among intermediaries (about uncertain future demand for final output) potentially leads to higher expected aggregate surplus. In this context, we show that a bargaining association can solve a prisoner's dilemma among firms where all parties (firms, consumers, and growers) are better off when information is fully shared, but where each firm's dominant strategy is to not reveal its information. The bargaining association serves two roles. First, it invests costly resources in verification of firm reports (firms can choose not to reveal their information, but if they do reveal, it is impossible to lie), and second, it provides a mechanism by which all parties commit to simultaneously revealing their information. We will argue that these two functions are reasonable descriptions of what bargaining associations actually do (among other things), and that they serve to solve the prisoner's dilemma.

In what follows, we begin with a description of bargaining in agricultural markets. We then develop a model of information sharing based on the work of Vives (1984), Raith (1996), and Li (1985) (see Vives 1999, chap. 8, for an excellent summary of this literature), and demonstrate how a bargaining association can lead to efficiency gains. The final section concludes and discusses the empirical implications of our model.

Bargaining in Agricultural Markets

Our intent in this section is not to provide an exhaustive overview of agricultural bargaining but rather to point out ways in which descriptions of the institutional features of bargaining associations seem consistent with the notion that bargaining can have efficiency consequences.

To begin, it is noteworthy that bargaining occurs primarily in markets for processing fruits and vegetables. This particular set of markets comprises only a small portion of all agricultural markets, and it is natural to ask why bargaining associations aren't more widespread. If the success of bargaining as an institution hinges on delivering higher prices to growers, we should expect to observe bargaining in a larger class of commodities. At least two features of markets for processing fruits and vegetables seem relevant to this point. First, processors obtain their output primarily through forward contracts, so that traditional modes of price discovery are absent. Moreover, procurement decisions are typically made in the context of uncertainty about the state of future demand (e.g., prior to planting). To the extent that price negotiations during bargaining facilitate industry-wide communication about future demand, bargaining can thus be viewed as a sort of indirect price discovery mechanism. Second, processing of fruits and vegetables is highly concentrated (both spatially and in numbers of firms), so that it is reasonable to expect some degree of oligopoly behavior by firms. This fact possibly increases the potential benefits of collective bargaining and (spatial concentration) reduces organizational and communication costs among growers. Although the efficiency consequences of bargaining in the context of oligopolistic markets are not immediately apparent, in the next section we show how centralized price discovery (or "information sharing") effectively increases competition among oligopsony buyers, thus leading to a more efficient outcome.[1]

Results and discussion from two studies of bargaining seem consistent with the notion that bargaining is more than simply "price enhancement." First, in a national survey of (processing) fruit and vegetable bargaining associations, Iskow and Sexton (1992) note that "the majority of associations felt their role was not only to improve the well-being of grower-members, but also to provide services to processors." Of the services provided, "increased price stability," "improved information," and "improved price discovery process" were mostly frequently cited.[2] Lacking similar responses from processing firms, it is difficult to know whether in fact such services are provided and valued. Nevertheless, the fact that nearly all respondents view price discovery and improved information as important services provided by their respective associations is certainly consistent with the hypothesis that "bargaining" can increase efficiency.

Bunje (1980) offers a comprehensive description of bargaining in U.S. agricultural markets;[3] in summarizing the role of farm bargaining he similarly notes:

> Bargaining associations can fill the needs of the market as well as the needs of the individual producer. They can serve a supply coordinating function for the market and furnish market intelligence for the producer. They can operate as a price discovery vehicle, establish market prices, and establish uniform terms of trade that serve the producer and the marketplace.

While such a quote might be viewed as self-serving coming from a representative of bargaining associations, it again conveys the idea that, at least in the minds of those who operate bargaining associations, bargaining can lead to efficiency gains.

In what follows, we formally analyze one possible source of such a gain. We develop an oligopoly model of *n* firms who produce substitute final goods, and who obtain their raw farm input from a group of homogeneous growers (represented by an aggregate supply relation). Before procurement, each firm is uncertain about the true state of future demand but receives an imperfect signal of demand. We study private incentives for firms to share (or pool) their signals, and the corresponding welfare implications. In this context, we interpret the intensive communication that occurs during the annual bargaining process as a means of implementing information sharing.

Model

The Setup

There are n firms who convert farm output into a vector of final consumption goods $q = (q_1, \ldots, q_n)$, where q_i represent the quantity of final goods sold by firm i. For simplicity, we suppose that each firm transforms q_i into final output in Leontief fashion with constant marginal cost (normalized to zero), and moreover that a single unit of farm output yields a single unit of final output. Thus, for given output price $p_i(q)$, and farm price $r(q)$, firm i's profits are given by $\Pi(q_i, q_{-i}) = [p_i(q) - r(q)]q_i$, where q_{-i} represents the $n - 1$ vector of outputs other than i's. Growers are represented by an aggregate (inverse) supply function $r = a + bQ$, where $Q = \sum_{i=1}^{n} q_i$ is the aggregate quantity of farm output purchased.[4]

Final goods are differentiated and valued by a representative consumer with utility function

$$U(q) = (\overline{\alpha} + \varepsilon)\sum_{i=1}^{n} q_i - \frac{1}{2}\left(\overline{\beta}\sum_{i=1}^{n} q_i^2 + 2\overline{\gamma}\sum_{i \neq j} q_i q_j\right), \tag{1}$$

where $\overline{\beta} > \overline{\gamma} > 0$, $\overline{\alpha} > 0$, and where ε is a normally distributed, aggregate source of uncertainty. We suppose that all firms share a common prior of 0 for the mean of this random variable, and that its variance, σ_ε, is known. For a given vector of prices $p = (p_1, \ldots, p_n)$, consumers choose quantities to maximize $U(q) - \sum_{i=1}^{n} p_i q_i$, , yielding inverse demand schedules for each firm's output given by

$$p_i(q_i, q_{-i}) = \overline{\alpha} + \varepsilon - \overline{\beta} q_i - \overline{\gamma}\sum_{j \neq i} q_j. \tag{2}$$

The timing of actions in our model is as follows. In period 0, each firm receives an independent (and private) signal $s_i = \varepsilon + \nu_i$, where ν_i is distributed normally and independently of ε with $E[\nu_i] = 0$, $E[\nu_i^2] = \sigma_\nu$, $E[\nu_i \nu_j] = 0$ for $i \neq j$. Thus, each s_i represents imperfect, though unbiased, information on the state of future demand. Based on these signals, firms form expectations in period 1 about demand in period 2 and coordinate with growers for delivery of some quantity of farm output that arrives in period 2. Expectations depend on the information available to each firm, and we consider two scenarios. In the first, each firm keeps its information private and thus forms an expectation based on s_i (for firm *i*). Alternatively, firms pool their information and thus form expectations based on the full vector of signals $s = (s_1, \ldots, s_n)$. Finally, in period 2, firms noncooperatively choose prices to maximize their individual profit, given the quantities of output arranged for delivery in the previous period. We assume "efficient rationing" (e.g., Tirole 1989) of quantities, so that equilibrium prices in period 2 are just those that form an equilibrium when all quantities are delivered to the market.

The structure of this market is analogous to Bertrand competitors choosing capacities in an *ex ante* period, where here "capacities" are given by the quantity of output arranged for delivery during period 1. For the equilibrium we described above, it is, of course, essential that no firm can obtain additional output in period 2 (relative to what was arranged for delivery during period 1). This is a natural feature of the markets we study given the time interval required to produce most kinds of farm output.[5]

Market Equilibrium Without Information Sharing

In period 1, after each firm receives its signal s_i, the firms play a Cournot game in choosing quantities of output for delivery in period 2. For given q_i, the (conditional) expected profit of firm *i* is given by

$$\overline{\Pi}(q_i, q_{-i} \mid s_i) = \left(\alpha + E[\varepsilon \mid s_i] - \beta q_i - \gamma \sum_{j \neq i} E[q_j \mid s_i] \right) q_i \tag{3}$$

where $\alpha = \bar{\alpha} - a$, $\beta = \bar{\beta} + b$, and $\gamma = \bar{\gamma} + b$. Let $\rho = \sigma_\varepsilon / (\sigma_\varepsilon + \sigma_v)$ represent the correlation between s_i and s_j. Then firms update their priors on ε with the formula $E[\varepsilon|s_i] = \rho s_i$, which is a (variance) weighted average of the prior and s_i. Firm *i*'s reaction function is then given by

$$q_i(q_{-i}) = \frac{\alpha + \rho s_i - \gamma \sum_{j \neq i} E[q_j \mid s_i]}{2\beta}. \tag{4}$$

To find an equilibrium for this game, we suppose that firms use strategies that are affine in their signals and we then verify that these strategies indeed form an equilibrium.

Letting firm *i*'s equilibrium strategy be given by $q_i = c_0 + c_1 s_i$, and noting that $E[s_j|s_i] = \rho s_i$, it is straightforward to verify that an equilibrium is obtained setting $c_0 = \alpha/\delta$, and $c_1 = \rho/\delta_\rho$, where $\delta = 2\beta + (n-1)\gamma$, and $\delta_\rho = 2\beta + (n-1)\gamma\rho$, and hence that the equilibrium quantity for firm *i* is given by

$$q_i^p = \frac{\alpha}{\delta} + \frac{\rho s_i}{\delta_\rho}. \tag{5}$$

For future reference, we note that $E[q_i^p] = \alpha/\delta$, $E[(q_i^p)^2] = E[q_i^p]^2 + \sigma_\varepsilon\rho/\delta_\rho^2$, and $E[q_i^p q_j^p] = E[q_i^p]^2 + \sigma_\varepsilon\rho^2/\delta_\rho^2$, for $i \neq j$.

The full information equilibrium level of production (when α is known for certain) is given by α/δ, so that firms increase or decrease their output relative to this benchmark depending on whether the realization of s_i is greater than or less than zero. The variance of signal noise σ_v has an ambiguous effect on the slope term ρ/δ_ρ. On the one hand, as σ_v decreases, firms put more weight on their signals relative to their prior, and this makes firms more responsive. This effect is reflected in the numerator of the second term in equation (5) where a decrease in σ_v increases ρ. However, a decrease in σ_v also increases the correlation of the firms' signals. This in turn implies that if some firm, say firm *i*, receives information suggesting high demand, it is likely that other firms have received similar information. Because the outputs of each firm are substitutes, an equilibrium response to this is a reduction in firm *i*'s output. This effect is reflected in the denominator, where a decrease in σ_v increases δ_ρ. Changes in σ_ε have a similarly ambiguous, though reciprocal, effect on firm responsiveness. A reduction in σ_ε lowers the weight placed on each firm's signal, making firms less responsive, but also reduces the correlation of signals, and this tends to increase responsiveness.

Expected profit for each firm prior to observing their signal s_i, but anticipating equilibrium behavior for any realization of *s*, is given by

$$\overline{\Pi}_p = E\left[\max_{q_i} \overline{\Pi}(q_i, q_{-i} \mid s_i)\right] \tag{6}$$

which from (4) reduces to $\overline{\Pi}_p = \beta E[(q_i^p)^2]$. Direct calculation from (5) then yields

$$\bar{\Pi}_p = \frac{\alpha^2}{\delta^2} + \frac{\sigma_\varepsilon \rho}{\delta_\rho^2}. \tag{7}$$

The first term in this expression represents the profits each firm would receive if there were no uncertainty ($\sigma_\varepsilon = 0$). From this term, expected profits are high when aggregate demand and supply are high (high $\bar{\alpha}$ or low a), or when the total price decrease resulting from a small increase in each firm's output is small (low δ).

One consequence of information sharing is an increase in the precision with which firms estimate ε. Thus, before considering the market equilibrium with information sharing, it is natural to consider how a reduction in the variance of the signal error σ_v (which reduces the variance of each firm's estimate of ε) affects expected firm profits when there is no information sharing. From (7), a reduction in σ_v has a similar qualitative effect on profits as on the equilibrium responsiveness of each firm's output to their signal (previously described). Firms benefit from a reduction in the variance of signal noise because their output decision more accurately reflects actual demand conditions. However, because the signals of each firm become more correlated, equilibrium outputs also have greater correlation, and this tends to reduce expected profits. Thus, whether or not firms gain from information sharing generally will depend on a direct comparison of expected profits in each regime. In the next section, we derive an expression for expected firm profits when information is shared and make this comparison.

Market Equilibrium With Full Information Sharing

Here we suppose that some mechanism is available for firms to share their information. Later in the paper, we'll argue that a bargaining association can be one such mechanism. To focus on the potential benefits from information sharing, we continue to assume that firms act as oligopsonists in the market for farm output.[6]

When information sharing occurs, firms receive the full vector of signals s and thus form common estimates of ε. With n independent signals, the best estimate of ε is given by $E[\varepsilon|s] = \rho_n \bar{s}$, where $\rho_n = n\sigma_\varepsilon/(n\sigma_\varepsilon + \sigma_v)$, and $\bar{s}$ is the mean value of the vector s. Proceeding as in the previous section, firm i's reaction function is then given by

$$q_i(q_{-i}) = \frac{\alpha + \rho_n \overline{s} - \gamma \sum_{j \neq i} E[q_j \mid s]}{2\beta}, \tag{8}$$

yielding the equilibrium quantity

$$q_i^s = \frac{\alpha + \rho_n \overline{s}}{\delta}, \tag{9}$$

with $E[q_i^s] = E[q_i^p] = \alpha/\delta$, and $E[(q_i^s)^2] = E[q_i^s q_j^s] = E[q_i^s]^2 + \sigma_\varepsilon \rho_n/\delta^2$.

Thus, equilibrium expected output is the same regardless of whether or not firms share information about their common demand uncertainty. Firms are more responsive to their aggregate signal $\overline{s}$ than to their private signal s_i when

$$\rho_n/\rho \geq \delta/\delta_\rho, \tag{10}$$

and it is straightforward to verify that this condition is always satisfied (for $\beta > \gamma$). Thus, the greater precision of the firms' estimate of ε, and the corresponding increase in responsiveness (measured by the term on the left-hand side of the above inequality), outweighs the reduction in responsiveness associated with increased (perfect) correlation among the firms' signals (measured by the right-hand side of the inequality). Expected firm profits with information sharing are given by

$$\overline{\Pi}_s = \frac{\alpha^2}{\delta^2} + \frac{\sigma_\varepsilon \rho_n}{\delta^2}, \tag{11}$$

and are thus higher than without information sharing when

$$\rho_n / \rho \geq \delta^2 / \delta_\rho^2. \tag{12}$$

The following proposition summarizes the conditions under which information sharing leads to higher expected firm profits.

PROPOSITION 1. *Information sharing increases expected firm profits when outputs are sufficiently differentiated and when aggregate farm supply is sufficiently elastic (for a given total quantity).*

Intuitively, a high degree of product differentiation is analogous to each firm acting as a monopolist in the downstream market for farm output. Improved information on future demand increases each firm's ability to price discriminate, and this in turn increases expected profitability. Similarly, when supply is sufficiently elastic, procurement decisions have a relatively small effect on the upstream price of farm output, and this also enhances expected profitability with information sharing. For the reasons discussed earlier, the magnitude of *ex ante* uncertainty σ_ε and variance of signal noise σ_v have ambiguous effects on the expected profitability of information sharing.

Welfare Comparison

In this section, we evaluate the effect of information sharing on total expected welfare and on the expected welfare of consumers and growers individually. We evaluate *ex ante* welfare (prior to the firms receiving their signals) but suppose, as in the previous section, that firms anticipate the equilibrium that will obtain in either scenario and for a given realization of *s*.

Surplus for growers is given by $\frac{1}{2}(r(Q)-a)Q=\frac{b}{2}Q^2,$ so that expected grower surplus is given by

$$\frac{nb}{2}\left(E[q_i^2]+(n-1)E[q_iq_j]\right). \tag{13}$$

Using the expressions for $E[q_i^2]$ and $E[q_iq_j]$ obtained in the previous sections, it is straightforward to verify that growers always benefit from information sharing. Intuitively, both growers and firms gain from increased precision in estimating aggregate demand. However, the increase in correlation among firms' outputs lowers expected firm profits, and increases expected grower surplus. Thus, the two effects associated with information sharing—increased precision in estimating aggregate demand and increased correlation among firms' outputs—are countervailing with respect to firm profits but complementary with respect to grower surplus.

Consumer surplus is given by $U(q)-\sum_{i=1}^{n}p_iq_i.$ Taking expectations (assuming equilibrium behavior by firms) yields

$$\frac{n}{2}\left(\overline{\beta}E[q_i^2]+(n-1)\overline{\gamma}E[q_iq_j]\right). \tag{14}$$

Thus, consumers also benefit from the correlation among firms' outputs, but only when there is some degree of product substitutability. As with grower surplus, the effects of information sharing on consumer surplus tend to complement, though to a lesser degree since $E[q_iq_j]$ is weighted by $\overline{\gamma} < \overline{\beta}$. Using the expressions for $E[q_i^2]$ and $E[q_iq_j]$ from the previous section, consumers gain from information sharing whenever

$$\frac{\rho_n}{\rho} \geq \frac{\delta^2(\overline{\beta}+(n-1)\overline{\gamma}\rho)}{\delta_\rho^2(\overline{\beta}+(n-1)\overline{\gamma})}. \tag{15}$$

Because $\rho < 1$, if information sharing leads to higher expected profits, then expected consumer surplus also increases. When $b = 0$, this inequality will always be satisfied since $\delta = \overline{\beta} + (n-1)\overline{\gamma}$ and $\delta_\rho = \overline{\beta} + (n-1)\overline{\gamma}\rho$. For $b > 0$, condition (15) will generally hold but can be violated. Thus, consumers generally gain from information sharing, though we cannot rule out the possibility that expected consumer surplus falls. Adding up the expected surplus measures for each party, total expected surplus is given by

$$\frac{n}{2}\left(3\beta E[q_i^2]+(n-1)\gamma E[q_iq_j]\right), \tag{16}$$

and is greater when information is shared if

$$\frac{\rho_n}{\rho} \geq \frac{\delta^2(3\beta+(n-1)\gamma\rho)}{\delta_\rho^2(3\beta+(n-1)\gamma)}. \tag{17}$$

As with consumer surplus, we cannot rule out the possibility that expected total surplus falls with information sharing, though in general it seems difficult to violate the inequality in (17).

The following proposition summarizes the effects of information sharing on the grower, the consumer, and the total surplus.

PROPOSITION 2. *Information sharing always benefits growers. Expected consumer surplus and total surplus increase whenever expected firm profits increase and may increase even as expected firm profits fall.*

Because the expressions for changes in expected profit and consumer surplus resulting from information sharing yield ambiguous results, we evaluate these measures (and expected grower surplus) for a particular specification of our model. We set $n = 5$, $\bar{\alpha} = 1$, $\bar{\beta} = 0.3$, $a = 0$, $b = 0.1$, $\sigma_\varepsilon = 0.3$, and $\sigma_\nu = 0.1$. With this specification, we then let $\bar{\gamma}$ range from 0 to $\bar{\beta}$ and evaluate differences in expected surplus with and without information sharing. The results are displayed in Figure 1. When outputs are sufficiently substitutable, expected firm profits fall when information is shared, though by a relatively small amount. Growers gain most from information sharing when outputs are highly

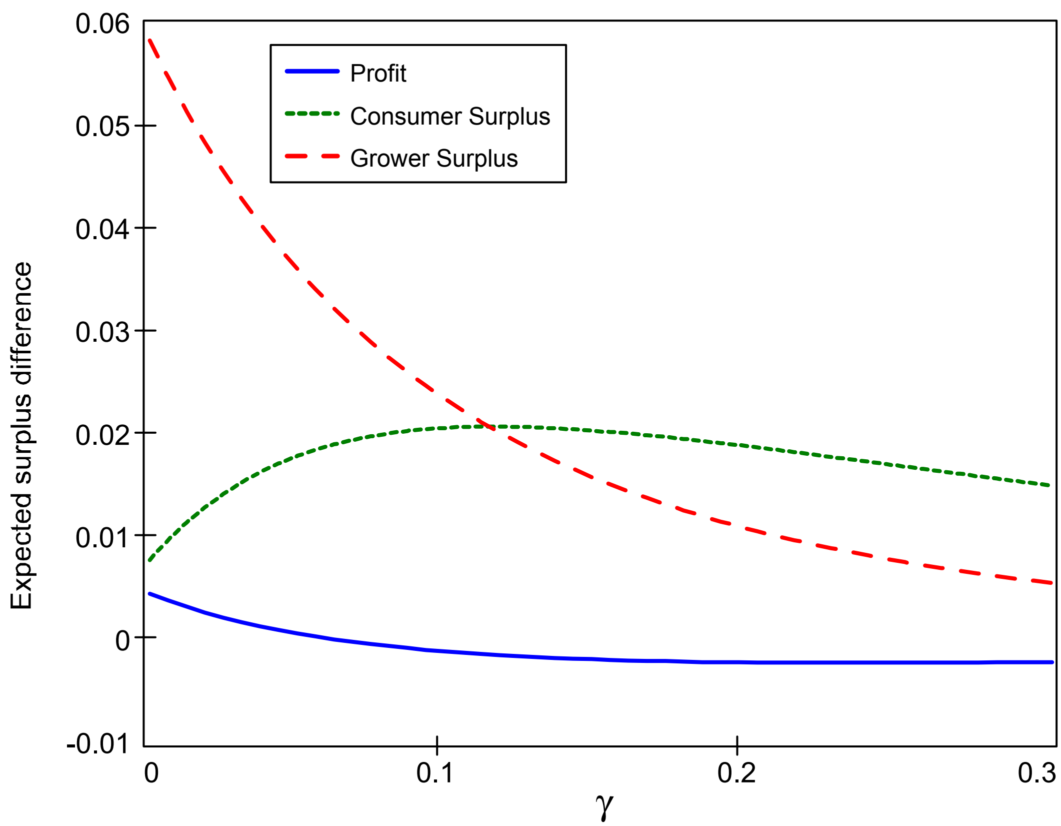

FIGURE 1. Difference in expected surplus with and without information sharing as firm outputs become increasingly substitutable in consumer preferences

differentiated. Interestingly, the change in expected consumer surplus with information sharing is initially increasing with the degree of product substitutability, then decreasing.

Figure 2 displays the results of a similar comparative static, but where we hold $\overline{\gamma}$ constant at 0.05 and let n range between 2 and 10 firms. Again, information sharing leads to a decrease in expected firm profits but now for n sufficiently large. Information sharing benefits growers (and, to a lesser degree, consumers) by a larger amount, as the number of firms increase.

Though not reported, a decrease in b (making supply more elastic for any given quantity of aggregate output) increases expected consumer surplus with information sharing and reduces expected surplus for growers. In all cases analyzed, expected total surplus increases from information sharing, and the benefit to firms is relatively small (and sometimes negative). It is also noteworthy that growers seem to gain substantially

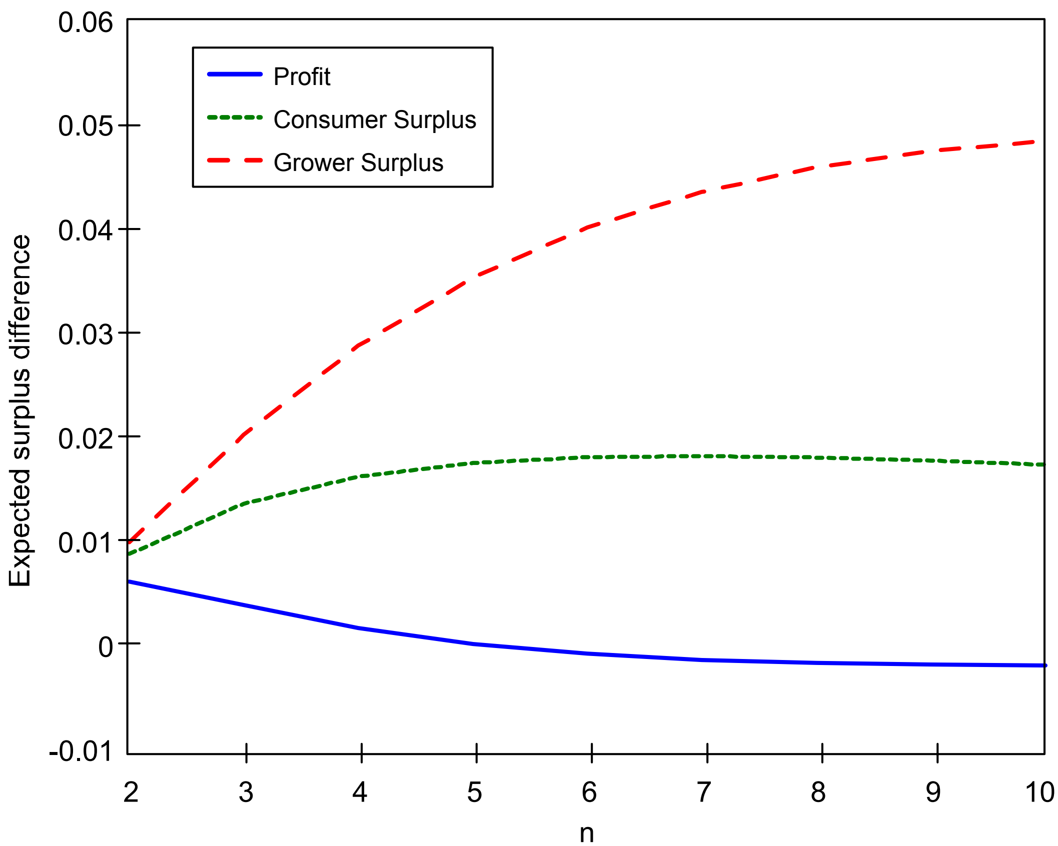

FIGURE 2. Difference in expected surplus with and without information sharing as the number of firms increases

from information sharing relative to firms, thus adding further potential benefit from bargaining beyond what might be achieved through changes in market structure (e.g., more competitive pricing of farm output; see endnote 6).

Private Incentives to Reveal Information and the Role of Bargaining Associations

We have seen that information exchange among firms can lead to a market equilibrium that Pareto-dominates the equilibrium with no information exchange; however, it turns out that when we examine each firm's private incentive to share information, a firm increases its expected profits by not reporting, given that all other firms have reported truthfully. More formally, suppose that firms play a two-stage game in which each firm can truthfully report its signal or report nothing in the first stage, and then firms choose quantities and prices noncooperatively in the second stage, conditional on equilibrium reports in the first stage. The following proposition (from Raith 1996) summarizes the first-stage equilibrium of this game.

PROPOSITION 3. *In the two-stage game in which firms first decide whether or not to report their signal to other firms and then choose quantities and prices noncooperatively (conditional on the vector of equilibrium first-stage reports), each firm's dominant equilibrium first-stage strategy is to not report its signal.*

In other words, given that all firms $j \neq i$ report their signals truthfully, firm i gains by deviating and reporting nothing. Intuitively, given that all other firms report their signals, firm i obtains the full benefits from increased precision in estimating aggregate demand and, by withholding its signal, reduces the correlation among equilibrium outputs. This unambiguously raises expected profits for firm i, relative to the equilibrium in which it also reports its signal.

Thus, firms potentially face a prisoner's dilemma in which all parties gain from information sharing but equilibrium behavior is to not share. Moreover, as we've seen in the previous section, this equilibrium generally leads to lower welfare for consumers and growers. It is thus natural to consider the kinds of institutions that might lead to an efficient outcome. Vives (1990) and Kirby (1988) suggest that "trade associations" are such an institution in markets where firms' outputs are strategic complements. With strategic complementarity, information sharing unambiguously increases expected firm profits, and it is a dominant strategy for firms to report their information. Thus, by collecting industry-wide information and reporting aggregate statistics, it is argued that these associations effectively implement an information-sharing outcome.

However, it is important to recognize that implementing the sharing outcome from the earlier section requires a highly detailed information-gathering effort by the association, even when firm outputs are strategic complements. In particular, we noted earlier that firms' reports of their signals must be verifiable in the sense that firms are unable to misreport their signals (though they can choose to not report at all). Ziv (1993) studies information sharing when firms can strategically distort their signals and finds that firms always will choose to report nontruthfully. Thus, in practice, verifiability is likely to be a substantial informational barrier, and it is not clear from existing theoretical work whether trade associations actually overcome this barrier or whether their primary service is on other dimensions (e.g., lobbying and promotional activities).

In the context of agricultural markets, bargaining associations represent a mechanism for sharing and verifying information among firms. The annual price negotiation that occurs with bargaining is an opportunity for explicit consideration of future demand conditions (perhaps even the primary activity) and is arguably a much more intensive information-gathering effort than is the reporting of aggregate industry conditions (as a trade association might do). Moreover, the structure of bargaining legislation effectively forces information revelation, since firms are required to engage in price negotiation. Thus, even when it is privately rational for firms to not report their information, or to misreport, bargaining may effectively force (truthful) information sharing. As we've seen, in some markets this will lead to an *ex ante* Pareto improvement, while in others, firms may collectively receive lower expected profits.

It is not immediately clear how to test whether bargaining associations are indeed playing this role, but the model presented above is suggestive. Suppose we take as the null hypothesis that the primary role of bargaining is price enhancement for growers. In principle, we could identify differences in the predictions of such a model (regarding the conditions that are conducive to the formation of bargaining associations) with those of the information-sharing model and examine which set of predictions best explains the incidence of bargaining associations across commodities and regions or whether predictions associated with information sharing add explanatory power. The key difference in these alternative explanations of bargaining lies in the potential gain for firms from information sharing. If information sharing were important, then, ceteris paribus, we'd expect bargaining to emerge if its effect on expected firm profits is relatively large (positive, or not too negative). In contrast, if price enhancement were the primary function of bargaining associations, then we'd expect the effect of bargaining on firm profits to be less important in explaining the incidence of bargaining.

Conclusion

We provide a rationale for the existence of bargaining associations in agricultural markets that is entirely independent of the role they may play in countervailing market power. In markets with a large proportion of "contracted" production, and a corresponding absence of spot markets, traditional modes of price discovery are absent. One possible substitute for price discovery via markets is direct communication among competing firms concerning expected future supply and demand conditions (prior to the annual procurement decision). In the spirit of work by Vives (1984), Li (1985), and Raith (1996), we model this communication as a Bayesian game among oligopolists in which each of n firms receives a signal of future demand (for simplicity we ignore supply uncertainty) and evaluate the welfare implications of firms sharing their respective signals with other firms. Information sharing tends to benefit consumers and growers but to have ambiguous consequences for expected firm profits. Information sharing allows firms to increase the precision of estimated future demand, but because the signals are positively correlated (a natural assumption, given the nature of the markets we study), information sharing also tends to increase the correlation among firms' equilibrium strategies. In markets where final outputs are substitutes, firm strategies are strategic substitutes, so that a positive correlation of strategies reduces expected profit. Thus, the effects of information sharing tend to countervail with respect to expected profits, and to complement with respect to consumer and grower surplus.

Even when expected profits for firms increase because of information sharing, firms face a prisoner's dilemma in which the equilibrium behavior of each firm is to not report its information (not reporting when other firms report reduces the correlation of strategies, with no effect on the precision of estimated future demand). We argue that collective bargaining represents one possible means of overcoming this equilibrium and, more generally, of increasing expected total welfare.

Endnotes

1. Of course, if information sharing leads to a collusive outcome, efficiency may be reduced. Though it may be in the interest of both processors and growers to collusively set output, it is doubtful that in practice such an outcome can be sustained. As we'll demonstrate, information sharing without collusion generally leads to higher expected surplus for consumers and growers (even when growers do not have countervailing market power), and possibly even higher expected profits for firms.

2. Of the 36 associations sampled, 31 cited increased price stability, 32 cited improved information, and 25 cited improved price discovery. When queried about services offered to growers, only "price negotiation" and "time and method of payment" were similarly cited by more than 30 associations.

3. Ralph Bunje was a leading spokesman and proponent of farm bargaining for over 30 years during his tenure as manager of the California Canning Peach Association (see forward in Bunje 1980).

4. This specification of the farm sector ignores grower heterogeneity, which may be important in considering the incentives for growers to form a bargaining association. We'd like to consider the industry-wide incentives to form a bargaining association, independent of the organizational and administrative difficulties created by grower heterogeneity.

5. It is also worth noting that we take as a given each firm's desire to coordinate with growers in period 1 (rather than to compete for aggregate output in period 2). This is consistent with the notion that firms "contract" with growers, rather than purchasing output on some kind of spot market. Understanding why firms choose to contract is an interesting question, but one that lies beyond the scope of this paper. Interestingly, as noted in the previous section, the absence of spot markets (and the corresponding prevalence of contracted arrangements) seems to be a necessary condition for the establishment of bargaining associations.

6. Bargaining that leads to competitive pricing for farm output would, of course, generate efficiency gains, but we'd like to evaluate the benefits from information sharing independent of changes in market structure.

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