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# Relational Contracts and Product Quality: The Effect of Bargaining Power on Efficiency and Distribution

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This paper studies how changes in bargaining power alter the surplus distribution and sustainability of incomplete agricultural contracts. When an enforceable payment exists, self-enforcement is always sustainable, the highest quality is traded, and any surplus distribution is possible. However, there is a limit to how much bargaining power can be exercised when contracts are fully incomplete, as a seller cannot extract too much of the surplus without breaking down the trading relationship. The results provide insight into the limits of policies that attempt to redistribute bargaining power in markets having informal institutions or in which parties rely on implicit contracts.

*Key words*: bargaining power, distribution, incomplete contracts, institutions

## Introduction

In the last decades, the global food and agriculture sector has experienced increased environmental and food safety concerns as well as an increase in specialized consumer needs (Myers, Sexton, and Tomek, 2010; U.S. Senate, Democratic Staff of the Committee on Agriculture, Nutrition, and Forestry, 2004; Wu, 2014). These changes require a higher degree of coordination along the production and marketing channels (Myers, Sexton, and Tomek, 2010) which have caused the agricultural sector to resort to consolidations and heavier use of contracts (U.S. Senate, Democratic Staff of the Committee on Agriculture, Nutrition, and Forestry, 2004; MacDonald and Korb, 2011) to meet these needs.

While the increased use of contracts has generated efficiency gains, policy makers and producers have raised concerns about fairness in the distribution of contract rents in highly concentrated markets (MacDonald et al., 2004; Wu, 2006; Love and Burton, 1999; U.S. Senate, Democratic Staff of the Committee on Agriculture, Nutrition, and Forestry, 2004; U.S. Department of Justice, 2010).[1] For example, because of large differences in bargaining power, buyers in such markets may

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[1] For example, Vavra (2009) argues that contracts are generally detrimental to small farmers, who typically have a weak bargaining position vis-á-vis large buyers.

be able to secure more favorable contract terms at the expense of small producers.[2] To address these concerns, policy makers have implemented policies with the intent to regulate contracts and equalize the participants' bargaining power. A recent example of this latter type is proposed federal legislation prohibiting packers from owning livestock, which would reduce their bargaining power and possible price manipulation (U.S. Senate, Democratic Staff of the Committee on Agriculture, Nutrition, and Forestry, 2004). Likewise, a provision in the U.S. Producer Protection Act (PPA) aims to improve small producers' bargaining position by protecting producers against discrimination from buyers for choosing to join a bargaining association. Similar provisions exist in the Australian Trade Practices Act and the European Dairy Package. This kind of policy attempts to change the allocation of bargaining power of the participants. Nevertheless, little is known about how much the surplus can be shifted from one party to the other and how this impacts economic outcomes when parties rely on informal incentives to self-enforce contracts. Furthermore, implicit or informal incentives are an important feature of agricultural contracts because some dimensions of performance—such as delivery timing, contract renewal, or quality aspects—are often omitted, limiting the use of formal enforcement (Wu, 2006; Lee, Wu, and Fan, 2008; Love and Burton, 1999).[3] In practice, given the limits of formal contract enforcement, contractors use discretionary adjustments in compensation and termination policies as a way of providing incentives for long-term performance, resulting in a potential lack of transparency in how payments and performance are determined. Thus, small producers with already low bargaining power may find themselves in an even weaker position.

This paper investigates the potential effect of the allocation of bargaining power on efficiency, the distribution of surplus, and the parties' ability to maintain long-term trade when using implicit contracts. Because repeated interaction and the use of incomplete contracts are important features of agricultural contracting (Wu, 2014), the model is based on the relational contracting literature. Unlike previous studies, however, contract terms are established by an asymmetric bargaining process (ANB) with outside options in which the bargaining power is exogenously assigned rather than using take-it-or-leave-it offers (e.g., Bull, 1987; MacLeod and Malcomson, 1998, 1989; Levin, 2003; Kvaløy, 2006; Halac, 2012). This setup implies that a change in outside options affects the parties' participation in the trading relationship but does not alter their ability to extract the generated surplus. Recent studies have examined bargaining in self-enforcing contracts (Halac, 2012; Miller and Watson, 2010) and self-enforcing contracts in agriculture (Kvaløy, 2006) in which an enforceable price is always included in the contracts or in which all contracts terms are fully enforceable (e.g., Inderst, 2003; Wang, 1998; Sen, 2000). To analyze a wider range of agricultural contracts, we study contracts that include incentive schemes that are fully discretionary, which have not yet been analyzed in the literature.

We consider two kinds of incomplete contracts: partially and fully incomplete. Partially incomplete contracts pay an enforceable price plus a premium according to specified attributes, such as oil content in corn (Hamilton, 2001; MacDonald and Korb, 2011). This payment structure is similar to that of contracts studied in labor markets, where payments are adjusted upward through performance bonuses (see Levin, 2003; Halac, 2012; MacLeod and Malcomson, 1998, 1989, among others). Similar to Wu and Roe (2007a), we model fully incomplete contracts as having a completely discretionary payment scheme (i.e., a promised price subject to premiums

[2] Controversies around the use of contract production have arisen in the U.S. livestock, meat, and poultry sectors (Wu and MacDonald, 2011). For example, U.S. cattle producers claim that meat packers reduce prices by using forward contracts (Farmers' Legal Action Group, 2010), while the Pew charitable Trust reports that regional concentration of buyers can result in lower prices paid to growers under broiler production contracts (Pew Charitable Trusts, 2013). In the European Union, dairy farmers complain about the lack of transparency in the prices paid by buyers (Stocks, 2011). According to Barrett and Mutambatsere (2008), farmers also have low bargaining power when negotiating with large firms in developing countries, though there are concerns about contractors exploiting producers through the use of contract farming (Singh, 2002; Watts, 1994; White, 1997). For example, Michelson, Reardon, and Perez (2011) and Hernández, Reardon, and Berdegué (2007) show that contracting with supermarkets does not improve farmers' mean output price despite the use of stricter product quality standards.

[3] Agricultural contracts can be incomplete for many reasons, including the existence of indescribable contingencies and barriers to enforcement, or because explicit contracts that include all possible contingencies are costly to design and enforce.

and discounts that depend on the observed product attributes). These contracts are studied as a special case of the partially incomplete contracts in which the enforceable price equals zero. As examples of fully incomplete contracts, Hamilton (2001) indicates that many broiler contracts have provisions that allow integrators to make *ex post* discretionary adjustments to the payments or rates while MacDonald et al. (2004) and Hueth and Melkonyan (2004b) point out that "extractable sugar' contracts pay according to the measured sugar content in the beet minus the percentage loss of sugar due to impurities.[4] This incentive structure gives buyers the freedom to unilaterally adjust payments after observing the unverifiable quality delivered and to potentially manipulate the quality-based incentive payments, a usual complaint among farmers (Wu, 2003). Thus, the effect of a shift of bargaining power on economic outcomes may vary according to the latitude parties have to structure the incentive scheme and adjust payments.

We find that when there is an enforceable price (i.e., when contracts are partially incomplete), contracts exist such that the desired product quality is achieved while the producer can still extract any portion of the surplus and maintain long-term trading relationships. Consequently, any surplus distribution can be achieved through an improvement of the producers' bargaining power, reaffirming past findings from the relational-contracting literature (see for example, MacLeod and Malcomson, 1998, 1989; Levin, 2003; Bull, 1987).

In sharp contrast, however, we find that self-enforcement limits the producer's effective bargaining power if the payment is entirely discretionary (i.e., contracts are fully incomplete). Trade could collapse if the producer tries to extract too much of the surplus, because this increases the incentive for the buyer to renege on the promised payments, resulting in an efficiency loss as potential gains from trade go unrealized. Thus, in equilibrium the producer supplies the desired product quality and exercises her power only to the threshold at which the buyer is indifferent between cooperating and reneging. Consequently, not all surplus distributions are feasible, suggesting that a policy maker's ability to redistribute surplus by increasing producers' bargaining power is limited.

The results of this paper are relevant for several reasons. First, the model captures three important features of agricultural contracting: bargaining power distribution (buyers market power), use of incomplete contracts, and repeated interaction among participants (Wu, 2014). Modeling these features is important because the changes in market structure derived from buyer concentration and buyer power in agricultural procurement markets have a direct impact on rent distribution and the efficiency of agricultural contracting. Thus, this paper contributes to the understanding of the effect of bargaining power on the payment structure and its impact on welfare.

Second, the distribution of rents in agricultural contracting has been subject to considerable controversy (Wu, 2014; Sexton, 2013; Crespi, Saitone, and Sexton, 2012) and created motivation for policy intervention to address complaints about unfairness in agricultural contracting. Agricultural economists have performed relatively few studies of legislation aimed to protect growers, especially using contract theory (Wu, 2006, 2014). Some examples are Tsoulouhas and Vukina (2001), who study the welfare effects of evaluation schemes that compare relative performance to a fixed standard in livestock production contracts, and Lee, Wu, and Fan (2008) and Wu (2010), who examine the welfare effects of policies that impose termination damages on agricultural production contracts. None of these papers address the issues derived from the allocation of bargaining power. This analysis is the first to provide insight into the economic consequences of policies that attempt to correct market failures derived from the existence of incomplete contract enforcement and possible opportunistic behavior from buyers with strong bargaining power in concentrated markets. As these market failures may limit the contribution of agricultural contracts to the improvement of farmers' welfare, the analysis of the effects of the allocation of bargaining power on efficiency and distribution informs the discussion about what policies can achieve at what cost.

[4] Similar payment structures are used for pea beans (Hamilton, 2001) and grain and livestock production (MacDonald et al., 2004).

Third, bargaining power allocation and contracting have usually been explored separately. Bargaining theory has been used to study cropsharing contracts (e.g., Bell and Zusman, 1976), while only a few analytical papers within the extensive literature on agricultural economics of cooperatives and bargaining associations have studied bargaining in agriculture and its implications (see, for example, Helmberger and Hoos, 1962, 1965; Helmberger, 1964; Oczkowski, 2006; Staatz, 1983; Sexton, 1986; Fulton and Giannakas, 2001). Myers, Sexton, and Tomek (2010) provide a nice review of the literature on agricultural markets and, in particular, highlight the contribution of these papers and others that study agricultural cooperatives. Moreover, recent research has been more descriptive and has focused on characterizing the environment that supports collective bargaining (see Iskow and Sexton, 1992; Worley et al., 2000; Hueth and Marcoul, 2003, among others). Nevertheless, none of these papers incorporate the use of incomplete contracts. Others have studied cooperatives and contracting (see Cook, Chaddad, and Iliopoulos (2004) for a review of this literature). For instance, Hendrikse and Veerman (2001) use an incomplete contract approach to study the governance choice and investment decisions within a finite game. Although bargaining power derives from the governance choice, the authors focus on the potential hold-up solutions. In contrast, this paper focuses on the effects of the bargaining power allocation on economic outcomes and long-term sustainability of contracts in the context of a repeated game.

There is also an extensive literature on self-enforcing contracts (examples include Bull, 1987; MacLeod and Malcomson, 1998, 1989; Levin, 2003), but these almost universally assume that the principal chooses the terms of the contract by making take-it-or-leave-it offers.[5] The literature studying self-enforcing contracts in an agricultural setting is rather scarce. Most of these studies have focused on issues with risk aversion, adverse selection, moral hazard, relative performance, and multitasking rather than the distribution of surplus. For example, Goodhue (2000) examines the effects of differentiated producer characteristics on production contract performance in the broiler industry; Hueth and Ligon (1999a) consider the role of price and production risk in shaping the supply decision of a single risk-averse farmer; Hueth and Ligon (1999b) present a theoretical model to study the relationship between quality measurement and price risk in the production of fresh-market tomatoes; Hueth and Ligon (2001) study the use of payment mechanisms that depend on market prices in fresh fruits and vegetables and specialty grains contracts; Hueth and Melkonyan (2004a) consider how multitasking and identity preservation affect the design of agricultural contracts; and Hueth et al. (1999) perform a descriptive analysis of the instruments used to alleviate information asymmetries in contracts between growers and first handlers in California fruit and vegetable markets.[6] All of these papers assume full contract enforcement and take as given that buyers have the bargaining power to make take-it-or-leave-it offers. Kvaløy (2006) specifically considers bargaining and the use of self-enforcing contracts but assumes an enforceable price, and Wu and Roe (2007a,b) look at relational contracting under different enforcement regimes but assume that the principal holds all bargaining power. Thus, ours is the first study that looks at the effects of changing bargaining power within a self-enforcing contracting environment featuring contracts used in agriculture, in particular on those contracts that are fully incomplete.

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[5] In a recent study, Halac (2012) allows contracting parties to propose a compensation with some probability which reflects the parties' bargaining power. However, she assumes that a base payment is always enforceable and the intermediate allocation of bargaining power is not characterized.

[6] There are also a few somewhat related empirical analyses of agricultural contracting. For instance, Knoeber and Thurman (1995) and Martin (1994) analyze the allocation of financial risks between grower and contractor in the broiler and hog industries, respectively, and Leegomonchai and Vukina (2005) study whether broiler processors strategically allocate production inputs of different quality according to observed contract growers' abilities. Allen and Lueck (1999) test the presence of ratchet effects in a two-period model with moral hazard using data on cash rent and cropshare contracts.

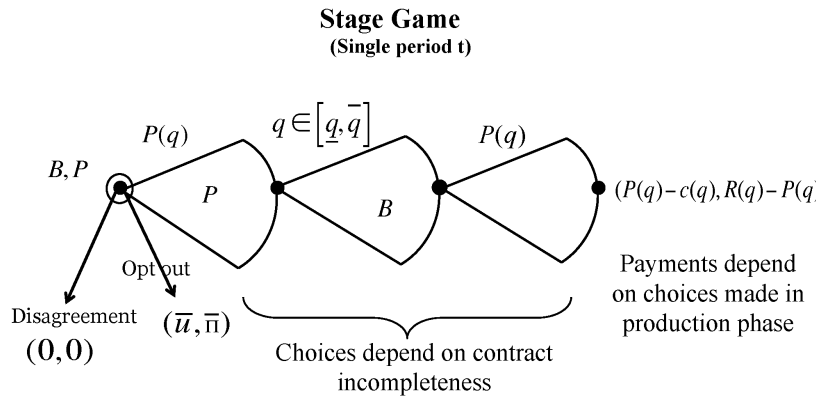


**Figure 1. Game Tree**

## The Model

Consider two risk-neutral parties,[7] a buyer and a producer, who can contract to trade one unit of a product at dates $t = 0, 1, 2, 3 \ldots$. The contracting relationship includes two phases: contracting and production. Figure 1 illustrates the events in each phase, which repeat in each period $t$. The first node corresponds to a joint-decision phase in which contracts are negotiated, indicated by the double circle labeled with $B$ and $P$.[8] At the beginning of period $t$ the buyer and producer are aware of the contracting environment and engage in a Nash bargaining process over the profit-sharing rule included in the contract. A contract, $y_t = \langle p_t, b_t(q_t) \rangle$, specifies a compensation scheme that the producer is entitled to when delivering the product of quality $q_t \in Q = [\underline{q}, \overline{q}]$ that she selects deterministically. Quality is observable by both parties but it is not enforceable because is not easily verified by a third party. Consequently, desired quality, $q_t^*$, may differ from delivered quality, $q_t$.

Total payment is made at the end of each period and is defined as $P_t(q_t) = p_t + b_t(q_t)$, where $p_t$ is a price and $b_t(q_t)$ is a bonus that is a mapping from outcome to payment, $b_t : Q \to \Re$. When contracts are partially incomplete, $p_t$ is enforceable and paid regardless of performance and the bonus is used to reward high quality.[9] When contracts are fully incomplete, $p_t$ is not legally binding and all payments are made contingent on quality (i.e., $P_t(q_t)$ is not enforceable).

The parties receive zero payoffs when bargaining takes place and disagreement occurs.[10] Once the parties agree on the contract, a production phase begins and, depending on how incomplete the contract is, parties make independent decisions about quality and payments (other decision nodes in figure 1). The producer chooses the quality $q_t \in Q$ to deliver and incurs a cost $c(q_t)$, where $c'(.) > 0$, $c''(.) \geq 0$, and $c(\underline{q}) = 0$. The producer's profit per trading round is $U_t = P_t(q_t) - c(q_t)$. Once production has taken place, the buyer keeps the value of such production,[11] and the quality provision generates a direct benefit for the buyer, $R(q_t)$, where

[7] To concentrate on the effect of bargaining with self-enforcement, the model assumes that both parties are risk neutral. Risk aversion impacts bargaining outcomes by reducing a party's share of the surplus, as she may be willing to reach an agreement that is more favorable to the other party (Muthoo, 1999; Binmore, Rubinstein, and Wolinsky, 1986).

[8] Because the paper does not focus on the bargaining process but on the effects of bargaining power on incomplete contracts, we reconcile the use of the axiomatic approach with the strategic contract game as one in which parties make joint decisions (Watson, 2002; Miller and Watson, 2010).

[9] As in previous literature (e.g. Levin (2003)), if contracts are partially incomplete, the decision to use the bonus belongs to the buyer if the adjustment is positive and to the producer if it is negative.

[10] These payoffs are the disagreement payoffs in the axiomatic Nash bargaining solution or the impasse payoffs in the strategic-bargaining game. The disagreement payoffs do not correspond with outside options unless these outside payoffs are more attractive than what parties would received in equilibrium (Shaked and Sutton, 1984). As in Levin (2003), parties receive the outside payoffs if the offer is rejected, which corresponds in this paper to either party opting out of the bargaining process.

[11] Some agricultural contracts use bailment clauses, which allow buyers to keep the value of the production (Hamilton, 2001). To simplify the analysis and in contrast with Kvaløy (2006), we assume that contracts include such clauses.

$R'(.) > 0$, $R''(.) \leq 0$, and $R(\underline{q}) = 0$. The buyer chooses whether to pay $b_t(q_t)$ or, alternatively, $P_t(q_t)$, depending on the contract incompleteness. The buyer's profit per trading round is $\Pi_t = R(q_t) - P_t(q_t)$. We also assume that $R'(.) > c'(.)\ \forall\ q \in Q$, so that it is socially efficient and Pareto optimal to trade $q = \overline{q}$, since $\overline{q}$ maximizes the total surplus defined by $S(q_t) = R(q_t) - c(q_t)$.

If either party decides to opt out of the bargaining process, trade does not occur, the game ends, and both parties receive outside payoffs: $\overline{u}$ for the producer and $\overline{\pi}$ for the buyer. These payoffs are assumed to be less attractive than trading, and any breakdown in trade represents an inefficient outcome. However, if the producer does not have incentives to perform, the parties prefer not to trade and take their outside payoffs. If in any given period the gains from trade are not more attractive than the outside options, then those gains from trade will not be attractive in any other period. The sum of the fixed payoffs is $\overline{s} = \overline{u} + \overline{\pi}$ and the net social surplus per period is given by $S(q_t) - \overline{s}$, where $S(q_t) - \overline{s} > 0\ \forall\ q \in (\underline{q}, \overline{q}]$ and $S(\overline{q}) > S(\underline{q}) \geq 0$.

*Bargaining and Surplus Distribution*

Contract bargaining is modeled as an application of the asymmetric Nash bargaining solution (ANBS) with outside options.[12] For trade to take place, the bargaining outcomes must meet the parties' individual rationality constraints (IRC):

$$U_t \geq \overline{u} \tag{1}$$

$$\Pi_t \geq \overline{\pi}. \tag{2}$$

Maximizing the asymmetric Nash product of the parties' objective functions, the Nash equilibrium of the bargaining game yields per period profits[13]

$$U(y^*) = \beta S(\overline{q}), \tag{3}$$

$$\Pi(y^*) = (1-\beta) S(\overline{q}), \tag{4}$$

where $y^*$ is the equilibrium contract, $\beta$ the producer's bargaining power, $(1-\beta)$ the buyer's bargaining power, and $\beta S(\overline{q}) \geq \overline{u}$ and $(1-\beta)S(\overline{q}) \geq \overline{\pi}$, respectively (for more details refer to Muthoo, 1999). Equation (3) reports the producer's bargaining outcome (PBO) and equation (4) reports the buyer's bargaining outcome (BBO). These outcomes identify how the surplus is split based only on the parties' bargaining power and not what form the payment takes. Notice that if $\beta < \underline{\beta} = \frac{\overline{u}}{S(\overline{q})}$ and $\beta > \overline{\beta} = \frac{S(\overline{q}) - \overline{\pi}}{S(\overline{q})}$, the IRCs are binding and the contract must offer a surplus share at least equal to the parties' outside options to ensure participation.[14] Consequently, any $\beta < \underline{\beta}$ is effectively the same as $\beta = \underline{\beta}$ and the buyer holds all the bargaining power. Similarly, any $\beta > \overline{\beta}$ is effectively the same as $\beta = \overline{\beta}$ and the producer holds all the bargaining power; finally, when $\beta \in (\underline{\beta}, \overline{\beta})$, both parties hold some bargaining power.

Figure 2 illustrates the distribution of surplus for different values of $\beta$. At point I the parties do not trade and receive outside payments. The shaded area is the trading surplus, which is maximized

[12] The ANBS leads to the same results as the strategic bargaining game of Rubinstein (1982), where the source of bargaining power is the individual cost of haggling, which is arbitrarily close to zero. Recalling Binmore, Rubinstein, and Wolinsky (1986), the unique subgame perfect equilibrium (SPE) of a non-cooperative game defined by an alternating offer procedure with outside options and discounting converges to the ANBS when the friction in the bargaining process is positive but arbitrarily small. Thus, in the limit, the SPE of such a non-cooperative model is equivalent to the ANBS outcome, in which the disagreement point $(0,0)$ is mapped to the impasse payoffs of the strategic game and the outside option does not affect the disagreement point (Muthoo, 1999). We use the ANBS for a simpler exposition.

[13] Time subscripts are omitted throughout the paper where expressions relate to the stage game and where it is not confusing.

[14] If the players' outside options exceed their respective surplus shares resulting from the bargaining process at the same time, $S(q_t) - \overline{s} \leq 0$, there are no gains from trade and parties do not trade in equilibrium. We study cases where $S(q_t) > \overline{s}\ \forall\ q \in (\underline{q}, \overline{q}]$.

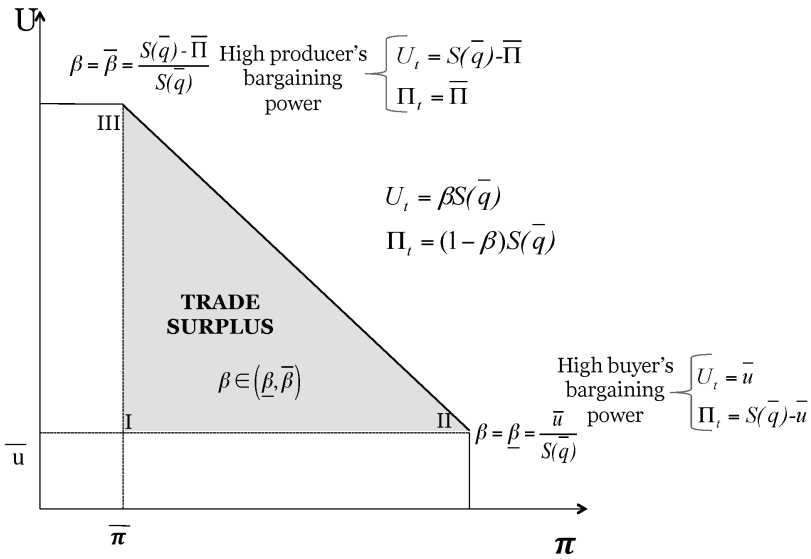


**Figure 2. Distribution of Surplus**

at $\overline{q}$. When the buyer has high bargaining power ($\beta = \underline{\beta}$), the distribution of surplus is given by II. The producer gets the value of her outside option and the buyer obtains all surplus. Similarly, point III illustrates when the producer holds high bargaining power ($\beta = \overline{\beta}$). She gets all the surplus while the buyer gets the value of his outside option. All other points on the Pareto frontier from II to III represent when $\beta \in (\underline{\beta}, \overline{\beta})$.

## Equilibrium Incomplete Contracts

When contracts are incomplete, parties rely on informal mechanisms to sustain trade. The parties interact repeatedly following these assumptions (Watson, 2002):

1. The parties know only the past actions of previous trading partners;
2. The parties care about the present value of future payoffs, where the common discount factor is $\delta \in (0,1)$;
3. The ongoing interaction sustains the equilibrium by allowing the parties to support future trade, contingent on the satisfactory performance of present trade.

The parties cooperate if the history of play in all periods has been that both parties fulfill the contract. The parties end trade forever if any deviation is observed.[15] This allows for self-enforcing contracts because it describes behavior on and off the equilibrium path.

The producer and the buyer maximize respectively their present discounted profit, $\sum_{t=0}^{\infty} \delta^t \left\{ d_t(P_t(q_t) - c(q_t)) + (1-d_t)\overline{u} \right\}$ and $\sum_{t=0}^{\infty} \delta^t \left\{ d_t(R(q_t) - P(q_t)) + (1-d_t)\overline{\pi} \right\}$, where $d_t = 1$ if an agreement is reached in the bargaining process and trade occurs in period $t$ and $d_t = 0$ if any party opts out and no trade occurs. Once either party opts out of the bargaining process, $d_t = 0$ thereafter, which occurs in equilibrium only if there is insufficient surplus to sustain trade. Notice that the parties do not earn payoffs when disagreement occurs. If the surplus is enough to sustain trade, parties agree on a contract and trade in equilibrium.

[15] Deviation causes the parties to end trade forever because this outcome never happens in equilibrium (Levin, 2003). If deviation occurs, the parties behave as in one-time interactions: the buyer offers a contract with no performance incentives and the producer supplies the lowest quality. In the bargaining subgame, breakdown is an off-equilibrium path outcome if there is enough surplus to share.

Additionally, each period is played following a Nash equilibrium, and the parties use a stationary contract in which the buyer always offers the same total payment, the producer always takes the same action, and the rents to the relationship are enough for parties to self-enforce the contract (MacLeod and Malcomson, 1989, 1998; Baker, Gibbons, and Murphy, 1994). The bargaining subgame is modeled as a cooperative game in which a Nash equilibrium is the solution. However, as players play a Nash equilibrium following each history, the subgame perfect Nash equilibrium imposes sequential rationality to the full game (Fudenberg, Levine, and Maskin, 1994). Thus, in equilibrium players self-enforce the contract through repeated play. Following this, in the Nash bargaining game the surplus distribution must be incentive compatible, while an optimal contract must satisfy a dynamic incentive compatibility constraint (DICC), distinct to each incomplete contract, which ensures that the parties prefer to honor the contract over reneging in the long run. The following subsections derive the optimal partially and fully incomplete contracts. As the derivation follows the previous literature, details are presented in the appendix.

*Partially Incomplete Contracts*

When contracts are partially incomplete, the structure is similar to labor contracts analyzed in the literature (e.g., MacLeod and Malcomson, 1998, 1989; Levin, 2003), in which an enforceable price can be adjusted upward through a bonus that the buyer promises to pay if the producer delivers sufficient quality. The producer's DICC is given by the expression $\frac{p+b(q)-c(q)}{1-\delta} \geq p - c(\underline{q}) + \frac{\delta}{1-\delta}\overline{u}$. Naturally, the producer cooperates if the present discounted value of cooperation (LHS) is greater than the present discounted payoff from shirking (RHS). Note that the most profitable deviation for the producer is to supply $\underline{q}$, but in this case the buyer will not pay the bonus. Similarly, a buyer cooperates if $\frac{R(q)-p-b(q)}{1-\delta} \geq R(q) - p + \frac{\delta}{1-\delta}\overline{\pi}$ (i.e., if his LHS is higher than his RHS). The most profitable deviation for the buyer is reneging on the payment of the bonus ($b(q) = 0$), as $p$ must be paid regardless of performance.

Let $U$ and $\Pi$ be the per period profit from the contract for the producer and buyer, respectively. The parties' DICCs can respectively be rewritten as the self-enforcing constraints

$$\frac{\delta}{1-\delta}(U - \overline{u}) \quad \geq \quad c(q) - b(q) \tag{5}$$

and

$$\frac{\delta}{1-\delta}(\Pi - \overline{\pi}) \quad \geq \quad b(q). \tag{6}$$

That is, the producer's future gains from the relationship must be greater than the cost of performing under the contract less the incentive given to perform in that period (inequality 5) and the buyer's future gains must be greater than the cost of incentivizing the producer (inequality 6). It follows that the bonus is bounded by the future gains of the relationship and must be sufficient to ensure mutual benefit.

When the producer has bargaining power $\beta \in \left(\underline{\beta}, \overline{\beta}\right)$, the optimal contract must satisfy the IRCs, DICCs, and the bargaining outcomes (inequalities 1, 2, 5, 6, and equalities 3 and 4). Proposition 1 reports the conditions for an optimal contract.

PROPOSITION 1. *When a price is enforceable and the producer has bargaining power $\beta \in (\underline{\beta}, \overline{\beta})$, a contract implements the efficient quality, $\overline{q}$, if and only if $\langle p^*, b^*(\overline{q})\rangle$ satisfies*

$$\frac{c(\overline{q}) + \beta S(\overline{q}) - \delta(R(\overline{q}) - \overline{\pi})}{1-\delta} \leq p^* \leq \frac{\beta S(\overline{q}) - \delta \overline{u}}{1-\delta}, \tag{7}$$

$$c(\overline{q}) - \frac{\delta}{1-\delta}(\beta S(\overline{q}) - \overline{u}) \leq b^*(\overline{q}) \leq \frac{\delta}{1-\delta}((1-\beta)S(\overline{q}) - \overline{\pi}), \text{ and} \tag{8}$$

$$p^* + b^*(\overline{q}) = c(\overline{q}) + \beta S(\overline{q}). \tag{9}$$

*Proof.* Proofs are in the appendix. ■

The total payment is established in the bargaining subgame and depends on the producer's bargaining power (equation 9). As any contract must provide the same total payment, there is a unique bonus for any price. Moreover, the lowest possible price, identified by the lower bound of equation (7), corresponds with the highest possible bonus, identified by the upper bound of equation (8). The smallest price and largest bonus are found by identifying the payments with which the buyer's DICC is binding. Smaller prices shift more of the total payment to the bonus, which increases the incentive for the buyer to renege. Similarly, the largest price and smallest bonus are found by identifying the payments with which the producer's DICC is binding. Larger prices increase the incentive for the producer to renege. When one party's DICC is binding, the other's is slack. It's because of this complementary slackness in the DICCs that there is flexibility in how the compensation is split between the price and bonus. These conditions allow for a self-enforcing contract that is optimal for any given history and generates the highest surplus (Levin, 2003). Given the highest surplus, the parties cannot jointly gain from renegotiating the contract, even when a decision is off the equilibrium path, because an optimal contract following Proposition 1 is individually rational and satisfies the bargaining outcomes. Thus, there is not a Pareto-improving contract.

Equations (7) and (8) also show that the bounds for the price and bonus are dependent on the producer's relative bargaining power. The upper and lower bounds for the bonus are decreasing with the producer's bargaining power. Higher bargaining power for the producer increases her future gains from the relationship while decreasing the buyer's expected gains. Because the buyer values the relationship less as his surplus share decreases, he must compensate the producer more through the price to reduce his incentive to renege. That is, a higher price functions as a commitment device for the buyer. The producer also has less incentive to deviate when she has higher bargaining power because the relationship is more valuable to her. Consequently, the maximum price can be higher, resulting in a lower lower bound for the bonus. In this way, the parties' bargaining power impacts how the total payment is allocated between the price and bonus, but nevertheless there exist payments that induce the efficient quality provision for any $\beta \in (\underline{\beta}, \overline{\beta})$.

Interestingly, the optimal contract does not require a positive bonus when $\beta \geq \beta_w \equiv \frac{\overline{u}}{S(q)} + \frac{(1-\delta)c(q)}{\delta S(q)}$. Observe that the upper bound of the bonus is greater than or equal to 0 as long as $\beta \leq \overline{\beta}$, while the lower bound of the bonus is less than or equal to 0 whenever $\beta \geq \beta_w$. To see why the producer will not need a performance bonus, observe that $\frac{\overline{u}}{S(q)}$ is the value of $\beta$ when the buyer holds all bargaining power, while the term $\frac{(1-\delta)c(q)}{\delta S(q)}$ represents the ratio of the cost of providing quality $q$ this period to the present discounted value of the surplus. The threshold bargaining power for which the producer does not need a bonus to perform is increasing with this ratio since a higher ratio implies lower net gains from cooperation. However, as the producer gets a higher share of the trade surplus when she has higher bargaining power, the relationship is sustained in the absence of a positive bonus because she receives her surplus share through the price alone. Because $p$ is enforced, any redistribution of the parties' bargaining power will not impact the parties' incentives to perform as it simply shifts the allocation of the payment from the bonus to the price. As a consequence,

the allocation of bargaining power only affects the surplus distribution and the contract structure. It follows that, compensation can resemble a pure-wage contract in markets where the producers have considerable bargaining power, as Corollary 1 summarizes.

COROLLARY 1. *A positive bonus is not necessary for an efficient self-enforcing contract when the producer's bargaining power equals or exceeds* $\beta_w \equiv \frac{\overline{u}}{S(q)} + \frac{(1-\delta)c(q)}{\delta S(q)}$.

As discussed above, Proposition 1 presents the set of self-enforceable contracts because the relationship is more valuable to the parties than acting opportunistically. When formal contract enforcement is limited, the value of future payoffs is critical to maintaining long-term trade. Thus, long-term contracts can be sustained only if the parties value the future enough. Observe that if $\delta < \hat{\delta}_{PE} \equiv \frac{c(q)}{R(q)-\overline{u}-\overline{\pi}}$—where $\hat{\delta}_{PE}$ is the minimum discount factor needed for self-enforcement when $p$ is enforceable—the bounds of equations (9) and (8) are inconsistent and there cannot be any payments that induce the efficient quality. Proposition 2 summarizes this result.

PROPOSITION 2. *When $p$ is enforceable and $\beta \in \left(\underline{\beta}, \overline{\beta}\right)$, an optimal self-enforcing contract exists if and only if $\delta \in \left[\hat{\delta}_{PE}, 1\right)$, where $\hat{\delta}_{PE} \equiv \frac{c(q)}{R(q)-\overline{u}-\overline{\pi}}$.*

$\hat{\delta}_{PE}$ is found by combining the parties' DICCs and represents the ratio of the cost over the net benefit generated by some quality level. If the net benefit is higher relative to the cost, the relationship is more attractive in the long run and the parties sustain trade for lower discount factors. Notably, $\hat{\delta}_{PE}$ does not depend on the producer's bargaining power. Therefore, when $p$ is enforceable and $\delta \geq \hat{\delta}_{PE}$, any distribution of the surplus can be supported by an optimal self-enforcing contract.

*Fully Incomplete Contracts*

Contracts are fully incomplete when the buyer offers the full payment contingent on quality delivered, so he can adjust the total payment through premiums and discounts. Conceptually this is the same as the buyer offering a pure bonus contract. Evidence suggests that this payment scheme is often used in agricultural contracts. For example, Brown and Sander (2007) observe that a common practice in agriculture is to delay payment up to sixty days after delivery with no upfront payment as a way to ensure quality; Iskow and Sexton (1992) observe that fruits-and-vegetables growers often received payments from processors after the crops were delivered; and some supply and marketing contracts offer only *ex post* payments.[16] This kind of contract clearly creates an opportunity for buyers to withhold payments altogether.

A bonus contract is a special type of partially incomplete contract in which the price equals zero. Note then that the producer's DICC is $\frac{P(q)-c(q)}{1-\delta} \geq -c(\underline{q}) + \frac{\delta\overline{u}}{1-\delta}$ and the buyer's DICC is $\frac{R(q)-P(q)}{1-\delta} \geq R(q) - \frac{\overline{\pi}}{1-\delta}$, where $P(q)$ reflects a pure bonus. Consequently, efficient long-term trade can be sustained with a pure bonus whenever $p = 0$ is within the set of contracts defined in Proposition 1. Notice that under partial enforcement there exists a contract with a positive price that induces the efficient quality when $\beta \in \left(\underline{\beta}, \overline{\beta}\right)$ and $\delta \in \left[\hat{\delta}_{PE}, 1\right]$ because the upper bound of the price is strictly positive for those parameters. Furthermore, for sufficiently high discount factors there exists a contract that induces the efficient quality level in which the price is zero or even negative. This happens because the lower bound of the price is nonpositive for all $\beta \in \left(\underline{\beta}, \overline{\beta}\right)$ and $\delta \in \left[\hat{\delta}_{IE}, 1\right]$, where $\hat{\delta}_{IE} \equiv \frac{c(q)+\beta S(q)}{R(q)-\overline{\pi}}$. The only exception is when the producer has all of the bargaining power, (i.e., $\beta = \overline{\beta}$). In this limiting case, sustainability requires a positive enforceable price. It follows that the contract $\langle p = 0, b(\overline{q}) = c(\overline{q}) + \beta S(\overline{q})\rangle$ is within the set of contracts that implement $\overline{q}$ if and only if $\delta \in \left[\hat{\delta}_{IE}, 1\right]$ and $\beta < \overline{\beta}$. This result is formalized in the following proposition.

[16] Other examples in which processors can make automatic adjustments after observing the product's characteristics are contracts for tobacco (Dimitri, 2003), extractable sugar (Hueth and Melkonyan, 2004b), grain, and livestock production (MacDonald et al., 2004).

PROPOSITION 3. *When contracts are fully incomplete and* $\beta \in \left(\underline{\beta}, \overline{\beta}\right)$*, the efficient quality is induced if and only if the buyer pays* $b^*(\overline{q}) = c(\overline{q}) + \beta S(\overline{q})$ *and* $\delta \in \left[\hat{\delta}_{IE}, 1\right]$.

Propositions 1 and 3 report, respectively, the partially and fully incomplete contracts that can implement the efficient level of quality. In both cases, the equilibrium contract yields the same total payment, which is determined by the bargaining process. If $\beta = \underline{\beta}$, the optimal contract gives a total payment that just meets the producer's IRC. If $\beta > \underline{\beta}$, the producer gets profit above her outside opportunity depending on the amount of bargaining power she exercises. However, in both cases implementation is limited by the discount factor, as the next subsection explores.

*Sustainability and the Limits of Surplus Distribution*

When the contracts are partially incomplete, the limiting discount factor, $\hat{\delta}_{PE}$, is not a function of the producer's relative bargaining power. Consequently, any distribution of the surplus is possible as long as the discount factor is sufficiently high. In contrast, the limiting discount factor when contracts are fully incomplete, $\hat{\delta}_{IE}$, is a function of the producer's relative bargaining power, suggesting that there may be a limit to how the surplus can be distributed. $\hat{\delta}_{IE}$ is the ratio of the total payment necessary to induce $q$ over the benefit generated from that same quality level net of the buyer's outside option. As the producer's bargaining power increases, the buyer's share of the surplus shrinks accordingly. To compensate for the buyer's loss, the minimum discount factor needed to sustain cooperation rises. If the producer's bargaining power is too high ($\beta > \hat{\beta}$), then the buyer's short term gains from deviation are greater than his value of the relationship for any discount factor less than one. As a result, the producer can only exercise a $\hat{\beta}$ bargaining power for sustainable self-enforcement. Proposition 4 summarizes this argument.

PROPOSITION 4. *When contracts are fully incomplete, self-enforcement is sustainable if only if the producer has static bargaining power,* $\beta \leq \hat{\beta} \equiv \frac{\delta R(q) - \delta\overline{\pi} - c(q)}{S(q)}$.

Proposition 4 states that there is a limit to how the surplus can be distributed under self-enforcement; when contracts are fully incomplete, shifting the distribution of surplus can impact efficiency by destroying the incentive to cooperate. As the total payment depends on performance, the buyer can withhold all payments if his share of the surplus is too small. When the producer's bargaining power is such that $\beta > \hat{\beta}$, she can demand compensation $P(q) = c(q) + \beta S(q)$, causing the buyer to shirk by not paying anything and leaving the relationship. The producer gets negative profit and the value of her outside option thereafter. If instead the producer demands $P(q) = c(q) + \hat{\beta} S(q)$, the buyer pays as promised and keeps trading. The producer gets positive profit and collects the long-term benefits; thus, self-enforcement limits the surplus share the producer can extract, as Corollary 2 states.

COROLLARY 2. *When contracts are fully incomplete, a producer extracts up to only a* $\hat{\beta}$ *share of the surplus in order to maximize her long-term profit, even if her static bargaining power is greater than* $\hat{\beta}$.

Because the producer maximizes her long-term profit, she extracts up to only a $\hat{\beta}$ share of the surplus so that the buyer complies with the contract. This result is consistent with other research, which has observed that there is no evidence that cooperative bargaining influences prices directly or that bargaining groups increase prices for growers (Hueth and Marcoul, 2003). A possible explanation is that producers cannot exercise strong bargaining power without losing long-term trade, as shown here.[17]

Figure 3 identifies the set of feasible partially and fully incomplete contracts. When contracts are fully incomplete, self-enforcement is sustainable for a smaller set of parameter values. When

[17] However, these observations may also reflect the existence of poor legislation supporting collective bargaining or weak cohesion of the group members, which may have a negative effect on their ability to exercise any bargaining power.

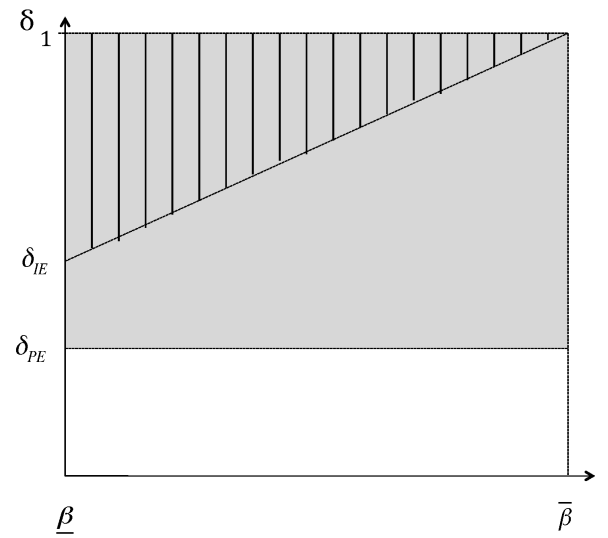


**Figure 3. Set of Discount Factors that Sustains Self-Enforcement for Different Levels of $\beta$**

the buyer holds the majority of the bargaining power, self-enforcing contracts can be sustained for lower discount factors when $p$ is enforceable. In fact, when $p$ is enforceable, the parties' minimum valuation of the future required to maintain cooperation remains constant for all distributions of the bargaining power (shaded area above $\delta_{PE}$). In contrast, when contracts are fully incomplete, a shift in bargaining power raises the minimum discount factor required for self-enforcement (striped area). In this case, parties have to value the future gains from the relationship more than when $p$ is enforceable because there is more opportunity to behave opportunistically. Thus, the combination of formal and informal enforcement is more successful in maintaining the long-term relationship than when only self-enforcement is used. As a consequence, the economic institutions in which parties operate are critical for the successful exercise of bargaining power and the distribution of surplus.

## Conclusions

Governments have implemented policies to balance bargaining power in an effort to respond to complaints about unfairness in contracts used in more vertically coordinated and concentrated agricultural markets. This paper contributes to the agricultural contracting literature by presenting an analytical framework that combines these elements to better understand the informal incentives that are critical for the implementation of self-enforcing agricultural contracts. The model is based on the relational contracting literature so that it includes the use of informal incentives and incomplete contracts and the repeated interaction of participants, two important features of agricultural contracting. In addition, the model allows for different allocations of bargaining power, another feature of the contracting environment, in contrast to previous research on self-enforcing contracts that assumed that the buyer holds all the bargaining power. Thus, the model identifies the effects of policies that attempt to balance bargaining power by showing how the producer's bargaining power affects the incentive provision, the surplus distribution, and the sustainability of self-enforcement with two kinds of incomplete contracts.

The model shows that when the contract is partially incomplete, there is great flexibility in how the producer's compensation is split between the base payment and bonus, which depends on the distribution of bargaining power. This flexibility in the payment structure allows for any distribution of surplus without impacting the parties' incentives to perform because the enforceable base payment can be adjusted to maintain constant the parties' minimum valuation of the future

required to maintain cooperation. This flexibility in the contract structure also allows for a broad range of payment schemes. For instance, pure-wage contracts may be used in agricultural markets where bargaining takes place and contracts are partially incomplete. When the producer has higher bargaining power, she gets most of the surplus and therefore lower contingent payments are optimal. Furthermore, while a self-enforcing contract is sustainable for any distribution of bargaining power when contracts are partially incomplete, good faith agreements collapse when parties rely only on self-enforcement if the producer extracts too much of the surplus by exercising high bargaining power. Higher bargaining power for the producer increases the incentive for opportunistic behavior by the buyer such that there is no way to incentivize a buyer to cooperate through a single unenforceable payment if the producer tries to capture too much of the surplus. The producer is thus limited in how much of the net surplus she can extract under self-enforcement, with stronger discounting further constraining her ability to extract surplus.

The results suggest that governments should evaluate the degree of incompleteness of agricultural contracts and how much market participants value the future when attempting to redistribute surplus through a reallocation of bargaining power. If contracts are fully incomplete and the parties insufficiently value the future, then shifting the power above some threshold may have no effect on the distribution of the surplus because it cannot be exercised without breaking down trade. In this case, a government more effectively achieves its goals through improvements in contract enforcement. In general, policies that require an enforceable price or encourage up-front payments are desirable when redistributing the bargaining power of agricultural parties as it allows for much more flexibility in the terms of the contract.

Although the theoretical results here provide important insight into the effects and limits of policies that attempt to balance bargaining power in agricultural contracting, considerable work remains to understand how parties behave under such policy interventions. Experimental and empirical research on contracting under the conditions described here would be particularly helpful in deepening our understanding of how parties behave and should be considered in future work.

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## Appendix

*Proof of Proposition 1.* The buyer offers $y^*$, which maximizes profits holding equation (3) with equality. Solving for $p$ in equations (3) and (5) and recalling that $c(\underline{q}) = 0$, we obtain

$$b(q) \geq c(q) + \delta\overline{u} - \delta p. \tag{A1}$$

Substituting $b(q)$ and $p$ into equation (A1) we get $p \leq p_{max} = \frac{\beta S(q) - \delta\overline{u}}{(1-\delta)}$ and $b(q) \geq b_{min} = c(q) + \frac{\delta}{1-\delta}(\overline{u} - \beta S(q))$. From equation (6):

$$p \leq R(q) - \overline{\pi} - \frac{b(q)}{\delta}. \tag{A2}$$

From BBO we solve for $b(q)$ and $p$ and substitute them into equation (A2), resulting in $p \geq p_{min} = \frac{c(q)+\beta S(q)-\delta(R(q)-\overline{\pi})}{1-\delta}$ and $b_{max} = \frac{\delta}{1-\delta}((1-\beta)S(q) - \overline{\pi})$. Thus, $p + b(q) = c(q) + \beta S(q)$ and price and bonus take any value in the corresponding range. The buyer solves

$$\max_{p,b(q),q} \left( \frac{R(q) - p - b(q)}{1-\delta} \right), \text{ subject to equation (3) and } q \in [\underline{q}, \overline{q}]. \tag{A3}$$

Using $S(q)$ and substituting $p + b(q)$ into $\Pi_t$, we confirm a concave maximization problem: $\frac{\partial^2 \pi}{\partial q^2} < 0$; solving for the first-order KTC results in:

$$R'(q) \begin{cases} < c'(q) & \text{if} \quad q^* = \underline{q} \\ = c'(q) & \text{if} \quad \underline{q} < q^* < \overline{q} \\ > c'(q) & \text{if} \quad q^* = \overline{q} \end{cases} \tag{A4}$$

Following the model assumptions, the buyer requests $\overline{q}$ and $P(\overline{q}) = c(\overline{q}) + \beta S(\overline{q})$, where $\beta S(\overline{q}) \geq \overline{u}$. ■

*Proof of Corollary 1.* It follows from examining the bounds for $b(q)$: $b_{max} \geq 0$ if $\overline{\beta} \geq \beta$ and $b_{min} \leq 0$, for $\beta \geq \beta_w$. The contract can be a wage contract if $\overline{\beta} \geq \beta \geq \beta_w$, which implies that $\delta \geq \frac{c(q)}{R(q)-\overline{\pi}-\overline{u}} = \delta_{PE}$. ■

*Proof of Proposition 2.* It follows from deriving $\hat{\delta}$ from $b_{max} \geq b_{min}$ and $p_{max} \geq p_{min}$. ■

*Proof of Proposition 3.* Let's find when $p = 0$: $p_{max} > 0$ for $\delta \in \left[\hat{\delta}_{PE}, 1\right)$ if $\beta S(q) > \delta\overline{u}$. From IRC, $\beta S(q) > \delta\overline{u}$ for all $\delta \in (0,1)$. If $\delta = 1$ and $\beta S(q) = \overline{u}$, then $\lim_{\delta\to 1} p_{max} = \overline{u}$. If $\delta = 1$ and $\beta S(q) = S(q) - \overline{\pi}$, then $\lim_{\delta\to 1} p_{max} = +\infty$. Hence, $p_{max} > 0$ for $\beta \in \left[\underline{\beta}, \overline{\beta}\right]$ and $\delta \in \left[\hat{\delta}_{PE}, 1\right]$. Lemma 1 summarizes this.

LEMMA 1. *When contracts are partially incomplete,* $p_{max} > 0 \; \forall \; \beta \in \left[\underline{\beta}, \overline{\beta}\right]$ *and* $\delta \in \left[\hat{\delta}_{PE}, 1\right]$.

See that $p_{min} \leq 0$ when $\delta \geq \hat{\delta}_{IE} \equiv \frac{c(q)+\beta S(q)}{R(q)-\overline{\pi}}$. When $\beta S(\overline{q}) = \overline{u}$, $0 < \hat{\delta}_{IE} = \frac{c(q)+\overline{u}}{R(q)-\overline{\pi}} < 1$. When $\beta S(\overline{q}) = S(\overline{q}) - \overline{\pi}$, $\hat{\delta}_{IE} = 1$. In this case, $p_{min} \leq 0$ for all $\beta \in \left[\underline{\beta}, \overline{\beta}\right]$. Lemma 2 summarizes this.

LEMMA 2. *When contracts are partially incomplete,* $p_{\min} \leq 0$ *for all* $\beta \in \left[\underline{\beta}, \overline{\beta}\right]$ *and* $\delta \in \left[\hat{\delta}_{IE}, 1\right]$, *where* $\hat{\delta}_{IE} \equiv \frac{c(q)+\beta S(q)}{R(q)-\overline{\pi}}$. *When* $\beta = \overline{\beta}$, $p_{min} > 0$.

Lemmas 1 and 2 give the conditions in Proposition 3. Because equations (3) and (6) bind while equations (4) and (5) do not, the buyer offers $y^*$ to a producer, solving:

$$\max_{P(q),q}\left(\frac{R(q)-P(q)}{1-\delta}\right) \text{ subject to equation (3) and } q\in[\underline{q},\overline{q}]. \tag{5}$$

As in Proposition 1, the maximization problem is concave. From the first-order KTC and by checking that BBO and equation (2) hold and that the outcome is sustainable, we get $\hat{\delta}_{IE}\geq\frac{c(q)+\hat{\beta}S(q)}{R(q)-\overline{\pi}}$. ■

*Proof of Proposition 4.* Note that $\hat{\delta}_{IE}\geq 1$ when $\beta=\overline{\beta}$. To find $\hat{\beta}$, we solve for $\beta$ in equation (6): $\hat{\beta}\leq\frac{\delta R(q)-\delta\overline{\pi}-c(q)}{S(q)}$. ■

*Proof of Corollary 2.* It follows from proposition 4 by comparing the producer's profits and the buyer's DICC from having the producer exercising $\hat{\beta}$ and $\beta>\hat{\beta}$ (e.g., $\overline{\beta}$). The producer gets profits of $U(\hat{\beta})=\frac{\delta R(q)-\delta\overline{\pi}-c(q)}{1-\delta}$ and $U(\beta>\hat{\beta})=-c(q)+\frac{\delta\overline{u}}{1-\delta}$, and $U(\hat{\beta})>U(\beta>\hat{\beta})$. ■