ASSET OWNERSHIP AND INCENTIVES IN AGRICULTURAL PRODUCTION

by Brent Hueth and Tigran Melkonyan*

A NUMBER OF AUTHORS HAVE NOTED THAT, relative to other producing sectors, the organization of agricultural production is unique (e.g., Nerlove 1996; Allen and Lueck 1998). In particular, it is noted that farming, with only a few exceptions and across a wide variety of political and economic environments, has been remarkably resistant to corporatization. Further, farm production is often carried out by relatively small, typically family-operated, production units. It is not difficult to find evidence backing up these claims. In the United States, for example, the U.S. Department of Agriculture reports that in 1997, “individual” or “family” farms made up 86 percent of all farms in the United States; this statistic is virtually unchanged from 1992 (85.9 percent), the year in which it was last reported (USDA 1992 and 1997). Moreover, of the remaining roughly 15 percent of farms, family partnerships and family-held corporations make up a substantial portion (USDA 1996).

Somewhat paradoxically, other authors have noted that many agricultural markets have become increasingly industrialized during the last few decades, with a greater degree of vertical coordination observed between farmers and food manufacturers. The reasons cited include changes in the relative benefits and costs of direct coordination due to consumers’ increasing preference for processed/pre-prepared food items, and technological change allowing the efficient manufacture of such foods.¹ How is it that relatively independent, family-run units continue to dominate farming while, at the same time, agricultural production and food manufacture become increasingly industrial in nature? The answer, of course, is that although in many cases their procurement methods have become more direct, food manufacturers have chosen not to engage in farm production but instead to rely mostly on arm’s-length contracts. For example, in a recent survey of California fruit and vegetable intermediaries, only 8 percent claimed to “grow within,” meaning that all production is obtained from acres owned by the intermediary (Wolf, Hueth, and Ligon 2001). Even in poultry, typically cited as the most heavily industrialized of the food sectors, production under vertically integrated structures accounts for only 15-20 percent of total output (Martinez 1999). Thus, while direct coordination between farmers and food

¹ See Hennessy (1996), Boehlje and Doering (2000), and Drabenstott (2000) for further discussion and related citations.
manufacturers has become increasingly common, food manufacturers have largely stopped short of owning the farm.2

Regardless of the number of fully integrated firms in agriculture, a food manufacturer’s decision to own farm assets and hire labor, or to contract with one or more independent producers, is a decision affecting farm-level organization that has been mostly neglected in the existing literature. Of the works cited above, Allen and Lueck (1998) come closest to addressing this issue. In their view, family operation is efficient, and tends to dominate other forms of farm-level organization, because production uncertainty and seasonality in farming (which generate unpredictable and lumpy labor demand) and task complementarity (which limits gains from specialization) all limit the total number of workers that can be effectively employed with a given set of assets. However, the “family farm” scenario they consider, where a single worker is full residual claimant on farm output and (presumably) owns the farm’s entire assets, is indistinguishable from a scenario where the single worker owns no farm assets. That is, the authors examine family operation as the defining feature of farm organization, where a “family farm” is one with a small number of workers. Below, we argue that owner operation is an important attribute of farm-level organization.

In a related paper, Nerlove (1996) emphasizes the role of heterogeneity in a farm’s principal factors of production, and the importance of location-specific human capital, as the primary determinants of the family and owner-operated organizational structure. Combined with production uncertainty, these factors generate “information costs and other inefficiencies” that limit the value of hired labor. Nerlove’s “principal factors” include land, labor, and management, but exclude capital. We highlight the importance of combined ownership of land and farmer-employed capital. In our analysis, combined ownership of assets is important because it offers farmers a degree of independence, which improves incentives for creation of asset-specific human capital.

Lewin-Solomons (1999) examines the role of asset specificity in shaping farmers’ incentives. Some degree of specificity may be optimal because it effectively increases the value of a farmer’s efficiency wage. That is, a farmer who has made an investment that is specific to a particular intermediary will, for a given wage, work harder so as to avoid losing his market (and hence a portion of his investment). However, asset ownership itself is not a choice, so there is no sense in which a farmer can be either an owner-operator or an employee.

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2 Interestingly, the converse (i.e., that farmers rarely own the set of assets associated with food manufacturing) is not true. Vertical (forward) integration by agricultural producers into marketing and processing activities is often observed. Production and marketing cooperatives, and the “grower/packer/shipper” organizational structure observed in fresh fruit and vegetable markets, are examples. See Hendrikse and Veerman (2001) and Hendrikse and Bijman (2002) for recent analyses of this issue.
We identify one set of tradeoffs determining the choice between owner operation and vertical integration. We focus on the benefits of a farmer’s independence, characterized in our model as asset ownership, versus improved monitoring of farmer effort under intermediary ownership. In the language of the incomplete contracting literature, asset ownership by the farmer provides residual property rights (Grossman and Hart 1986), allowing discretion in choosing whether or not to contract with the intermediary. Asset ownership by the intermediary provides control rights (e.g., Aghion and Bolton 1992; Aghion and Tirole 1997), allowing discretion in how best to use the physical assets (which may mean employing some type of “monitor”). The set of assets a farmer owns conditions his incentive for acquiring asset-specific human capital, and for taking unobserved actions that affect the market value of the farm’s assets (e.g., actual depreciation of machinery). The assets owned by an intermediary condition her benefit from monitoring a farmer’s behavior. When the intermediary owns farm-level assets, the benefits from monitoring are relatively high because farmers internalize fewer noncontractible elements of total farm value. Moreover, a monitor, if one is used, allows an intermediary to more accurately measure a farmer’s performance. These countervailing forces generate a tradeoff between the two ownership regimes that turns on the relative importance of “internal” incentives provided by farmer ownership, versus “external” incentives made possible with more accurate performance measurement under intermediary ownership.

Modeling these dimensions of farm production and marketing helps sort out possible consequences of recent technological and food-policy change. As two examples, we consider the implications of precision farming and food-safety regulation for farm-level organization. Precision farming technologies (e.g., yield monitors, remote sensing) improve production efficiency, and simultaneously generate considerable information about farm-level activities. Some authors view this information-gathering attribute of precision farming as a potential threat to family (or owner-operated) farming. Similarly, ensuring food safety requires accountability in food production and distribution, and accountability demands detailed information about farmers’ activities. As with precision farming, a possible byproduct of improved production efficiency (where here efficiency is some measure of food safety) is therefore more in-

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3 The assignment of asset ownership can be an important economic decision for a variety of reasons that we choose to ignore. For example, federal employment taxes and agricultural production subsidies, if they are contingent on asset ownership, influence observed ownership allocations. Similarly, some states explicitly prohibit corporate farming or otherwise try to influence farm structure with legislation (Knoeber 1997). Also, Gillespie and Eidman (1998) provide evidence suggesting that farmers obtain direct utility from asset ownership and from their status as autonomous producers.

4 For example, Wolf and Wood (1997) note that emerging information technologies, particularly those associated with precision farming, provide off-farm interests with a mechanism for “appropriation of field and farm-level decision processes through substitution of capital for local knowledge.” In the model presented in the next section, we view this “appropriation” as the ability of an intermediary to easily substitute for the farmer’s noncontractible, productivity-enhancing investment.
tensive monitoring of farm-level behavior. A food-safety management regime may, for example, employ “traceback” to ensure that the origin (e.g., date, location, farmer) of a firm’s final product(s) can always be recovered. Will the improved monitoring that is associated with each of these technologies favor a hierarchical (e.g., corporate) organizational structure in farming? Below, we argue that this may indeed be the case, but only if the value of monitoring is higher under intermediary ownership than under farmer ownership. This latter qualification is an empirical question for which we tentatively provide an affirmative response.

Although we draw from well-established literatures to carry out our analysis, the model we use has a number of novel features. It employs “incomplete” (e.g., Hart 1995) and “complete” (e.g., Holmström 1979) contract-design theories along the lines suggested by Foss (1999, p. 31). In most agricultural markets, farmers face high-powered incentives with respect to measured output and quality, because such measures provide good summaries of farm-level performance. However, farmers engage in a variety of activities that do not directly influence measures of output but that do have an important impact on “total farm value.” Activities such as caring for land and machinery and expending effort to acquire asset-specific human capital are not easily rewarded with explicit incentives. For such activities, asset ownership by farmers generates a set of incentives that complement those made possible with explicit performance measurement. In our model, both sorts of incentives play a role. Holmström and Milgrom (1991, 1994) examine complementarity between asset ownership and performance incentives, but in a model where all actions are taken ex post (after the contract relationship has been established). In our model, actions that affect the productivity of physical assets are taken prior to incentive contracting. We model the interaction between farmer and intermediary this way to better reflect the stylized nature of a typical agricultural contracting environment where contracts are typically negotiated on an annual basis.

In what follows, we present our analysis and then provide a detailed summary of the model’s predictions. The subsequent section examines two recent forces affecting agriculture – precision farming and food safety regulation – and considers the incentives they generate for vertical integration of farming activities. The final section concludes.

Model of Asset Ownership and Incentives

We consider a model with two parties, a farmer and an intermediary. The farmer uses land in combination with his human capital and other inputs to produce an agricultural output q. This output can be sold to the intermediary or to some third party. The per-unit value of output depends on investments x and y by the intermediary and farmer, and is given by the continuously differentiable function
\( p(x, y) \), assumed strictly increasing in both its arguments. After the investments are made and observed by both parties, the intermediary offers the farmer an incentive contract. The farmer then accepts or rejects this contract, and chooses an unobservable effort \( a \) that stochastically affects output. We suppose that \( q = a + \varepsilon_1 + \varepsilon_2 \), where \( \varepsilon_i \) is distributed normally with mean 0 and variance \( \sigma_i^2 \), and distinguish between ex ante uncertainty that is potentially observable by the intermediary ex post, given by \( \varepsilon_1 \), and uncertainty that is never observable, given by \( \varepsilon_2 \). The random variables \( \varepsilon_1 \) and \( \varepsilon_2 \) are assumed statistically independent. The farmer has preferences that exhibit constant absolute risk aversion, and his cost of effort is assumed quadratic and separable from his utility of payment. For effort level \( a \) and payment \( t \), the farmer’s utility of income is given by \(-e^{-rt}\), where \( r \) is the farmer’s measure of absolute risk aversion, and the farmer’s disutility of effort is given by \( \frac{1}{2}a^2 \).

In order to observe \( \varepsilon_1 \), the intermediary must make an investment in a monitoring technology that has two components. The first component is represented by the physical monitoring equipment such as yield monitors, GPS and remote sensing equipment, and so on, that once installed on a particular machine or plot of land are not easily removed for installation on another, and that have potentially limited use outside the relationship with the intermediary. This portion of the investment thus exhibits a degree of specificity both with respect to farm-level assets and to the relationship with the intermediary. The second component of the monitoring technology is the complementary investment in human capital needed to make the results of monitoring meaningful. Here we have in mind the knowledge that is required to properly interpret measurements from the monitoring technology. Although the intermediary makes the investment in human capital, in principle either party can make the investment in physical capital. Because physical capital is durable, however, and future returns to that capital are uncertain, only its owner (who has residual income rights) will have full incentives to invest. Thus, because the farmer cannot make the human capital investment on behalf of the intermediary, efficient incentives for investment in the monitoring technology exist only under intermediary ownership of the farm assets. This is captured in our model by making \( \varepsilon_1 \) observable (and contractible) to the intermediary only under intermediary ownership of the farm assets.

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5 We suppose that the intermediary uses a fixed proportions technology in processing or packaging the farmer’s output. With such a technology, there exists some parameter \( \phi \) representing the fraction of finished product obtained from one unit of the farmer’s output. If the price of finished product is given by \( \bar{p}(x, y) \), then \( p(x, y) = \phi \bar{p}(x, y) \).

6 While our justification here is admittedly somewhat ad hoc, this information structure is intended to capture the idea that farmers tend to be guarded about what goes on inside their farms. It seems intuitively plausible that an intermediary who owns farm-level assets will have greater access to information about farm-level activities than an intermediary who contracts at arm’s length. See Holmström and Tirole (1993) and Lewis and Sappington (1991) for analyses that employ similar kinds of informational assumptions.
Thus, under farmer ownership, $\varepsilon_1$ and $\varepsilon_2$ are unobserved by the intermediary, and hence the incentive contract can be conditioned only on $q$. The intermediary who owns farm assets observes the realization of $\varepsilon_1$ after the investment in monitoring, which for simplicity we assume to be costless. The intermediary uses a linear incentive contract under both ownership structures. In the case of farmer ownership, this contract is given by $w_F(q) = \alpha_F + \beta_F q$, and in the case of intermediary ownership by $w_I(q, \varepsilon_1) = \alpha_I + \beta_I q + \gamma \varepsilon_1$. With these contracts, it is simple to verify that the agent’s utility can be represented in terms of the following certainty equivalent (Holmström and Milgrom 1991):

$$CE_i(a) = \alpha_i + \beta_i a - \frac{1}{2} [a^2 + r \text{var}_i] \quad \text{for } i \in \{F, I\},$$

where $\text{var}_F = \beta_F^2 (\sigma_1^2 + \sigma_2^2)$ and $\text{var}_I = \beta_I^2 \sigma_2^2 + (\gamma + \beta_I)^2 \sigma_1^2$ denote the variance of compensation under farmer and intermediary ownership, respectively. The intermediary is assumed risk neutral, with expected profits given by $\Pi_i(a) = p(x,y) a - \alpha_i - \beta_i a$ for $i \in \{F, I\}$.

A farmer owner has discretion over whether or not to contract with the intermediary. As a result, he can always sell in some other market if he chooses. We let $p(y)$ represent per-unit returns for his most attractive outside option. The farmer’s maximized certainty equivalent from producing in this market is given by $u(p(y)) = \frac{1}{2} p(y) [1 - r (\sigma_1^2 + \sigma_2^2)]$. Note that in this case, the farmer bears all production risk. Because $y$ is specific to the farm’s assets, $y$ has a lower marginal return on the outside, for all values of $y$. Under intermediary ownership, the farmer’s outside option (which may or may not involve farming) requires use of a different set of physical assets. To simplify our analysis, we make the extreme assumption that the farmer employee’s outside option offers an expected wage $\bar{w}$, independent of $y$.

**Incentive Contracting**

We begin by considering the constrained first-best environment where the farmer’s investment is contractible, but where the farmer’s effort $a$ cannot be perfectly monitored. In this environment, intermediary ownership always dominates farmer ownership provided that the cost of monitoring is sufficiently low. This is because the intermediary owner has access to a superior monitoring technology, and hence one with reduced agency costs. As we shall see below, when either $x$ and $y$ or $y$ and $p(x,y)$ are noncontractible, intermediary ownership may have a perverse effect on the farmer’s investment decision, rendering intermediary ownership nonoptimal.

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7 Of course, it would be possible to build other features into our model that would change this, but we wish to show how asset ownership by farmers can dominate intermediary ownership, even though we stack the deck in favor of the latter.
Investments \((x, y)\) and the incentive contract \((\alpha, \beta, \gamma)\) are chosen to maximize expected profits of the intermediary subject to the constraint that the farmer’s effort \(a\) maximize his return given the incentive contract, and that this incentive contract offer the farmer at least \(w\). Together, these constraints imply that the farmer will choose \(\alpha = \beta\) (incentive compatibility), and that \(\alpha\) will solve \(CE_\alpha(a) = w\) (individual rationality). Making these substitutions, we can write the intermediary’s maximization as

\[
\max_{x, y, \beta, \gamma} \{p(x, y) \beta - \frac{1}{2} \beta^2 - \frac{1}{2} r [\beta^2 \sigma_2^2 + (\gamma + \beta)^2 \sigma_1^2] - x - y\}.
\]

Note that this expression is exactly equal to \textit{ex ante} expected total surplus, where for simplicity we assume that \(x\) and \(y\) represent both the level and cost of investment. Because lump-sum transfers between the intermediary and the farmer are possible in our model, it is always in the interest of the intermediary to maximize \textit{ex ante} expected total surplus. Doing so requires shielding the farmer from all observable risk by setting \(\gamma = -\beta\). Making this substitution, and using an asterisk to denote solution values, it is straightforward to verify that for any \(x\) and \(y\), \(\beta^*(x, y) = p(x, y)/(1 + r \sigma_2^2)\), and hence that \(x\) will be chosen (assuming an interior solution) to satisfy

\[
\frac{p(x^*, y^*) \partial p(x^*, y^*)}{\partial x} = 1.
\]

A nearly identical expression (with \(\partial p(x^*, y^*)/\partial x\) replaced by \(\partial p(x^*, y^*)/\partial y\)) determines the first-order condition with respect to \(y\). Condition (1) equates the \textit{ex ante} expected marginal cost and benefit of investment by the intermediary. The marginal benefit of investment by either party is strictly higher when the variance associated with unobservable uncertainty and the farmer’s degree of risk aversion are lower. This occurs because greater uncertainty and risk aversion imply a lower-powered incentive contract (recall the expression for \(\beta^*(x, y)\) above), which induces a lower equilibrium effort from the farmer. The \textit{ex ante} expected marginal benefit from investment depends positively on expected output, which is lower for lower effort. Thus, the marginal benefit from investment is also lower.

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8 As long as total \textit{ex ante} expected surplus is greater than \(w\), the choice of investments \((x, y)\) and power of the incentive contract \((\beta, \gamma)\) are unaffected by the farmer’s outside option. In other words, \(\alpha\) is used only to redistribute the gains from the relationship between farmer and intermediary.

9 These solutions are guaranteed to be unique provided that \(p(x, y)\) is sufficiently concave (specifically, strict concavity of \(p(x, y)^2\) guarantees uniqueness). In what follows we suppose that this condition (strict concavity of \(p(x, y)^2\)) always holds.
Asset Ownership

We carried out our analysis of the (constrained) first-best environment where the intermediary had access to a superior monitoring technology when she owned the farm assets. In a world where this superior technology is available, the two ownership structures are equivalent in all respects (equilibrium investments, incentive contract, and equilibrium expected utilities) except for who owns the assets. Thus, so far in our analysis, we are unable to generate predictions regarding asset ownership that are consistent with the stylized facts noted in our introduction. Moreover, the only prediction generated so far is based on a somewhat ad hoc motivation for superiority of monitoring under intermediary ownership.

The observation that asset ownership does not matter when everything is contractible (and when there are no obvious forces supporting one ownership structure over another) is consistent with arguments by Williamson (1985), Grossman and Hart (1986), and Hart and Moore (1990) among others, who observe that if all contractual contingencies are costless to write, and can be foreseen, then allocation of property rights is often ambiguous. If some aspect of the contracting environment is noncontractible, then non-trivial predictions regarding ownership structure emerge. In such settings, asset ownership matters because it affects contracting parties’ incentives for choosing noncontractible elements of their relationship.10

In what follows, the farmer’s investment is assumed nonverifiable.11 In such a world, it is still possible to reach a first-best outcome provided that an ex ante (before investments are made) contract can include \( p(x, y) \), and provided that the intermediary’s investment is contractible. One mechanism that can implement this outcome is an option contract with the following structure: if the intermediary chooses \( x \neq x^* \), she pays a very large penalty. If \( x = x^* \) and a per-unit value for the farmer’s output other than \( p(x^*, y^*) \) is observed, the intermediary can offer the incentive contract, but with no lump sum transfer between the parties. Otherwise, the intermediary pays the farmer \( y^* + \delta \) for \( \delta > 0 \) after observing \( p(x^*, y^*) \), and then has the option of offering an incentive contract. It is easy to verify that in this mechanism (and for \( \delta \) sufficiently

10 Maskin (1999) notes that even when investments are not contractible, their first-best levels can be indirectly implemented if the parties can commit to a message game in which ex post actions and transfers are made contingent on announcements of the state of the world. This result is predicated on the ability of parties to commit to not renegotiate the outcome of the message game; if renegotiation is allowed, and the environment is difficult to describe ex ante (Maskin and Tirole 1999) or complex in the sense that there are many possible contingencies to consider (Segal 1999), then first-best investments may be unachievable.

11 Because the investment cannot be verified, it cannot be included in a contract, and hence may be noncontractible. In our model, we also have unobservable actions which are taken by the farmer, and which are always noncontractible. Where we do not fear confusion we sometimes use the term “noncontractible” interchangeably with “unverifiable” and “unobservable,” though it is apparent that each of the latter terms has a more specific meaning.
small), neither party will want to deviate from their first-best investment level; as a result, intermediary ownership will strictly dominate farmer ownership if \( p(x,y) \) is contractible. In what follows, we therefore assume that some aspect of the per-unit value of output, represented by \( p(x,y) \), is always noncontractible.

Motivating “incompleteness.” Contract incompleteness (i.e., noncontractibility of \( y \) and \( p(x,y) \)) is crucial to our analysis. Before proceeding with the details of our analysis, we therefore provide motivation for this assumption. Agricultural land exhibits considerable heterogeneity, even within a relatively small geographic region (e.g., Nerlove 1996; Binswanger and Rosenzweig 1985). Moreover, location-specific knowledge used in farming is costly to acquire, and is difficult to describe in precise terms. For example, agricultural contracts (between independent farmers and intermediaries) often have clauses stipulating that only “good farming practices” be used, and are quite vague regarding the manner of preparation, cultivation, and harvest of the farmer’s crop. Similarly, depreciation of physical assets other than land depends importantly on how such assets are used, and it is quite difficult to measure depreciation accurately. Thus, it is natural to interpret \( y \) as either the (ex ante) investment a farmer makes in acquiring location-specific human capital, or the effort expended in ensuring proper care of physical assets.

Intermediaries affect the value of farmers’ output with their handling, processing, and marketing activities. These sorts of activities may or may not be contractible, but perhaps it is plausible that they are somehow more describable, and hence can more easily be written into a contract, than the investments in learning and knowledge of the farmer mentioned above. In what follows, we allow for contractibility of the intermediary’s investment, but find that the resulting outcome does not differ from the one where both investments are noncontractible – i.e., contracting over the intermediary’s investment adds no value to the relationship. This outcome is the result of allocating all bargaining power to the intermediary (i.e., assuming that the farmer always earns his reservation utility). We discuss the implications of relaxing this assumption in our concluding remarks.13

12 Note that this degree of discretion may be the result of farmer ownership, and not the cause. However, consideration of discretion as an attribute of ownership would lead us into another model beyond the scope of this chapter, and is perhaps a topic for future research. Aghion and Bolton (1992) consider a related issue in the context of an investor-entrepreneur relationship, and Aghion and Tirole (1997) analyze real versus formal authority (which involves discretion) in the context of research and development projects.

13 We assign all bargaining power to the intermediary in part to reflect the stylized features of many agricultural markets in which farmers are typically in a weak bargaining position relative to their intermediaries. However, we also make this assumption to accommodate the hybrid nature of our model. The ex post interaction between the intermediary and the farmer is modeled as a standard principal-agent relationship where the intermediary makes a take-it-or-leave-it offer to the farmer who has a fixed outside option or “reservation utility.” While somewhat extreme, this assumption buys us a great deal in that we are able to evaluate the interaction between “explicit” incentives awarded through the incentive contract and “implicit” incentives awarded through asset ownership.
The per-unit value of output \( p(x,y) \) can be interpreted in a variety of ways, depending on the context in which it is considered. Generally, it can be thought of as any value creation due to the farmer’s *ex ante* investment \( y \) that is appropriated by the intermediary. For example, when \( y \) represents investment in asset-specific human capital, any effort \( a \) that the farmer employee makes to improve his knowledge and thereby achieve more efficient outcomes for the intermediary go unrewarded – he continues to earn the reservation wage \( w \).

**Model Solution and Analysis**

For given \( x \) and \( y \), the intermediary who is owner will offer an incentive contract that has analogous structure to the one that was optimal in the complete contracting environment. Expected profit of the intermediary is given by \( \Pi_I(x,y) = S_I(x,y) - w \), where \( S_I(x,y) = \frac{1}{2} p(x,y)^2/(1 + r \sigma_2^2) \) is the total *ex post* (after investments are made) expected surplus generated under intermediary ownership. Under farmer ownership, the intermediary’s incentive contract will be slightly different, reflecting the additional unobservable uncertainty associated with \( \varepsilon_1 \). Analogous to the first-best incentive contract, one can show that \( \beta_F(x,y) = \frac{p(x,y)}{1 + r (\sigma_1^2 + \sigma_2^2)} \), and hence that total *ex post* expected surplus is given by \( S_F(x,y) = \frac{1}{2} p(x,y)^2/[1 + r (\sigma_1^2 + \sigma_2^2)] \). In this case, the intermediary’s expected profits are given by \( \Pi_F(x,y) = S_F(x,y) - u(p(y)) \). For future reference, we will say that the investment \( y \) is relationship specific when \( \frac{\partial S_F(x,y)}{\partial y} > \frac{\partial u(p(y))}{\partial y} \) for all \( y \) and all \( x \in [0, x^*] \).

We suppose that \( x \) and \( y \) are noncontractible, and hence that they are chosen simultaneously and independently before the incentive contract is offered by the intermediary. Also, recall that \( p(x,y) \) is noncontractible. We therefore rule out any opportunities for dividing up *ex post* surplus as a function of chosen investment \( x \) and \( y \).

For any level of investment \( y \) chosen by the farmer, the intermediary earns *ex ante* expected payoff \( \Pi_I(x,y) - x \) from choosing \( x \) under farmer ownership, and \( \Pi_F(x,y) - x \) otherwise. For either ownership structure we can define the intermediary’s best response function \( B_i(y) \) for \( i \in \{F, I\} \), which characterizes her optimal choice of \( x \) for any given level of investment \( y \) by the farmer. Under ownership structure \( i \), \( B_i(y) \) is the solution to

\[
p(B_i(y),y) \frac{\partial p(B_i(y),y)}{\partial x} = 1 + R_i,
\]

where \( R_I = r \sigma_2^2 \) and \( R_F = r (\sigma_1^2 + \sigma_2^2) \). From expression (2), and because \( p(x,y)^2 \) is assumed strictly concave in \( x \), it is clear that for any level of investment \( y \) by the farmer, the intermediary’s optimal investment \( x \) will be strictly higher under intermediary ownership. When the intermediary owns the land and assets, the farmer’s best
response is always to choose zero investment since in that case his ex ante payoff is equal to \( w - y \). When the farmer owns the land and assets, his optimal investment \( y_F \) solves \( \frac{1}{2} p'(y_F) \left( 1 - R_F \right) = 1 \).

**Initial Exchange of Asset Ownership.** Thus, asset ownership has an important effect on the equilibrium investments chosen by each party, and hence on total ex ante expected surplus. Lump sum transfers are possible, either as part of the incentive contract or prior to transfer of asset ownership. As a result, both parties will always choose the ownership structure that maximizes total ex ante expected surplus. Because the intermediary has all the bargaining power, she will extract the farmer’s full increase in surplus associated with any exchange of ownership. If the intermediary owns the assets, and farmer ownership is optimal, the intermediary will extract from the farmer an amount which exactly equals the farmer’s increase in ex ante expected surplus from ownership. If the farmer owns the assets, and intermediary ownership is optimal, the intermediary will buy the assets, compensating the farmer for the reduction in ex ante expected surplus associated with a loss of asset ownership. In both cases, the transfer between the parties is given by \( u( \bar{p}(y_F)) - y_F - w \), which is positive so long as a farmer owner earns a larger certainty equivalent than a farmer employee.

Table 1 summarizes payoffs and equilibrium strategies for each party. The intermediary’s expected ex ante surplus is expected total surplus in the table less the reservation utility (outside option) of the farmer, less the cost of the intermediary’s investment, \( x \). For given \( x \) and \( y \), the intermediary clearly prefers owning the assets: the farmer exerts higher equilibrium effort, resulting in larger expected total surplus, and the farmer’s reservations utility is lower. However, we know that equilibrium investments are generally different under the two ownership structures, and we need to consider the magnitude of this difference in order to evaluate which ownership arrangement is preferred. To do so, it is necessary to distinguish between the situation in which \( x \) and \( y \) are strategic complements or strategic substitutes.\(^{14}\)

We begin with the case of strategic complementarity.

**Strategic Complements.** Figure 1 displays the best response functions of each party when \( x \) and \( y \) are strategic complements, and where we let \( x^*(y) \) and \( y^*(x) \) denote the solutions to equation (1) for given \( y \) and \( x \), respectively. The farmer’s best response curve coincides with the \( x \) axis under intermediary ownership, and is represented by a horizontal line at \( y_F \) under farmer ownership. The intermediary’s best response function slopes upward because the marginal benefit of investment by the intermediary increases with \( y \) under strategic complementarity. Also, for any level of investment \( y \)

\(^{14}\) Bulow, Geankoplos, and Klemperer (1985) first coined these terms. In our model, \( x \) and \( y \) will be strategic complements when each party’s marginal benefit from further investment is an increasing function of the other party’s investment. For this model, \( \partial^2 p / \partial x \partial y > 0 \) ensures strategic complementarity. Strategic substitutes are similarly defined, and are guaranteed by \( \partial^2 p / \partial x \partial y < 0 \).
Table 1. Payoffs and Equilibrium Strategies for Intermediary and Farmer

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<thead>
<tr>
<th>Payoffs and Strategies</th>
<th>Farmer Ownership</th>
<th>Intermediary Ownership</th>
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</thead>
<tbody>
<tr>
<td>Farmer Action</td>
<td>$p(x,y)/(1 + r (\sigma_{12}^2 + \sigma_2^2))$</td>
<td>$p(x,y)/(1 + r \sigma_2^2)$</td>
</tr>
<tr>
<td>Farmer Investment</td>
<td>$Y_F$</td>
<td>0</td>
</tr>
<tr>
<td>Intermediary Investment</td>
<td>$B_F(y_F)$</td>
<td>$B_I(0)$</td>
</tr>
<tr>
<td>Monitoring Investment</td>
<td>no</td>
<td>yes</td>
</tr>
<tr>
<td>Outside Option</td>
<td>$u(\bar{p}(y))$</td>
<td>$\bar{w}$</td>
</tr>
<tr>
<td>Ex-Post Surplus</td>
<td>$\frac{1}{2} p(x,y)^2/(1 + r (\sigma_{12}^2 + \sigma_2^2))$</td>
<td>$\frac{1}{2} p(x,y)^2/(1 + r \sigma_2^2)$</td>
</tr>
</tbody>
</table>

by the farmer, the intermediary’s best response $B_I(y)$ lies to the right of $B_F(y)$ and coincides with the first-best best response curve $x^*(y)$.

When the intermediary owns the assets, equilibrium investments are given by point $(x^c_I, 0)$, where $x^c_I = B_I(0)$. When the farmer owns the assets, equilibrium investments are given by $(x^c_F, y_F)$, where $x^c_F = B_F(y_F)$. Note that when asset ownership by the intermediary does not result in better monitoring ($\sigma_{12}^2 = 0$), the best response functions of the intermediary coincide under both ownership structures. In this case, farmer ownership results in a strictly higher investment by both parties. This occurs because the farmer has incentive to invest in order to enhance his outside opportunities, and the intermediary has incentive to invest more than when the farmer does not. Due to the relationship specificity of the farmer’s investment, $x^c_F < x^*$ and $y_F < y^*$, and as a result farmer ownership leads to a welfare improvement (since $S_F(x,y)$ is strictly concave). When intermediary ownership results in better monitoring ($\sigma_{12}^2 > 0$), the equilibrium investment by the intermediary may be higher or lower than under farmer ownership. In this case, the relative net benefits of the two ownership structures depend on the relative importance of each party’s respective investment, and on the benefits from monitoring. For example, when $y$ contributes little to $p(x, y)$ (the farmer’s investment is relatively unimportant) and when $x$ goes up under intermediary ownership (because monitoring increases the farmer’s equilibrium action, and hence the marginal benefit of $x$), intermediary ownership is more likely to dominate. We evaluate this dependence further in a subsequent section where we consider various comparative static effects.
Result 1 summarizes the effect of strategic complementarity on optimal ownership:

Result 1. Farmer ownership dominates under strategic complementarity when the benefits from better monitoring under intermediary ownership are sufficiently small. Intermediary ownership may dominate when either $x_I$ is large relative to $x_F$, the farmer’s investment is relatively unimportant (the marginal contribution of $y$ to $p(x, y)$ is small), or potentially observable uncertainty represents a large portion of total uncertainty ($\sigma_1^2$ is large).

Strategic Substitutes. Figure 2 displays the best response functions of each party when $x$ and $y$ are strategic substitutes. Note that relative to the case of strategic complementarity, the farmer’s equilibrium level of investment is unchanged. This reflects the fact that his investment is totally determined by the influence of $y$ on his outside option, which is independent of $x$ under both ownership structures. As in the previous figure, intermediary ownership results in a rightward shift of the intermediary’s best response curve, and coincides with the intermediary’s first-best best response curve. The
intermediary’s equilibrium investment when she owns the assets is given by $x^s_I$, and by $x^s_F$ otherwise. Note that $x^s_I$ exceeds the intermediary’s first-best level of investment, while the relationship between $x^s_F$ and $x^s_I$ is ambiguous. Under intermediary ownership the intermediary over-invests to compensate for the absence of investment by the farmer, while under farmer ownership, the presence of the farmer’s investment reduces incentive for the intermediary to invest. Unlike in the case of strategic complements, in general it is not possible to show that one ownership structure can Pareto dominate another (recall that under strategic complementarity, farmer ownership is the dominant ownership structure when $\sigma_1^2 = 0$).

When the intermediary’s investment is a poor substitute for the farmer’s, or in other words when the farmer’s investment is relatively important, farmer ownership will tend to dominate intermediary ownership. The converse will be true when the intermediary’s investment is a good substitute for the farmer’s. This can be clearly seen by considering an example where investments have a constant marginal rate of substitution. Suppose $p(x, y) = A(\alpha x + y)^{1/4}$, where $\alpha$ is the marginal rate of substitution between $x$ and $y$. Then it is not difficult to verify that the total *ex ante* expected surplus under farmer ownership is given by $(1/16) A^3 \alpha/(1 + R_F)^2 + y_F (1 - \alpha)/\alpha$ and

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**Figure 2. Best Response Functions and Equilibrium Investments Under Strategic Substitutability**
under intermediary ownership by \( (1/16) A^4 \alpha/(1 + R_i)^2 \). Thus, if \( \sigma_1^2 = 0 \) (there are no potential benefits from better monitoring) and \( \alpha < 1 \) (the intermediary’s investment is a poor substitute for the farmer’s investment), then farmer ownership will always strictly dominate intermediary ownership. For the case of perfect substitutes (\( \alpha = 1 \)), both structures yield the same total \textit{ex ante} expected surplus. When the intermediary can easily substitute for the farmer’s investment (\( \alpha > 1 \)), intermediary ownership will strictly dominate farmer ownership, and to an even greater degree as \( \sigma_1^2 \) increases. Even when the intermediary’s investment is a poor substitute for the farmer’s investment, intermediary ownership may still dominate for \( \sigma_1^2 \) sufficiently large.

For this specification of \( p(x,y) \) it is also possible to relate the power of the intermediary’s incentive contract to ownership structure. Direct calculation yields \( \beta_I = \frac{1}{2} A^2 \alpha^{1/4}/(1 + r \sigma_2) \) and \( \beta_F = \frac{1}{2} A^2 \alpha^{1/4}/(1 + r(\sigma_1^2 + \sigma_2^2)) \). Thus, when monitoring by the intermediary has value (\( \sigma_1^2 > 0 \)), the incentive contract under intermediary ownership is always more highly powered, and explicit performance incentives substitute for incentives associated with asset ownership. This is in contrast to Holmström and Milgrom (1994), where high-powered incentives and asset ownership are complementary. It is also interesting to observe that when \( \alpha < 1 \) (that is, when the farmer’s investment is relatively important), there is a very clear tradeoff between ownership structures. Under intermediary ownership, the farmer is presented with highly powered incentives and as a result exerts higher effort than under farmer ownership. However, the farmer makes no asset-specific investments. This outcome may support farmer ownership, but only if the farmer’s investment is sufficiently important relative to his effort in determining total \textit{ex ante} expected surplus.

Result 2 summarizes the effect of strategic substitutability on optimal ownership:

\textbf{Result 2.} Strategic substitutability tends to support intermediary ownership of assets when the intermediary’s investment substitutes well for the farmer’s, and when the benefits from monitoring (represented by \( \sigma_1^2 \)) are high.

Comparative Statics and Predictions

In this section we consider how the nature of the farmer owner’s outside option, risk preferences, and production uncertainty influence optimal ownership structure and the equilibrium investment levels of each party.

First, note that the farmer employee’s outside option \( \bar{w} \) has no effect on ownership structure so long as \( \bar{w} < u(p(y_F)) - y_F \). This is because \( \bar{w} \) does not depend on either party’s investment, and hence has no effect on total \textit{ex ante} expected surplus – only the division of total surplus in the case of intermediary ownership is affected by changes in \( w \).
**Marginal Value of Investment in Outside Option.** An increase in \( p'(y) \) for all \( y \) increases \( y_F \) under both strategic complementarity and substitutability. In the case of strategic complementarity (substitutability), this leads to a strictly higher (lower) investment by the intermediary under farmer ownership. If investments are strategic complements, this in turn leads to an increase in total *ex ante* expected surplus; if investments are strategic substitutes, total *ex ante* expected surplus may either increase or decrease. Under intermediary ownership, total *ex ante* surplus is unchanged (under both strategic complementarity and substitutability), with an increase in \( p'(y) \) since under this ownership structure the farmer’s investment is equal to zero, and hence the intermediary’s investment is unchanged. Thus, when investments are strategic complements, and when farmer ownership is optimal initially (before any change in \( p'(y) \)), then it will dominate by an even larger margin for higher \( p'(y) \). Moreover, the optimal ownership structure may switch from intermediary to farmer ownership for sufficiently large increase in \( p'(y) \). When investments are strategic substitutes, the effect of an increase in \( p'(y) \) on optimal ownership structure is ambiguous. For the example presented in the previous section there is no ambiguity – an increase in \( p'(y) \) always favors farmer ownership; however, one could construct an example where this is not the case.

Result 3 summarizes the effect of a change in the marginal value of the farmer’s outside option:

**Result 3.** An increase in the marginal value of the farmer’s outside option \( p'(y) \) raises support for farmer ownership when investments are strategic complements. Support for farmer ownership may increase or decrease when investments are strategic substitutes.

Intuitively, investments are always below their first-best levels when they are strategic complements. This occurs because the farmer chooses his investment according to its marginal value in his outside option, and this is strictly below the marginal value of his investment to the intermediary. Because the farmer under-invests, strategic complementarity leads the intermediary to also under-invest. Thus, under farmer ownership, an increase in \( p'(y) \) results in an increase in both investments, moving the parties closer to the first best. When the farmer is owner and investments are strategic substitutes, we cannot be sure that both parties under-invest. Moreover, unlike in the case of strategic complementarity, an increase in \( y_F \) results in a decrease in \( x \). Thus, an increase in total *ex ante* expected surplus is not guaranteed.

**Risk and Monitoring.** Next, we consider the effect of the farmer’s measure of absolute risk aversion, \( r \), and the variance associated with each source of uncertainty, on equilibrium investments and optimal ownership structure. We begin with \( r \). A
farmer who is more risk averse will produce less expected output when on his own (his equilibrium effort in the outside option will be lower), reducing the marginal value of his investment. As a result, \( y_f \) will decrease. Similarly, the cost to the intermediary of inducing effort by the farmer increases. In Figures 1 and 2 this results in a leftward shift of the intermediary’s best response curves under both ownership structures. When the farmer is owner, and when investments are strategic substitutes, this may lead to an increase in the intermediary’s investment. This increase is unambiguous only if (after the increase in \( r \)) there is a switch in optimal ownership: when farmer ownership continues to dominate, the intermediary’s investment may go up or down. Under both ownership structures, and provided there is no change in optimal ownership, an increase in \( r \) unambiguously reduces equilibrium investments by both parties when investments are strategic complements. The same result holds when investments are strategic substitutes and the intermediary initially owns the assets. Thus, we have that an increase in the farmer’s measure of risk aversion, \( r \), generally has an ambiguous effect on optimal ownership structure.

Though in general it is impossible to determine unambiguously the effect of an increase in the farmer’s level of risk aversion, in the case of strategic complements it is reasonable to expect that such an increase will tend to favor intermediary ownership. Under intermediary ownership, investment falls by an amount that corresponds to the leftward shift in the intermediary’s best response curve. Under farmer ownership, intermediary investment falls for the same reason, but also because the farmer’s investment falls. Intuitively, this reflects the fact that under farmer ownership both the farmer’s investment and action fall, while under intermediary ownership only his equilibrium action falls. In both cases, the intermediary’s equilibrium investment will also decline, but possibly by less under intermediary ownership. As a result, the decrease in total ex ante expected surplus associated with an increase in \( r \) can be greater under farmer ownership than under intermediary ownership. By itself, the effect of an increase in the variance of unobservable uncertainty has much the same effect as an increase in \( r \). A more interesting comparative static is the effect of a change in the relative contribution of potentially observable uncertainty to total uncertainty. Holding the variance of total uncertainty \( \sigma_1^2 + \sigma_2^2 \) constant, we can view an increase in the variance of potentially observable uncertainty \( \sigma_1^2 \) as an improvement in the intermediary’s ability to monitor the farmer. For example, consider an extremely simple example where there are just two sources of production uncertainty: weather and pests. Suppose initially that only weather is observed, and hence that the incentive contract can be conditioned on only the realization of weather (and output). In this case, the variance \( \sigma_1^2 \) is equal to the variance of weather. Now suppose that pests are also observable under intermediary ownership, but not under farmer ownership. In this case, the intermediary can condition the incentive contract on both weather and pests (and output), and the variance \( \sigma_1^2 \) is equal to the sum of the variances of weather and pests.
Because the farmer must bear all production risk when producing for the outside market, $y_F$ is unchanged with respect to a change in $\sigma_1^2$. Under farmer ownership, the best response curve of the intermediary depends only on total uncertainty and therefore is also unchanged. Thus, an increase in $\sigma_1^2$ has no effect on equilibrium investments under farmer ownership. Under intermediary ownership, an increase in $\sigma_1^2$ allows the intermediary to offer higher-powered incentives, which induces a higher equilibrium effort, and hence increases the marginal value of the intermediary’s investment. Thus,

**Result 4.** An improvement in the intermediary’s monitoring technology (represented by an increase in $\sigma_1^2$, holding total variance constant) will always favor intermediary ownership of assets.

Results 3 and 4 are illustrated in Figure 3 for the case of strategic complements. Curve AB in Figure 3 corresponds to combinations of $\sigma_1^2$ and $\bar{p}'(y)$ for which the two ownership structures yield the same total *ex ante* expected surplus. AB is upward sloping since increases in $\sigma_1^2$ ($\bar{p}'(y)$) favor intermediary (farmer) ownership. Intermediary ownership dominates farmer ownership for the points to the right of indif-

![Figure 3. Dominant Ownership Regime Under Strategic Complementarity](image-url)
ference curve AB and vice versa for the points to the left of AB. Changes in parameters that favor intermediary ownership will shift AB upward since then a larger set of parameter pairs \((\sigma_1^2, \tilde{p}'(y))\) supports intermediary ownership. For example, if an increase in the farmer’s absolute degree of risk aversion \(r\) favors intermediary ownership, then AB will shift to a position like CD in Figure 3. Under strategic substitutability, increases in \(\tilde{p}'(y)\) do not necessarily favor farmer ownership, and curve OA may be nonmonotonic.

**Food-Safety Policy, Precision Farming, and Integration Incentives**

These comparative static results suggest a number of possibilities regarding the impact of agricultural policies and specific types of technological change on farm-level organization in agriculture. In this section we consider two examples: food safety regulation and use of precision farming technologies. Each is viewed as an exogenous change in one or more parts of the model presented in the previous section.

**Food Safety Regulation**

Food safety concerns provide firms with a powerful incentive to ensure accountability throughout their respective food production systems. This incentive has become stronger in the last few years, as branded and pre-prepared food items have become increasingly prominent. Hennessy, Roosen, and Miranowski (2001) examine the role of leadership (granting one party a first-mover advantage in choosing investments) in ensuring safe food. They find that when investments are strategic complements, leadership by one or more parties can result in improved outcomes.

In our model, it is natural to think of food safety as a probability \(p(x,y) \in [0, 1]\), with \(1 - p(x,y)\) the probability of a negative food-safety “incident.” Suppose the intermediary pays a cost \(c\) when such an incident occurs. Expected revenue for the intermediary is then given by \(p(x,y) a - (1 - p(x,y)) c = p(x,y) (a + c) - c\). An increase in \(c\) raises the marginal value of \(p(x,y)\) (with respect to both investments) for any level of effort \(a\). It is not difficult to verify that the preferred ownership regime will be the one that results in relatively large \(p(x,y)\). Under strategic complementarity, this will be farmer ownership. Intermediary ownership will dominate when the intermediary’s investment is a sufficiently good substitute for the farmer’s. Irradiation is perhaps the best example of an investment by the intermediary that can substitute well for food-safety related activities of the farmer.

Also, it is clear that independent of these effects, the value of contracting on \(y\) becomes higher as \(c\) increases. Although we have presumed in our analysis that \(y\) is strictly noncontractible, if we relax this assumption, and allow contractibility at some
cost, then intermediary ownership will be optimal when this cost is sufficiently low, or when the benefits from contracting on y (which depend on the magnitude of $c$) are sufficiently high. Moreover, this incentive is reinforced by the fact that standard procedures for meeting food safety requirements – traceback, identity preservation, and so on – can expand the range of contractible variables in a relationship. When there are fewer noncontractibles, intermediary ownership tends to dominate.

For this example, the key friction that influences the integration decision is the noncontractibility of potential costs associated with a food safety incident, and difficulties in verifying farm-level investments to improve food safety. In the next example, similar kinds of noncontractibilities are important, but so are potential improvements in performance measurement.

**Precision Farming**

The suite of technologies associated with “precision farming” (e.g., on-the-go yield and quality monitors, adjustable-rate input applications, in-field monitors) affect the assignment of asset ownership through two channels. First, information that is collected with precision farming technologies can improve the intermediary’s ability to monitor farm-level activities. This can be represented as a reduction in unobservable uncertainty in our model. As explained earlier, such a reduction unambiguously supports intermediary ownership of assets if improved monitoring occurs only under intermediary ownership. However, in principle both parties can gain from improved monitoring, regardless of who owns the farm’s physical assets. A key question is therefore whether the improved monitoring made possible with precision technologies can be accessed by contractors. Although at a theoretical level there is no good reason for the answer to be no, in practice farmers are notoriously private about what goes on within their farm operations. If farmers are unwilling (for reasons outside the scope of our model) to freely share information about their farms with contractors, and if such information can be usefully employed when made available, one response is contractor ownership of assets.

Precision technologies can also make location-specific knowledge of production systems hard, rather than tacit. In the context of our model, this can be represented by supposing that the intermediary’s investment substitutes better for the farmer’s investment. Such a change unambiguously supports intermediary ownership. *Ex ante* expected surplus under intermediary ownership goes up by more than it does under farmer ownership, because increasing substitutability is more important when the farmer’s investment is low.

Though extremely stylized, these examples demonstrate important economic forces – contractibility, performance measurement, outside options, and strategic interaction – that shape the organization of farming activities. Although predicting the response of ownership allocations to changing agricultural technologies and food
policies in specific commodities awaits further empirical analysis, our model offers some direction for such work.

**Conclusion**

In this chapter we consider the optimal assignment of land and physical asset ownership between a farmer and a market intermediary. Ownership is important to the farmer because it gives him discretion with respect to producing for the intermediary when contracts are incomplete. That is, ownership gives him the option to sell to some other party if he chooses. Ownership is important to the intermediary because it allows her to more effectively monitor the farmer’s activities. This is true because the intermediary owner has greater access and control over the assets and can, for example, engage in monitoring activities that would not occur under farmer ownership. Because he can sell to a third party, a farmer who is owner is provided with greater incentive to maintain and improve the productivity of his assets. Doing so increases the value of his outside option (or, in other words, improves his bargaining position), and this increases the expected payment the farmer receives in the intermediary’s incentive contract. When the intermediary owns the farm assets, the farmer has no incentive to invest in activities that enhance the value of farm-level assets because any surplus generated from these investments will be appropriated by the intermediary. Because she can more effectively monitor the farmer, however, the intermediary who is owner offers a higher-powered incentive contract for given investments by each party. This induces a higher equilibrium unobservable effort by the farmer for given investments, increasing the marginal return from investment by the intermediary. The basic tradeoff that determines equilibrium ownership structure is one where the intermediary can hire the farmer as an employee and monitor him closely and ensure that he works hard, but at the expense of muting incentives for learning how to use and care for farm-level physical assets; alternatively, she can hire the farmer as an independent contractor, in which case the incentives to exert effort and invest in learning and care are reversed.

Thus, intermediary ownership is favored when it affords the intermediary an opportunity to monitor the farmer, and when the intermediary can easily substitute for the farmer’s investment. Farmer ownership is favored when noncontractible investments are complementary, when opportunities for monitoring a farmer employee under intermediary ownership are limited, and when the farmer’s investment is not very relationship specific (i.e., when marginal returns in the farmer’s outside option are high). Lastly, if we interpret the farmer’s investment to be “important” when its marginal contribution to \( p(x,y) \) is large relative to the marginal contribution of the intermediary’s investment, then the farmer should own the assets when he has an important investment to make.
We have simplified the analysis in this chapter by assuming that the intermediary has all the bargaining power.\textsuperscript{15} Although this assumption may accord reasonably well with the actual distribution of bargaining power in many environments involving agricultural contracts, it is useful to consider alternative distributions of bargaining power. For example, in the case of strategic complements, it will always be true that granting the farmer some degree of bargaining power will favor intermediary ownership. To see this, note that as a result of an increase in bargaining power, the farmer’s investment (and hence the intermediary’s investment) under intermediary ownership increases by at least as much as under farmer ownership. Thus, total ex \textit{ante} expected surplus increases by granting the farmer bargaining power, and under intermediary ownership increases by even more.

An interesting extension of our analysis would be to build on previous work that considers incentives for farmers to acquire the assets of the intermediary. As noted in our introduction, integration of this sort is commonly observed in agricultural markets in the form of cooperative ventures. Although there has been some work that considers this issue, the importance of incentive contracting and associated free-riding problems that might be present in such a venture has not been emphasized.

\vspace{1cm}

**References**


\textsuperscript{15} “Bargaining power” here refers to the share of total \textit{ex post} gains from trade appropriated by the party. De Meza and Lockwood (1998) and Chiu (1998) provide theoretical treatments of the relationship between one’s assumed bargaining game and optimal ownership assignment.


