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Relational Contracts and Termination Damages

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by

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Abstract

We study the economic impact of proposed legislation requiring processors to pay termination damages to growers when contractual relationships are prematurely severed. In doing so, we derive the optimal relational contract in the presence of asset specificity, ex post market power on the part of processors, and the presence of an exogenous shock that might destroy gains from trade from contracting. The optimal contract then provides a credible framework for assessing how government intervention might affect optimizing behavior of contracting parties. We conclude that termination damages would not be distortionary and would *not* undermine processors' ability to design effective relational incentives. However, the distribution of surplus would be affected.

Agribusinesses are increasingly relying on contracts to source and market agricultural commodities. While contracts enable improved coordination of the supply chain, many growers, farm advocacy groups and policy makers have become concerned that contracts may be oppressive to growers (Wu, 2003). One stylized fact that is frequently observed in the livestock sector is that, in order to secure a contract, growers are often required to make substantial investments in new production facilities (Lewin-Solomons, 2000). These facilities can be relationship specific if they must meet unique requirements of each integrator, and they often force growers into debt as they can cost hundreds of thousands of dollars to build.² At the same time, processors do not always provide growers with explicit written agreements about the duration of the contract or provisions for termination and renewal, leaving growers vulnerable as the relationship may end before all debts are paid. Consequently, lawmakers in various states have proposed legislation to protect farmers from undue termination or non-renewal of contracts by providing farmers with the right to be “...reimbursed for damages incurred due to termination, cancellation, or failure to renew. Damages shall be based on the value of the remaining useful life of the structures, machinery or equipment involved.”³ If implemented, such legislation essentially imposes a “severance payment” on agricultural contracts.

Because agricultural contracts typically contain both explicit (e.g. written clauses and payment terms that are legally enforceable) as well as implicit components (verbal agreements and payment terms that are not legally enforceable), textbook principal agent models of contracting may be inadequate for tackling questions pertaining to government intervention in

² For example, “Growers must borrow about \$125,000 per chicken house to build facilities according to the poultry company’s specification.” is referred at “Down On The Farm: Modern Day Sharecroppers” published in TomPaine.com January 23, 2002.

³ This wording was taken from the Producer Protection Act proposed by Iowa Attorney General Tom Miller and 16 other state attorney generals.

agricultural contracting relationships. Implicit or *relational contracts* (Levin 1999 and 2003; Macleod and Malcolmson, 1989) are increasingly recognized by economists as important trade mechanisms in environments where certain aspects of performance are difficult for third parties to verify. As such, relational contracts must be *self-enforcing*, which, loosely speaking, implies that the promise of future payoffs from the relationship must be sufficiently high in order to discipline behavior today. Relational contracts also fit many of the stylized facts of agricultural contracting because, even if explicit contracts exist to govern some obligations and payment terms, quantity commitments, timing of deliveries, harvest scheduling, and/or contract renewal policies are frequently omitted from the explicit contracts. In addition, successful relationships often require trading partners to exhibit flexibility, cooperation, and adaptability. For example, in agriculture, growers' willingness to engage in disease detection, acquire special skills and/or upgrade facilities and management skills might be beneficial to processors. However, these aspects of "performance" are either impossible or difficult to contract on. In some cases, even explicit written obligations may be difficult to enforce. For example, in some livestock sectors, processors weigh animals themselves and determine mortality rates without a third party present (Hamilton) so that quality is difficult to enforce even if an explicit contract contains payment schedules that are contingent on quality. In this case, an integrator has the power to renege on promised bonuses or premiums by not reporting quality truthfully.⁴ In this latter case, relational contracting is necessitated by the fact that an important institution for verifiability is missing. Thus, a better understanding of relational contracts can improve the modeling of agricultural contracting problems and allow for richer analysis of government policy intervention.

⁴ A recent E-bulletin by the Rural Advancement Foundation International alleged that some growers want to put scales in their chicken houses to document their chicken's weight before leaving the farm. But the processor, has refused which raises the question of truthful reporting of quality.

The primary purpose of this paper is to assess the efficiency and distributional consequences of termination damages on contractual relationships. In doing so, we also derive the optimal relational contract when the principal has all of the ex post bargaining power and the agent is exposed to asset specificity. Deriving the optimal contract is important as credible policy analysis must begin by understanding how government intervention will affect the *optimizing* behavior of economic decision makers.

This paper makes a contribution to the literature on relational contracts by making three major departures from the important work of Levin. The first two departures have to do with asset specificity and ex post bargaining power of the principal. The introduction of bargaining power is particularly important for modeling agricultural contracting problems because the number of processors offering contracts in a given region tends to be fewer than the number of growers vying for contracts thereby leading to unbalanced bargaining power. Moreover, farmers are often required by processors to make expensive investments in new equipment and housing facilities that meet the exact specifications of processors so that asset specificity is an important feature of agricultural contracting. Both of these extensions affect the self enforceability of relational contracts and can have consequences for efficiency, distribution and contract structure. The final departure we make is to incorporate an industry wide negative exogenous shock (bad state of nature) that will eliminate future surplus from contracting. In this case, the principal will exit the industry and sever relationships with all agents. An example might be that a negative downstream demand shock makes it unprofitable for processors to continue operations. In this case, the processor will no longer renew contracts as it will exit the industry. This is a situation where growers might be terminated even if they perform up to expectations. The introduction of this exogenous shock allows us to credibly introduce termination into our optimal contract.

Without this shock, Levin has shown that termination should never occur in equilibrium in an optimal relational contract.

This paper also contributes to the small but growing literature on agricultural contract regulation. The papers that are most closely related to ours are those by Lewin-Solomons (LS), and by Fan, Lee, and Wu, (FLW) as both of these papers focus on regulation issues pertaining to contract termination. The work of LS focuses on a ban on terminations “without cause” in a complete contracting environment where performance is verifiable by a third party. A regulation is essentially modeled as a reduction in the probability of being terminated for poor performance. LS finds that this type of regulation is generally distortionary and creates unintended consequences that can actually harm growers. Our paper differs from LS’s work in that we are modeling termination damages rather than prohibitions against termination. In addition, LS uses a two period complete contracting model, whereas we use an infinite period, relational contracting framework. Thus, the two studies are complementary in that they focus on two different types of regulations under two distinct contracting environments. The work of FLW also focuses on termination damages. However, the FLW study uses a two-period complete contracting model and finds that, in some cases, termination damages can be distortionary and reduce efficiency.

Unlike both LS and FLW, we find that government regulation of contracts via breach damages would not reduce a processor’s ability to design effective incentives and would therefore *not* be distortionary. However, processors would factor into their contract design problem, the expected future liabilities from termination. As such, growers can expect to earn less per period in the shadow of a termination damages law. Nonetheless, such a regulation would protect growers *ex post* by compensating them for losses in asset value due to termination.

One might also wonder whether government imposed termination damages can be efficiency *enhancing*. On the surface, it might appear that, when the principal has bargaining power, so that it has little incentive to commit to any single grower, this imposes a severe constraint on the set of self-enforcing contracts, as the principal can switch to another agent at very little cost. Thus, it may be reasonable to assume that some sort of “severance cost,” such as government imposed breach damages, might be warranted facilitate self enforcement which can enhance the efficiency. Surprisingly, we find that termination damages or severance payments do not affect the self enforcement constraint at all and therefore do not widen the set of implementable allocations. The intuition is that the absence of switching costs for the principal would only limit the *types* of incentives that can be credibly used but would not reduce the *strength* of incentives. In particular, we find that discretionary bonuses contingent on non-verifiable performance are no longer credible mechanisms for motivating effort as the principal always prefers to switch to another grower rather than to pay the bonus, *ex post*. However, the principal can credibly use deducts (negative bonuses) that deliver the same incentives. Hence, neither severance payments nor government imposed damages are necessary to enhance self enforcement. Because termination damages and severance payments have no impact on efficiency, negatively or positively, they appear to be ideal policy instruments for protecting growers from termination.

The Model

To facilitate understanding, we begin by outlining a relational contracting model that is similar Levin's. We will then gradually introduce ex post bargaining power, asset specificity and the exogenous shock into our model before deriving key results. This provides a self contained

introduction to relational contracting, and at the same time, allows us to highlight our contribution.

We assume that the principal (e.g. food processor) is attempting to gain a competitive edge on the downstream consumer market by producing a high quality consumer product which requires specialized inputs and/or reducing costs in its supply chain by exploiting new technologies or improving coordination, although we do not specify the exact reason in order to maintain generality of the model.⁵ As an illustration, if a food processor is interested in producing a high quality consumer good that is differentiated from those of competitors, then the processor must consistently source high quality inputs which may not obtainable on the spot market; hence, the processor must contract with individual growers and design a contract that provides adequate incentives for agents (e.g. growers) to produce high quality inputs. Relational contracting in this case becomes important if the quality of the input is not verifiable by a third party. For example, some processors in livestock sectors weigh the animals themselves and determine mortality rates without a third party present (Hamilton) so that quality is difficult to enforce even if an explicit contract contains payment schedules that are contingent on quality. In this case, an integrator has the power to renege on promised bonuses or premiums by not reporting quality truthfully. We can also consider other reasons for relational contracting. For example a processor may contract with growers in order to optimize processing plant capacity which requires delivery schedule coordination with growers. In this case, successful coordination may require both parties to “perform” by exhibiting a certain degree of flexibility, adaptability, and cooperation, which are difficult to verify performance factors. We can construct similar examples if there are other reasons for contracting such as when integrators

⁵ We specify several possibilities for contracting so as not to limit the scope of our analysis. Our model is sufficiently general to allow us to analyze a range of contracting issues in agriculture.

want to reduce costs by exploiting scale effects or new technology which would require growers to remain “flexible” and upgrade facilities or adopt new technologies and/or special skills for disease control or biosecurity reasons at the integrator’s request.

Formally, like Levin’s model, we consider an infinite horizon principal-agent relationship between a risk neutral principal and a risk neutral agent. Trading occurs over an infinite sequence of time periods, $t = 0, 1, 2, \dots$. At each date t , the principal contracts with an agent to obtain a benefit, a_t , where a_t is drawn from a continuous distribution with a cumulative distribution function $F(\cdot | e)$ on the support $A = [\underline{a}, \bar{a}]$, which is conditional on effort level $e_t \in E = [0, \bar{e}]$ exerted by the agent. We also assume that a_t is observable but not verifiable.⁶ Hence, any incentive scheme that is based on a_t is merely promised but cannot be enforced by a court of law. We assume that $F(\cdot | e)$ has the monotone likelihood ratio property (MLRP) and the convexity of the distribution property (CDFC), which allows us to use the first order approach in specifying the incentive compatibility (IC) constraint to deal with moral hazard (Rogerson). For any $e_t \in E$, the agent incurs a cost $c(e_t | I)$ with assumptions $c(0 | I) = 0$, $c_e(e_t | I) > 0$, and $c_{ee}(e_t | I) \geq 0$, and $c(\bar{e} | I) = +\infty$ where $I \in \{0, I^0\}$ represents a binary valued relationship specific investment that is specified by the principal during the initial period when the relationship is established. While the principal specifies the level of I , the cost of I is borne by the agent. Alternatively, one can think of an investment level of $I = I^0$ as a technological requirement for producing a_t so that $c(e_t | I = 0) = +\infty \quad \forall e > 0$. However, we assume that it only

⁶ We do not specify what a is exactly to maintain generality. Using our previous examples, if the principal is chiefly concerned with input quality, then a might denote measured quality of the commodity which is not verifiable by a third party. If maintaining plant capacity is the principal’s primary aim so that delivery schedule coordination is crucial, then a could be the degree of cooperation and flexibility exhibited by the grower to meet scheduling requirements. The key point is that a represents a measure of performance that is not verifiable by a third party.

needs to be carried out once at $t = 0$ and is therefore a sunk investment in all subsequent periods. To maintain notational simplicity, we will henceforth suppress I in the cost function.

We also assume that, at the beginning of any period t , the principal can decide whether to continue to contract with the agent or not. If the principal decides to continue the relationship, it offers a compensation plan that consists of a fixed payment w_t^m , a discretionary bonus schedule $b_t(\theta_t)$ contingent on performance outcome $\theta_t \subseteq \{e_t, a_t\} \in \Theta$, and a possible severance payment, w_{t+1}^s that would be paid in the event that the relationship is terminated at the beginning of $t+1$. Note that although w_{t+1}^s is specified in the contract for period t it would be paid in $t+1$ conditional on termination at the beginning of period $t+1$. We assume that there are two parts to the payment scheme offered by the processor - an explicit component, based on verifiable information, and an implicit component based on non-verifiable performance. In our model, the only verifiable information is whether the relation continues or separates. Therefore, the explicit part consists of fixed payment, w_t^m that is to be paid in period t , and a severance payment, w_{t+1}^s , to be paid in period $t+1$, if the relationship is terminated at the beginning of $t+1$. The implicit component includes any payments, bonuses or penalties, that are contingent on non-verifiable information and are captured by $b_t(\theta_t)$, which can be either positive or negative. To motivate a negative bonus, consider a case where performance is very low. Then the agent can “compensate” the processor and restore goodwill by granting a discount for poor performance. Indeed, in many buyer-supplier relationships both within agricultural and outside of agricultural, suppliers have been known to grant price discounts when a shipment of goods fails to meet certain quality standards. Therefore, total transfers from the principal to the agent at the end of period t is $w_t(\theta_t) = w_t^m + b_t(\theta_t)$. In addition, if termination occurs at the beginning of $t+1$, an

additional amount w_{t+1}^s , would be paid in $t + 1$. However, Macleod and Malcomson (1989) and Levin (1999) show that a positive severance payments cannot improve upon the set of allocations that can be implemented with self enforcing contracts. Therefore, we will assume that $w_{t+1}^s = 0$ for now. However, we will consider $w_{t+1}^s > 0$ later when we introduce bargaining power, asset specificity and exogenous shocks to determine if severance payments can impact efficiency. This will allow us to assess government mandated termination damages as this legislation would essentially impose a positive severance payment on the relational contract. The agent's payoff for period t is then $w_t(\theta_t) - c(e_t)$, the principal's payoff is $a_t - w_t(\theta_t)$, and social surplus is $a_t - c(e_t)$. In order to accommodate different information environments, we allow the principal to observe either both e_t and a_t (symmetric information) or only a_t (moral hazard).

Due to the non-verifiability of θ_t , it is not possible to provide incentives contingent on θ_t in a static relationship, so that productive trading must be governed by a relational contract that extends beyond a single period. Since the contingent payment $b_t(\theta_t)$ cannot be enforced by a third party, either the principal or the agent has an incentive to renege on a contract in a one-shot relationship. However, when both parties are engaged in a repeated relationship, the promise of future payoffs can provide incentives for parties not to renege, leading to self enforcing agreements. Bolton and Dewatripont (2005) suggest that agreements are self enforcing when there are credible future threats (or rewards) that can induce parties to stick to the terms of the informal agreement. More formally, a relational contract is a complete plan of action which describes for every period t and every possible history up to t , (i) the principal's decision to continue or terminate the relationship; (ii) the payment scheme offered by the

principal in the case of continuation; (iii) the agent's decision to accept or reject the principal's offer; and (iv) the action (effort level) the agent should take.⁷

In order to illustrate the timing of the relationship, we provide a graph of the first two periods $t=0$ and $t=1$. All periods $t \geq 1$ are identical.

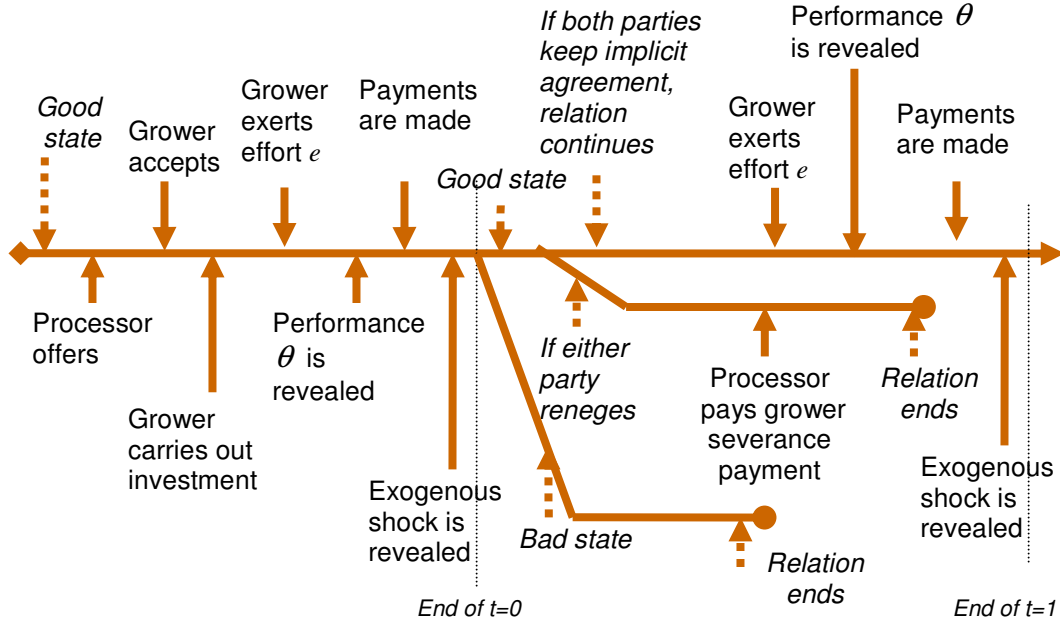


Figure 1: Timing of relational contracts

Next, we will specify reservation payoffs for the principal and the agent in the case that no trade occurs. If a principal cannot find an agent to produce the benefit, a_t , or it cannot appropriately incentivize agents, then we assume that the principal pursues an alternative line of business and receives a fixed per-period outside payoff of $\bar{\pi}$. For example, in order to produce a high quality consumer product, the principal may have to source input commodity with special quality characteristics. If it cannot incentivize agents to produce the required quality

⁷ Our definition of a relational contract is closely related to the definition given by Levin (2003). It describes a perfect public equilibrium of the repeated game.

characteristics, then the principal may be better off sourcing inputs from the spot market and producing a generic consumer good from which it will derive profits of $\bar{\pi}$. Thus, we will call $\bar{\pi}$ the principal's *ex ante* reservation payoff. Similarly, if the agent does not receive a contract offer or rejects an offer, the agent gets fixed per-period outside payoff of \bar{u} . We will call this the agent's *ex ante* reservation payoff.

It is also important to specify the *ex post* reservation payoffs, which are the payoffs received by the parties if an existing contract is terminated. We assume that if the principal separates from a specific agent, it can still sign a contract with another agent and earn expected per period payoffs of $\pi_{-G}(e)$ under efficient trade. We will call $\pi_{-G}(e)$ the principal's *ex post* reservation payoff, and will henceforth denote it by π_{-G} to conserve notation. The principal has an incentive to find another agent rather than exit the industry so long as $\pi_{-G} \geq \bar{\pi}$. For the agent, we will denote *ex post* reservation utility as \tilde{u} and assume that it differs from the ex-ante reservation utility, \bar{u} , due to the presence of the asset specific investment I . For example, with relationship specific investments, we have $\bar{u} > \tilde{u}$ which stems from the fact that an agent's asset will be worth less outside the relationship than within the relationship. While our specification of reservation payoffs is more complex than Levin's, we are able to examine a broader range of cases relating to ex post bargaining power and asset specificity. Levin's original assumptions is consistent with the special case in which $\pi_{-G} = \bar{\pi}$, $\tilde{u} = \bar{u}$, and $w^s = 0$. Finally, we assume that if the parties separate, the agent cannot contract with the same principal again. This assumption greatly simplifies our expression of discounted expected profits with no loss in generality.

Assuming that the principal can make an offer that is sufficiently attractive to agents and can provide adequate incentives, the discounted expected payoffs expressed as per-period averages, starting in period t are:

$$(1) \pi_t \equiv (1-\delta) \sum_{\tau=t}^{\infty} \delta^{\tau-t} \left[(1-v_\tau) \{ d_\tau E_{a_\tau} [a_\tau - w_\tau | e_\tau] + (1-d_\tau) \pi_{-G} \} + v_\tau \pi_{-G} \right]$$

$$(2) u_t \equiv (1-\delta) \sum_{\tau=t}^{\infty} \delta^{\tau-t} \left[(1-v_\tau) \{ d_\tau E_{a_\tau} [w_\tau - c(e_\tau | I^0) | e_\tau] + (1-d_\tau) \bar{u} \} + v_\tau \tilde{u} \right]$$

where $\delta \in [0,1]$ is a common discount factor; d_t is 1 if the agent accepts the principal's offer and 0 otherwise; and v_t is 0 if the relationship has not been terminated up to t and 1 otherwise. If $t = 0$, we would have to factor in the investment I^0 made by the agent at the request of the principal. To simplify the analysis, we will assume that the ex ante reservation payoff \bar{u} implicitly captures the opportunity cost of this investment.

Self Enforcing Stationary Contracts

The most important feature of relational contracts is that contracts must be self-enforcing to both parties. This means that each party must find it advantageous to honor the contract rather than renege on promised bonuses that are contingent on non-verifiable performance outcomes. In addition, relational contracts must specify what happens if either party reneges by not holding up her end of the bargain. Levin suggests that, since reneging should never occur in equilibrium, there is no harm in assuming that the parties terminate the relationship as this is the worse possible outcome. Thus, if either party reneges, then the parties deviate to the static one-shot equilibrium. This implies that the parties either break off trade and receive ex post reservation payoffs or, if the principal makes an offer that deviates from the expected offer, but still allows the agent to earn some payoff that is greater than his reservation payoff, then the agent accepts the offer but does not exert any effort.

Levin explains the conditions necessary for a relational contract to be self-enforcing in the special case where $\pi_{-G} = \bar{\pi}$, $\tilde{u} = \bar{u}$, and $w^s = 0$.⁸ Suppose that a contract in the initial period specifies effort, e , a fixed payment w^m , a bonus schedule $b: \Theta \rightarrow \mathbb{R}$, and if parties do not renege on their obligations, continuation payoffs of $u(\theta)$ and $\pi(\theta)$, which are functions of the performance outcome θ .⁹ The expected average per period payoffs from this contract are:

$$(3) \quad u \equiv (1-\delta)E_a[w^m + b(\theta) - c(e) | e] + \delta E_a[u(\theta) | e]$$

$$(4) \quad \pi \equiv (1-\delta)E_a[a - w^m - b(\theta) | e] + \delta E_a[\pi(\theta) | e]$$

and $s = u + \pi$ is expected surplus from the relationship.¹⁰ Denoting the principal by “P” and the agent by “A”, the contract is self-enforcing if and only if:

$$(i) \quad u \geq \bar{u} \quad \text{and} \quad \pi \geq \bar{\pi} \quad (\text{P and A willing to initiate the contract})$$

$$(ii) \quad e \in \arg \max_{\tilde{e}} E_a \left[b(\theta) + \frac{\delta}{1-\delta} u(\theta) | \tilde{e} \right] - c(\tilde{e}) \quad (\text{IC constraint when } e \text{ is unobservable})$$

$$(iii) \quad -b(\theta) + \frac{\delta}{1-\delta} \pi(\theta) \geq \frac{\delta}{1-\delta} \bar{\pi} \quad \forall \theta \in \Theta \quad (\text{P does not renege on bonus payments})$$

$$(iv) \quad b(\theta) + \frac{\delta}{1-\delta} u(\theta) \geq \frac{\delta}{1-\delta} \bar{u} \quad \forall \theta \in \Theta \quad (\text{A does not renege on bonus payments})$$

⁸ Macleod and Malcolmson (1989) and Levin (1999) show that a positive severance payment cannot improve upon the set of allocations that can be implemented with self enforcing contracts.

⁹ These continuation payoffs can also be thought of as continuation value functions.

¹⁰ One can also think of (3) and (4) in terms of the discounted expected average per-period payoffs expressed in (1) and (2). If in $t = 0$, we evaluated (1) and (2) using the initial contract and assumed that $v_t = 0$ (no termination in any period t) and $d_t = 1$ (agent always accepts the contract) for $t = 0, 1, 2, \dots$, then we would obtain some π_0 and u_0 , which are equivalent to π and u in (3) and (4). Moreover, the continuation payoffs $\pi(\theta)$ and $u(\theta)$ in (3) and (4) can be thought of as the period $t = 1$ discounted expected payoffs expressed as per-period averages contingent on the outcome of θ in period 0. Again, we would assume that $v_t = 0$ and $d_t = 1$ for all t . Therefore, u and π are value functions of expressions (1) and (2) under the assumption that the contract is never terminated in any period and that the agent will always accept an offer in every period.

The final condition that is required is: (v) $\forall \theta \in \Theta$, the continuation payoffs $u(\theta)$ and $\pi(\theta)$ are compatible with a self-enforcing contract that will be initiated in the next period; that is, the continuation contract must also be self enforcing.

The conditions specified in (iii) and (iv) can also be called *discretionary payment constraints* as they ensure that both the principal and the agent are willing to pay promised bonuses rather than renege. For the principal, paying the bonus and continuing the relationship will earn discounted payoffs of $-b(\theta) + \frac{\delta}{1-\delta}\pi(\theta)$ which should exceed discounted payoffs of, $\frac{\delta}{1-\delta}\bar{\pi}$, from reneging. A similar interpretation holds for the agent.

Before proceeding, we will define a *stationary contract*. An advantage of restricting attention to stationary contracts is that it significantly simplifies the problem of finding the optimal contract. A stationary contract is one where in every period, the principal offers the same payment plan and the agent acts according to the same decision rule. Levin (2003) defines a stationary contract as follows:

DEFINITION 1 (Levin, 2003): A contract is stationary if on equilibrium path $w_t = w^m + b(\theta_t)$ and $e_t = e$ in every period t , for some $w^m \in \mathbb{R}$, $b: \Theta \rightarrow \mathbb{R}$, and $e \in E$

Additionally, Levin's (2003) Theorem 2 makes the important point that if optimal relational contracts exist, then there are also stationary contracts that are optimal. Intuitively, in simple moral hazard models, the principal can provide incentives either through current period bonuses (punishments) or by ratcheting up (down) promised continuation payoffs. However, under the assumption of risk neutrality, it matters little whether the principal motivates effort through bonuses (punishments) or continuation payoffs as they are perfectly substitutable. Thus, the parties can adjust discretionary payments at the end of each period to account for variations in

performance rather than change equilibrium behavior through a change in continuation payoffs.

This makes it possible for the parties to enter the next period with exactly the same contract with no change in continuation equilibrium.

In this paper, we will characterize a stationary contract as a list $(w^m, w^s, b(\theta_t), e, \pi, u)$

where the subscript t is no longer needed except on performance outcome, θ_t , which is a random variable, because the compensation plan, effort, and expected payoffs are stationary across periods. While we list w^s in the contract, we still assume that private parties would not negotiate a contract that offers non-zero severance payments. Nonetheless, when we assess termination damage legislation later, we will need to consider government imposed severance payments.

Moral Hazard

In this section, we outline how moral hazard is incorporated in a relational contract. In a complete contracting environment, where a is both observable and verifiable, it is well known that, under risk neutrality, there exist contracts that can implement the first best effort level, unless a binding limited liability constraint exists. However, when a is not verifiable, first best level of effort may not be implementable for yet another reason, which is related to the requirement of self enforcement. To see this, note that the discretionary payment constraints, which were listed in conditions (iii) and (iv) imply that:

$$(5) \quad \frac{\delta}{1-\delta}(\pi - \bar{\pi}) \geq \sup_{\theta} b(\theta)$$

$$(6) \quad \frac{\delta}{1-\delta}(u - \bar{u}) \geq -\inf_{\theta} b(\theta)$$

These restrictions entail that the largest discretionary payments that the parties may have to pay can be no greater than the discounted future payoffs from continuation. This will ensure that,

even under the best (worst) performance outcomes, the parties will not renege on payments.

Adding (5) and (6) together gives us:

$$(7) \quad \frac{\delta}{1-\delta}(\pi + u - \bar{u} - \bar{\pi}) = \frac{\delta}{1-\delta}(s - \bar{s}) \geq \sup_{\theta} b(\theta) - \inf_{\theta} b(\theta)$$

which implies that the allowable variation in discretionary payments under self enforcement cannot exceed discounted future gains from trade from contracting. Because $b(\theta)$ is used to provide incentives and motivate effort, limiting its range constrains incentive provision in the same way that limited liability constraints do so in the complete contracting environment.

Because “high-powered” incentives are typically associated with large variations in performance pay, (7) acts as a constraint that limits the power of incentives, which reduces the set of e that can be implemented with a self enforcing contract. The constraint (7) is formally called a *dynamic enforcement constraint* (Levin) and must be included alongside an incentive compatibility constraint in the stationary relational contract design problem. We will now let $\theta = \{a\}$ because e is not observable under moral hazard so the discretionary payment will now be expressed as $b(a)$. According to Levin (2003), any effort level, e , that generates a per-period expected surplus of s can be implemented with a stationary contract $(w^m, 0, b(a), e, u, \pi)$ if and only if the following conditions are met:

$$(8) \quad e = \arg \max_{\tilde{e}} \int b(a) f(a | \tilde{e}) da - c(\tilde{e})^{11} \quad (\text{IC})$$

$$(9) \quad \frac{\delta}{1-\delta}[s - \bar{s}] \geq \sup_a b(a) - \inf_a b(a) \quad (\text{DE})$$

Under the conditions and assumptions described above, Levin (2003) shows that the optimal relational contract that can implement any $e < e^{FB}$ satisfying (8) and (9) is of a “one-step” form,

¹¹ Henceforth, we omit \underline{a}, \bar{a} , in $\int_{\underline{a}}^{\bar{a}} b(a) f(a | e) da$ for simplicity of notation.

where e^{FB} is the first best effort level.¹² A one-step contract compresses performance information into just two levels: “good” performance and “bad” performance. The corresponding “one-step” bonus schedule is then $b(a) = \sup_a b(a) = \inf_a b(a) + \frac{\delta}{1-\delta}(s - \bar{s})$ for all $a \geq \hat{a}$, and $b(a) = \inf_a b(a)$ for all $a < \hat{a}$, where \hat{a} is the point at which the likelihood ratio $f_e(a | e) / f(a | e)$ changes from negative to positive. In other words, this contract calls for maximal reward and punishment allowable under the (DE) constraint. The intuition is that, under risk neutrality, the strongest possible incentives should be used to motivate effort.¹³

Ex Post Market Power

A major contribution of this paper is that it provides an analysis of how the optimal contract and the distribution of surplus are affected when the principal has ex post bargaining power. We assume that the principal has full bargaining power if $\pi = \pi_{-G}$; that is, it is costless for the principal to terminate any specific agent because the principal can earn the same payoffs through another agent. This imposes a constraint on the set of self enforcing contracts as the principal has little incentive to commit to a long term relationship with any specific agent. In some agricultural subsectors, large processors such as Tyson Foods, Gold Kist, Perdue Farmers, Pilgrim’s Pride, etc. dominate input markets so that there are few buyers but many growers lining up for contracts.¹⁴ In this case, a large processor may lose little if separated from a specific grower because there is always another grower waiting to replace the departed grower.

¹² See Theorem 6 and the associated proof in Levin (2003).

¹³ The first order condition of the (IC) constraint is $\int b(a) f_e(a | e) da = c_e(e)$. Note that, for all $a \geq \hat{a}$, $f_e(a | e) \geq 0$, and for all $a < \hat{a}$, $f_e(a | e) < 0$. Furthermore, for all $e > 0$, $c_e(e) > 0$. This implies that the one step bonus schedule maximizes the LHS for any available variation in bonus schedule and then, the level of effort to satisfy the first order condition is maximized.

¹⁴ CR4 - the total market share of the four firms with the largest market shares in a market - of Broilers was 50% in 2001. (Source: Mary Hendrickson and William Heffernan (2002), Concentration of Agricultural Markets, Department of Rural Sociology University of Missouri)

We can represent less extreme cases of bargaining power by allowing for $\pi > \pi_{-G}$ so that the principal earns some agent specific rents, which gives the agent some ex post bargaining power.

Exogenous Shocks

At the conclusion of each period $t \geq 0$ and prior to the beginning of $t + 1$, we allow for the possibility of a negative exogenous shock. Introducing this shock allows us to accommodate non-performance related contract termination, which occurs in agriculture and many other industries. Negative economic shocks often induce firms to lay off growers, workers or suppliers even if these agents performed well in the past. To model this, we assume a binary exogenous shock $x = \{x_G, x_B\}$, where x_G and x_B represent respectively good state and bad state. Prior to the realization of the shocks, we assume that the probabilities $p = \text{prob}(x = x_G)$ and $1 - p = \text{prob}(x = x_B)$ are common knowledge and that these probabilities remain stable across periods. The key assumption we make is that when x_B is realized at the end of any period, $\pi_{|x_B} + u_{|x_B} < \bar{\pi} + \tilde{u}$ in all future periods so that at least one party wants to terminate the relationship.¹⁵ Intuitively, because there is insufficient surplus, it will be impossible to reward both parties using the promise of future payoffs to sustain a self enforcing contract. For simplicity, we will assume that this holds between the principal and all agents so that the principal is better off exiting the industry and earning $\bar{\pi}$ in all future periods. Under a bad shock,

¹⁵ Since $\pi_{|x_B} + u_{|x_B} < \bar{\pi} + \tilde{u}$, at least one party always wants to terminate the relationship ex post after a bad state is observed. If $u_{|x_B} \geq \tilde{u}$ ($\pi_{|x_B} \geq \bar{\pi}$), the processor (grower) wants to terminate the relationship since $\pi_{|x_B} < \bar{\pi}$ ($u_{|x_B} < \tilde{u}$). If we assume that $\pi_{|x_B} + u_{|x_B} < \bar{\pi} + \tilde{u}$, both parties agree on termination ex ante since at least one party's participation constraint cannot be satisfied. However, if $\pi_{|x_B} + u_{|x_B}$ could be larger than $\bar{\pi} + \tilde{u}$ so both parties want to continue the relationship ex post even in bad state. Therefore, in order to exclude this case, we assume that $\pi_{|x_B} + u_{|x_B} < \bar{\pi} + \tilde{u}$.

it becomes socially efficient for the relationship to terminate as it can no longer generate positive surplus. However, if a good shock, x_G , is realized, the relationship continues as before.

Separation can also occur under a good shock if the parties renege on their promises, say, because the contract is not self enforcing. If either party reneges by withholding the discretionary payment $b(a)$, then the relationship is terminated. However, in this case, because a bad shock has not occurred, there is still sufficient surplus to be earned if the processor can find a replacement grower. We assume that the processor can expect to earn $\pi_{-G|x_G}(e)$ from some other grower. However, the terminated grower would earn only fixed per-period outside utility of $\tilde{u} < \bar{u}$ due to the relationship specific investment. Thus, once a relationship is terminated in the good state, the processor and the grower receive, respectively, $\pi_{-G|x_G}(e)$ and \tilde{u} in each period, which are called the processor's and the grower's *ex post* reservation payoffs conditional on x_G . We assume that $\pi_{-G|x_G}(e) \geq \bar{\pi}$ so that the processor continues to contact for a with some other grower rather than engage in some outside option such as operating on spot markets.

With the introduction of the exogenous shock and ex post bargaining, we must make some modifications to the earlier relational contract. Now when a contract specifies effort, e , a fixed payment, w^m , a bonus schedule, $b: A \rightarrow \mathbb{R}$, and continuation payoffs $\{u(a), \pi(a)\}$, the continuation payoffs are contingent on x_G . If x_B occurs instead, the relationship breaks off and the parties receive their bad state reservation payoffs. The average per period payoffs are:

$$(10) \quad u \equiv (1 - \delta)E_a[w^m + b(a) - c(e) | e] + p\delta E_a[u(a) | e] + (1 - p)\delta \tilde{u}$$

$$(11) \quad \pi \equiv (1 - \delta)E_a[a - w^m - b(a) | e] + p\delta E_a[\pi(a) | e] + (1 - p)\delta \bar{\pi}$$

and $s = u + \pi$ is expected surplus. This contract is self-enforcing if and only if :

$$(i^*) \quad u \geq \bar{u} \quad \text{and} \quad \pi \geq \bar{\pi} \quad \quad \quad (\text{P and A willing to initiate the contract})$$

$$(ii^*) \quad e \in \arg \max_{\tilde{e}} E_a \left[b(a) + p \frac{\delta}{1-\delta} u(a) | \tilde{e} \right] - c(\tilde{e}) \quad (IC)$$

$$(iii^*) \quad -b(a) + p \frac{\delta}{1-\delta} \pi(a) \geq p \frac{\delta}{1-\delta} \pi_{-G|x_G} \quad \forall a \in A \quad (\text{Discretionary payment constraint for P})$$

$$(iv^*) \quad b(a) + p \frac{\delta}{1-\delta} u(a) \geq p \frac{\delta}{1-\delta} \tilde{u} \quad \forall a \in A \quad (\text{Discretionary payment constraint for A})$$

and (v*) $\forall a \in A$, a pair of the continuation payoffs in the good state $\{u(a), \pi(a)\}$ corresponds to a self-enforcing contract.

As before, we would like to restrict our attention to stationary contracts, as this would greatly simplify the problem of describing the optimal self enforcing contract in the presence of the exogenous shock. Proposition 1 to follow allows us to focus on stationary contracts, but we first define a stationary contract under our modifications.

DEFINITION 2: *A contract is stationary if on the equilibrium path contingent on a good state, $w_t = w^m + b(\theta_t)$ and $e_t = e$ in every period t for some $w \in \mathbb{R}$, $b(\theta) : \Theta \rightarrow \mathbb{R}$, and $e \in E$; and on equilibrium path contingent on bad state, at least one party wants to terminate the contract.*

Under this definition, the principal offers the same payment plan and the agent acts according to the same decision rule in every period in which x_G is observed. Additionally, if x_B is observed, future trading will no longer yield sufficient surplus to sustain the relational contract so that the parties break off trade and receive ex post outside payoffs $\bar{\pi}$ and \tilde{u} .

PROPOSITION 1: *When $\pi \geq \pi_{-G|x_G} \geq \bar{\pi} \geq \pi_{-G|x_B}$, $\bar{u} > \tilde{u}$, $\pi_{|x_B} + u_{|x_B} < \bar{\pi} + \tilde{u}$, and $x = \{x_G, x_B\}$ with $p = \text{prob}(x_G)$ and $1-p = \text{prob}(x_B)$, if an optimal self-enforcing contract exists, there also exists stationary contracts that are optimal.*

Proofs for all remarks and propositions are provided in the Appendix.

Ex Post Market Power, Asset Specificity and Contract Structure

In this section, we will outline how relational contracts are impacted by the introduction of ex post bargaining power and asset specificity. We will also characterize the optimal relational contract. The main results presented in this section extend the work of Levin's and are, to the best of our knowledge, new findings that have not been previously derived.

We begin with a remark which suggests that, in order to motivate effort, the principal must provide the agent with some relationship specific rents. To simplify our presentation, we will assume for the moment that $\tilde{u} = \bar{u}$, which implies that there is no asset specificity.

REMARK 1: When $\pi = \pi_{-G|x_G}$ and $\tilde{u} = \bar{u}$, a self-enforcing stationary contract,

$(w^m, 0, b(a), e, \pi, \bar{u})$, that promises the agent only expected per-period utility $u = \bar{u}$ cannot implement any $e > 0$.

Remark 1 makes the important point that the principal must provide the agent with a level of u that exceeds \bar{u} if the principal wants the agent to exert a positive level of effort. The intuition here is that, because each party earns no relationship specific rents, no separation costs exist for either party, which makes self enforcement particularly difficult. Consequently, relationship specific rents must be provided to the agent to ensure that the agent stays in the relationship. If we relax the assumption $\tilde{u} = \bar{u}$ and allow for asset specificity, $\tilde{u} < \bar{u}$, then the principal can decrease the amount of rents paid to the agent due to the fact that asset specificity creates a separation cost for the agent.

While rents to the agent ensure a degree of self enforcement on the agent side of the relationship, the principal can still costlessly switch to another grower ex post. The question then is, what types of relational contracts can simultaneously ensure that both parties have the incentive to stay in the relationship? First, note that the principal can never credibly promise a positive discretionary payment; i.e., the principal can always do better by reneging on the bonus

ex post and costlessly switching to another grower rather than paying the bonus. Hence, the only credible incentive scheme is one that involves a negative bonus with a base pay that is sufficiently high to promise the agent an expected payoff of $u > \bar{u}$. A positive discretionary bonus would not be credible. To see this, note from the principal's discretionary payment constraint that $-\sup_a b(a) + p \frac{\delta}{1-\delta} \pi \geq p \frac{\delta}{1-\delta} \pi$, which implies $0 \geq \sup_a b(a)$ so that the largest possible bonus is zero. Also, because the principal gets a payoff of $\pi = \pi_{-G|x_G}$ regardless of which agent she contracts with, the principal earns no relationship specific rents from any agent. Thus, all relationship specific surplus would go to the agent to motivate effort. Mathematically, we can see this by combining the agent's and the principal's discretionary payment constraints to get $\frac{p\delta}{1-\delta}(u - \bar{u}) \geq \sup_a b(a) - \inf_a b(a)$. It is clear that if this constraint is binding, the only way for the principal to provide higher powered incentives is to promise the agent higher u . This suggests that it is not possible to separate efficiency from distribution. While Levin's theorem 1 notes that distribution can be separated from incentives through discretionary adjustments of the fixed payment portion of the compensation scheme to achieve any desirable distribution of the total surplus across the two parties, we show here that this is no longer possible when the principal has full ex post market power.

Assuming that $\bar{u} \geq \tilde{u}$, which is general enough to accommodate both asset specificity and non-asset specificity, the only credible self enforcing contract involves a high fixed pay combined with a negative discretionary payment.

REMARK 2: When $\pi = \pi_{-G|x_G}$ and $\bar{u} \geq \tilde{u}$, if there is a self-enforcing stationary contract

$(w^m, 0, b(a), e, \pi, u)$, then $\sup_a b(a)$ cannot be positive and $\inf_a b(a)$ must be negative and satisfy

$$\inf_a b(a) \geq -\frac{p\delta}{1-\delta}(u - \tilde{u}).$$

Remark 2 combined with the discussion following remark 1 suggest that *discretionary* adjustments in pay tend to be deducts rather than bonuses.¹⁶ In relational contracting settings where performance is not verifiable and buyers hold extensive bargaining power, it is not uncommon for suppliers (growers) to offer discretionary discounts, which may not be part of the formal agreement, to buyers when performance is unsatisfactory. However, when performance is satisfactory, no adjustments are usually made. Even if price discounts are not made, suppliers may take other types of costly actions to correct bad performance. For example, in the California processing tomato industry, when a delivery of tomatoes falls below reject standards, a processor may either accept the deliver at a discounted price or the grower may have to replenish the shipment by replacing bad tomatoes with good tomatoes. Another indirect way penalties are imposed on growers for bad performance is for processors to slash quantity commitments by, for instance, reducing flock placements or reducing the volume purchased. Quantity reductions adversely affect the financial situations of growers.

There is also experimental evidence supporting the notion of discretionary downward adjustments are used much more frequently then upward adjustments in price when buyers have bargaining power (Wu and Roe). In a series of relational contracting experiments, Wu and Roe show that when sellers perform well, they are rewarded only 20% of the time, whereas when they underperform, they receive deducts 80% of the time. Hence, deducts are used much more

¹⁶ Note that this may not necessarily be true for explicit bonus schedules based on verifiable performance. Indeed, many agricultural contracts contain explicit premiums as well as deducts.

frequently in response to low performance than rewards are used in response to good performance, which is broadly consistent with our prediction.

The Optimal Relational Contract

We will now characterize the *optimal* self-enforcing stationary contract. From this point forward, we will focus exclusively on the case where $\pi = \pi_{-Gl_x_G}$ and $\bar{u} > \tilde{u}$ as market power and asset specificity are prevalent in agricultural contracting. These assumptions imply that the principal can costlessly switch to another grower, while the agent incurs separation costs due to a loss in value of the asset specific investment. We will characterize an optimal self-enforcing stationary contract in this scenario by analyzing the principal's contract design problem:

$$\begin{aligned}
 \text{(P1)} \quad \max_{w^m, b(a), e} \quad & \pi = \frac{1-\delta}{1-\delta p} \left\{ \int (a-b(a)) f(a|e) da - w^m \right\} + \frac{\delta - \delta p}{1-\delta p} \bar{\pi} \\
 \text{s.t.} \quad & u = \frac{1-\delta}{1-\delta p} \left\{ w^m + \int b(a) f(a|e) da - c(e) \right\} + \frac{\delta - \delta p}{1-\delta p} \tilde{u} \geq \bar{u} \quad (\text{Participation}) \\
 & e = \arg \max_{\tilde{e}} \int b(a) f(a|\tilde{e}) da - c(\tilde{e}) \quad (\text{IC}) \\
 & -\sup_a b(a) + p \frac{\delta}{1-\delta} \pi \geq p \frac{\delta}{1-\delta} \pi \quad (\text{Discretionary payment constraint for P}) \\
 & \inf_a b(a) + p \frac{\delta}{1-\delta} u \geq p \frac{\delta}{1-\delta} \tilde{u} \quad (\text{Discretionary payment constraint for A})
 \end{aligned}$$

While the above problem looks like a static optimization problem, the stationary nature of the relational contract allows us to write the dynamic optimization problem as above.

Before solving (P1), we will first analyze some of the constraints of the problem.

Combining both discretionary payment constraints implies the following (DE) constraint,

$$(12) \quad \frac{p\delta}{1-\delta} (u - \tilde{u}) \geq \sup_a b(a) - \inf_a b(a)$$

Note that the principal can relax the (DE) constraint by promising the agent greater u . This would enable increased variation in discretionary payments across different performance outcomes so that higher powered incentives can be provided which can increase the set of implementable effort levels. However, it is costly for the principal to increase u as increased transfers to the agent means a reduction in π . Therefore, the principal must weigh the efficiency gains from increasing u (increased effort) against the cost of making costly transfers to the agent. Additionally, the (DE) constraint can be relaxed if p increases. Thus, increased likelihood of continuation would also relax (DE) and lead to a possible increase in efficiency.

The (P1) constraints also allow us to derive a key result which is that non-zero severance payments are not needed to enhance efficiency even when the principal has full market power.

PROPOSITION 2: *When $\pi = \pi_{-Gl x_G}$ and $\bar{u} > \tilde{u}$, if the self-enforcing stationary contract*

$(w^m, w^s, b(a), e, \pi, u)$ is such that $w^s > 0$, there exists a self-enforcing stationary contract with $w^s = 0$ that can implement the same effort and give the same expected per-period payoffs.

This proposition is important as it suggests that government imposed termination damages, which are essentially externally imposed severance payments, would not improve efficiency.

We will discuss this point in greater detail the subsequent section on regulation.

We will now explicitly solve (P1) to obtain the optimal contract. To do so, we will convert (P1) into the following program:

$$\begin{aligned}
 \text{(P2)} \quad & \max_{u, e, b(a)} \pi = \frac{1-\delta}{1-\delta p} \left\{ \int a f(a|e) da - c(e) \right\} + \frac{\delta - \delta p}{1-\delta p} \bar{\pi} - u + \frac{\delta - \delta p}{1-\delta p} \tilde{u} \\
 \text{s.t.} \quad & \text{(i) } u - \bar{u} \geq 0 \\
 & \text{(ii) } \int b(a) f_e(a|e) da - c_e(e) = 0
 \end{aligned}$$

$$(iii) -\frac{p\delta}{1-\delta}(u-\tilde{u}) \leq b(a) \leq 0 \text{ for all } a$$

(P2) can be obtained from (P1) by noting that,

$$u = \frac{1-\delta}{1-\delta p} \left\{ w^m + \int b(a) f(a|e) da - c(e) \right\} + \frac{\delta - \delta p}{1-\delta p} \tilde{u}, \text{ which can be expressed as:}$$

$$(13) \quad w^m = \frac{1-\delta p}{1-\delta} \left\{ u - \frac{\delta - \delta p}{1-\delta p} \tilde{u} \right\} - \int b(a) f(a|e) da + c(e)$$

Equation (13) can be substituted into the objective function of (P1) to produce the objective function of (P2). Now the principal is optimizing over u , e , and $b(a)$ rather than w^m , e , and $b(a)$ as in the original (P1). This change of variables will make the optimization problem more tractable. This also allows the agent's participation constraint of (P1) to be simplified to $u - \bar{u} \geq 0$.

The incentive compatibility constraint of (P1) can be replaced with $\int b(a) f_e(a|e) da - c_e(e) = 0$ under CDFC and MRLP, and the discretionary payment constraints for P and A in (P1) jointly imply constraint (iii) in P2, which we will call the *double-side boundary constraint* for $b(a)$.

Once we solve (P2), the fixed payment w^m can be recovered by substituting the solutions to (P2) into (13). Finally, if π evaluated at a solution to (P2) is equal to or larger than $\bar{\pi}$, then there exists an optimal self-enforcing stationary contract. To ensure interior solutions, we assume that the Inada conditions $c_e(0) = 0$ and $c_e(\bar{e}) = +\infty$ hold. The following proposition characterizes an optimal self-enforcing stationary contract which be derived from solving (P2).

PROPOSITION 3: *When $\pi = \pi_{-Gl_{xG}}$ and $\bar{u} > \tilde{u}$, if there exists an optimal self-enforcing stationary contract, then it takes one of the following three forms:*

i) the contract promises a payoff of $u > \bar{u}$, specifies effort of $e < e^{FB}$, and includes a one-step

bonus schedule such that $b(a) = 0$ for all $a \geq \hat{a}$ and $b(a) = -\frac{p\delta}{1-\delta}(u-\tilde{u})$ for all $a < \hat{a}$,

ii) the contract promises a payoff of $u = \bar{u}$, specifies effort of $e < e^{FB}$, and includes a one-step

bonus schedule such that $b(a) = 0$ for all $a \geq \hat{a}$ and $b(a) = -\frac{p\delta}{1-\delta}(\bar{u} - \tilde{u})$ for all $a < \hat{a}$, and

iii) the contract promises a payoff of $u = \bar{u}$, specifies first best effort $e = e^{FB}$, and includes some monotone bonus schedule satisfying the incentive compatibility constraint,

$$\int b(a) f_e(a | e^{FB}) da - c_e(e^{FB}) = 0 \text{ and the constraint, } -\frac{p\delta}{1-\delta}(\bar{u} - \tilde{u}) \leq b(a) \leq 0 \quad \forall a \in A. \text{ In}$$

addition, if $\frac{c_e(e^{FB})}{F_e(\hat{a} | e^{FB})} \geq -\frac{p\delta}{1-\delta}(\bar{u} - \tilde{u})$, the bonus schedule can be “one-step” such that

$$b(a) = 0 \text{ for all } a \geq \hat{a} \text{ and } b(a) = \frac{c_e(e^{FB})}{F_e(\hat{a} | e^{FB})} \text{ for } a < \hat{a} \text{ where } \hat{a} \text{ is such that}$$

$$f_e(\hat{a} | e) / f(\hat{a} | e) = 0.$$

This proposition outlines all possible forms of the optimal contract, where each case depends on exogenous parameters p , δ , \tilde{u} and \bar{u} . Parts (i) and (ii) state that when the principal does not find that implementing the first best effort level is optimal, the optimal contract will be of a “one-step” form where performance is compressed into just two levels, “good” and “bad”. Parts (i) and (ii) are distinguished from each other by the amount of rents promised to the agent, which in turn depends on exogenous parameters.

Part (iii) states that when it is optimal for the principal to implement the first best effort level, then any monotone bonus schedule (not necessary one-step) that satisfies the necessary constraints can be part of an optimal contract. For example, if $\frac{p\delta}{1-\delta}(\bar{u} - \tilde{u}) \geq \bar{a} - \underline{a}$, the bonus schedule $b(a) = a - \bar{a}$ for all a can implement e^{FB} , since substituting such a bonus schedule into

$\int b(a)f_e(a|e)da - c_e(e) = 0$ yields $\int af_e(a|e)da - c_e(e) = 0$. Note that part (iii) also does not rule out one-step bonus schedules in the optimal contract so long as they satisfy some specific conditions.

In summary, even if the principal has full market power, there is asset specificity, and there is an exogenous shock, Levin's "one-step" bonus schedule is still optimal for implementing $e < e^{FB}$ in a moral hazard environment. However, the optimal bonus schedule only includes non-positive discretionary payments which depend heavily on the relationship between promised payoffs u and the reservation utilities \bar{u} and \tilde{u} , making it impossible to separate efficiency from distribution.

The Impact of Government Regulations

In this section, we analyze the distributional and efficiency consequences of government regulations on relational trading. The specific regulation we focus on are government mandated breach damages that compensate growers for "...the value of the remaining useful life of the structures, machinery or equipment involved..." when growers are terminated. Termination occurs in our model when x_B is realized, which occurs with probability $1 - p$. These sorts of regulations have been proposed in the Producer Protection Act of 2000, as well as by various individual state legislatures. One can interpret the "value of the remaining useful life" to mean the additional amount of profit that the grower could have earned had the grower not been terminated. In this case, damages would be calculated to be the difference between payoffs that can be earned with the current processor and payoffs from the next best opportunity. These damages would be analogous to severance payments of the size $w^s = \frac{u - \tilde{u}}{1 - \delta}$ which would be similar to *expectation damages* in the legal literature. It is also possible that $w^s = \frac{\bar{u} - \tilde{u}}{1 - \delta}$ which would be akin to *reliance damages* which make the grower indifferent between breach with

damages and no contract. We can, however, make a general statement about the impact of damages (severance payments) without specifying the size of these payments.

PROPOSITION 4: *When $\pi = \pi_{-G|x_G}$ and $\bar{u} > \tilde{u}$, if there exists a self-enforcing stationary contract $(w^m, 0, b(a), e, \pi, u)$, then there exists a self-enforcing stationary contract $(w^m - \delta w^s, w^s, b(a) + \delta p w^s, e, \pi, u)$ for any positive severance payment w^s imposed by regulation.*

This result is surprising as it suggests that damages, whatever the size, would have no impact on effort and payoffs of the parties as the principal can always restructure the contract to accommodate the regulation. Thus, processors would still be able to design effective incentives that deliver the same effort levels and payoffs irrespective of whether damages are in place or not. To see this, observe that damages would enter the discretionary payment constraints of both the processor and grower which gives us:

$$(14) \quad -\sup_a b(a) + p \frac{\delta}{1-\delta} \pi \geq p \left\{ \frac{\delta}{1-\delta} \pi - \delta w^s \right\} \quad (\text{Discretionary payment constraint for P})$$

$$(15) \quad \inf_a b(a) + p \frac{\delta}{1-\delta} u \geq p \left\{ \frac{\delta}{1-\delta} \tilde{u} + \delta w^s \right\} \quad (\text{Discretionary payment constraint for G}),$$

However, once they are added together to derive the dynamic enforcement constraints, the severance payments cancel and we obtain the (DE) constraint equivalent to (12). Hence, severance payments have no impact on the ability of the processor to provide incentives.

While termination damages have no impact on effort, they would affect the size of the fixed payment and the bonus schedules offered to grower. Thus, termination damages would increase (decrease) the payoff of the grower (processor) given a bad state of nature (contract terminated) by the amount, w^s . This implies that ex post payoffs for the grower and processor

contingent on termination are $w^s + \frac{1}{1-\delta} \tilde{u}$ and $-w^s + \frac{1}{1-\delta} \bar{\pi}$, respectively. Hence,

termination damages are a non-distortionary means of protecting growers' relationship specific investments. However, the processor, who has rational expectations, would foresee that it may have to pay damages in the future and would therefore price expected future liabilities into its offer to the grower. Thus, if the processor promises the grower an expected continuation payoff of $w^m + \int b(a)f(a|e)da - c(e)$ when there is no law, then payoffs would decrease by $(1-p)\delta w^s$ if the law were passed. Consequently, regulation affects the distribution of ex ante and ex post payoffs. Given that termination damages are a tool with which policy makers can redistribute rents across states of nature while not creating contracting distortions, it is a rather effective means of ensuring that growers never realize extremely low payoffs in any state of nature.

So far, we have only made passing reference to the optimal *size* of the termination damages. It is well known in the law and economics literature that expectation damages are a double edge sword in the sense that, while they lead to optimal breach decisions, they also result in *over-reliance*.¹⁷ However, no such conflict exists in our model as we have shown that severance payments would not affect the ability of the principal to structure incentives so that the amount of effort (reliance) invested by the agent would be independent of the size of termination damages. Consequently, policy makers ought to structure termination damages to induce optimal breach; that is, damages should be set at a level so that the parties agree to terminate the

¹⁷ Reliance is a technical term for investments made by one party to enhance the value of the relationship. In our model, reliance would be the effort supplied by the agent. Note that one might also suggest that the relationship specific investment I also qualifies as reliance. However, the way we have modeled I does not quite fit the traditional definition of reliance. This is because it is the principal who decides on I even if it is carried out by the agent. Thus, the agent has little choice in determining the level of I .

contract ex post if surplus from trade does not exceed the surplus from outside options. This can be accomplished by mandating *expectation damages* of the size $w^s = \frac{u - \tilde{u}}{1 - \delta}$.

Conclusion

This paper analyzes optimal relational contracts under the assumptions that agents (e.g. growers) must make relationship specific investments prior to contracting, that principals (e.g. processors) have full ex post bargaining power due to monopsony power, and that an exogenous economic shock can render a contracting relationship obsolete thereby undermining gains from trade. Our model provides a framework for understanding how government regulation can impact contractual relationships in agriculture, particularly when many aspects of a relationship are based on non-verifiable performance factors. We focus specifically on the potential impact of government imposed termination damages on incentive design, efficiency and the distribution of surplus.

Our primary findings are that, in the presence of processor bargaining power, relational contracts are characterized by a base price, which is sufficiently high to ensure participation of growers, combined with discretionary deducts that punish growers for poor performance. Optimal contracts never contain rewards for performance because when performance is unenforceable and processors can switch to other growers at low cost, then the processor has little incentive to ever pay a positive bonus. When asset specificity is added, it allows the processor to reduce the amount of rents to agents.

The optimal contract also does not require a positive severance payment even when the principal has full bargaining power and hence low severance costs. This insight is particularly important for analyzing government imposed termination damages as it suggests that damages would not improve the self enforcement of relational contracts and would therefore not enhance

efficiency. We also show that severance payments do not decrease efficiency because they would not affect the processor's ability to design effective incentives. Therefore, termination damages are non-distortionary policy instruments. However, regulation would cause rational processors to factor into their contract design problem, the expected future liabilities from termination. As such, growers can expect to earn less per period, conditional on contract continuation, in the shadow of a termination damages law. Nonetheless, this redistribution of growers rents across states of nature may not be undesirable as it would protect growers from realizing extremely low payoffs in any state of nature.

Our result that termination damages would not be distortionary might be surprising to some, as government intervention and efficiency might sound contradictory. However, termination damages involve the *enforcement* of contracts rather than *interference* in private agreements. As such, our conclusions are consistent with the Coasian principle that enforcement and allocation of property rights would not be distortionary and would only affect distribution.

There are two possible directions for future research. First, while our model assumes that performance is not verifiable, we do assume that the principal and agent agree on the performance outcome. As such, our model cannot explain conflicts that may arise about the quality of performance. Such disagreements are common in contracting relationships when performance is not verifiable and a possible way of modeling these disagreements is to introduce subjective performance outcomes. In this case, while both the principal and the agent observe performance, there might be disagreements about the quality of performance thereby leading to conflicts. Second, our model assumes that both parties are risk neutral. One might extend this model by allowing one or both parties to be risk averse but such an extension would not be trivial. A convenient feature of risk neutrality is that it allows us to restrict our attention to stationary

contracts. If we introduce risk aversion, then stationary contracts may no longer be optimal and the researcher would have to account for changes in the equilibrium behavior over time. While finding the optimal contract in this scenario would be a formidable task, it would be an important extension to the relational contracting literature.

Appendix: Proofs

Proof of Proposition 1: Suppose that a contract that delivers payoffs (10) and (11) implements effort level, e , is self-enforcing, optimal, and generates surplus $s = \pi + u$. Let us construct a stationary contract that implements e in every period and thus is optimal. Our goal is to show that incentives provided through variations in continuation payoffs $\pi(a)$ and $u(a)$ can also be provide via changes in the discretionary payments. Thus, there would be no need to change the continuation equilibrium. Define stationary discretionary bonuses:

$$(A1) \quad \dot{b}(a) \equiv b(a) + p \frac{\delta}{1-\delta} u(a) - p \frac{\delta}{1-\delta} u \text{ for all } a.$$

After substituting (A1) into (10) and rearranging, we can define the fixed payment,

$$(A2) \quad \dot{w}^m = \frac{1-\delta}{1-\delta p} u - \frac{\delta-\delta p}{1-\delta} \tilde{u} - E_a[\dot{b}(a) | e] + c(e).$$

This is the level of fixed payment that will guarantee an expect per-period utility equal to u .

Therefore, we have the stationary contract $(\dot{w}^m, 0, \dot{b}(a), e, \pi, u)$, where

$$u \equiv \frac{1-\delta}{1-\delta p} E_a[\dot{w}^m + \dot{b}(a) - c(e) | e] + \frac{\delta-\delta p}{1-\delta p} \tilde{u} \text{ and}$$

$$\pi \equiv \frac{1-\delta}{1-\delta p} E_a[a - \dot{w}^m - \dot{b}(a) | e] + \frac{\delta-\delta p}{1-\delta p} \bar{\pi}.$$

If the principal deviates from the offer specified above and/or the parties renege on the discretionary payment, then the parties revert to a static equilibrium where $e=0$.

To see whether this stationary contract is self-enforcing, note that, by assumption, $u \geq \bar{u}$ and $\pi \geq \bar{\pi}$. We can rearrange (A1) to get:

$$(A3) \quad \dot{b}(a) + p \frac{\delta}{1-\delta} u \equiv b(a) + p \frac{\delta}{1-\delta} u(a) \quad \forall a \in A.$$

Substituting (A3) into (iv*) produces $\dot{b}(a) + p \frac{\delta}{1-\delta} u \geq p \frac{\delta}{1-\delta} \tilde{u}$ for all a and this means that the discretionary payment constraint for the agent is satisfied in the stationary contract. Additionally, we can verify by substituting (A3) into the incentive compatibility constraint (ii*) that the agent will choose the same effort level as he would under the original contract. Moreover, by Levin's (2003) Lemma 1, we can use the relationship $u + \pi \equiv u(a) + \pi(a)$ for all a , we have (from (A3)),

$$(A4) -\dot{b}(a) + p \frac{\delta}{1-\delta} \pi \equiv -b(a) + p \frac{\delta}{1-\delta} \pi(a) \quad \forall a \in A$$

Substituting (A4) into (iii*) produces $-\dot{b}(a) + p \frac{\delta}{1-\delta} \pi \geq p \frac{\delta}{1-\delta} \pi_{-Glx_G}$ for all a , which means that the discretionary payment constraint for the principal is satisfied under the stationary contract. Finally, note that since the stationary contract repeats in every period, the continuation contract is self-enforcing. Therefore, the stationary contract $(\dot{w}^m, 0, \dot{b}(a), e, \pi, u)$ is self-enforcing.

Proof of Remark 1: Suppose that there exists a self-enforcing stationary contract that promises the agent $u = \bar{u}$ and implements some $e > 0$. Self enforcement implies that, $\forall a \in A$, the discretionary payment constraints for both parties should be satisfied; that is, we have:

$$-b(a) + p \frac{\delta}{1-\delta} \pi \geq p \frac{\delta}{1-\delta} \pi \quad \text{and} \quad b(a) + p \frac{\delta}{1-\delta} \bar{u} \geq p \frac{\delta}{1-\delta} \bar{u} \quad \text{for all } a.$$

From these two constraints, we can see that they are simultaneously satisfied only when $b(a) = 0$ $\forall a \in A$. Using the incentive compatibility constraint, it is straightforward to verify that when $b(a) = 0$, then the agent will choose $e = 0$, which is a contradiction.

Proof of Remark 2: Since the severance payment is zero ($w^s = 0$), we know from the discretionary payment constraint for the principal that $-\sup_a b(a) + p \frac{\delta}{1-\delta} \pi \geq p \frac{\delta}{1-\delta} \pi$, which is satisfied if and only if $\sup_a b(a) \leq 0$. Also, we conclude from the agent's discretionary

payment constraint that $\inf_a b(a) + p \frac{\delta}{1-\delta} u \geq p \frac{\delta}{1-\delta} \tilde{u}$ which is equivalent to

$$\inf_a b(a) \geq -\frac{p\delta}{1-\delta} (u - \tilde{u}).$$

Proof of Proposition 2: A stationary contract $(w^m, w^s, b(a), e, \pi, u)$, where $w^s > 0$, is self-enforcing, if and only if the following constraints are satisfied:

$$(A5) \quad \pi = \frac{1-\delta}{1-\delta p} \left\{ \int (a - b(a)) f(a|e) da - w^m \right\} + \frac{\delta - \delta p}{1-\delta p} (\bar{\pi} - (1-\delta)w^s) \geq \bar{\pi}$$

(Principal's Participation Constraint)

$$(A6) \quad u = \frac{1-\delta}{1-\delta p} \left\{ w^m + \int b(a) f(a|e) da - c(e) \right\} + \frac{\delta - \delta p}{1-\delta p} (\tilde{u} + (1-\delta)w^s) \geq \bar{u} \quad (\text{Agent's Participation Constraint})$$

$$(A7) \quad e = \arg \max_{\tilde{e}} \int b(a) f(a|\tilde{e}) da - c(\tilde{e}) \quad (\text{IC})$$

$$(A8) \quad -\sup_a b(a) + p \frac{\delta}{1-\delta} \pi \geq p \left\{ \frac{\delta}{1-\delta} \pi - \delta w^s \right\} \quad (\text{Discretionary payment constraint for P})$$

$$(A9) \quad \inf_a b(a) + p \frac{\delta}{1-\delta} u \geq p \left\{ \frac{\delta}{1-\delta} \tilde{u} + \delta w^s \right\} \quad (\text{Discretionary payment constraint for A})$$

We will now construct a self enforcing stationary contract without a severance payment that implements the same e and delivers the same expected per-period payoffs. Adding (subtracting) $\delta p w^s$ to (from) both sides of discretionary payment constraints for P (A) and

setting $\dot{b}(a) = b(a) - \delta p w^s$ for all a yields $-\sup_a \dot{b}(a) + p \frac{\delta}{1-\delta} \pi \geq p \frac{\delta}{1-\delta} \pi$ and

$\inf_a \dot{b}(a) + p \frac{\delta}{1-\delta} u \geq p \frac{\delta}{1-\delta} \tilde{u}$. Thus, the discretionary payment constraints are satisfied for the

new bonus schedule $\dot{b}(a)$. Now define a new base payment, $\dot{w}^m = w^m + \delta w^s$. Solving for w^m and substituting $w^m = \dot{w}^m - \delta w^s$ and $b(a) = \dot{b}(a) + \delta p w^s$ into (A5)-(A7) produces:

$$(A10) \quad \pi = \frac{1-\delta}{1-\delta p} \left\{ \int (\dot{b}(a) + \delta p w^s) f(a|e) da - \dot{w}^m \right\} + \frac{\delta - \delta p}{1-\delta p} \pi \geq \bar{\pi},$$

$$(A11) \quad u = \frac{1-\delta}{1-\delta p} \left\{ \dot{w}^m + \int \dot{b}(a) f(a|e) da - c(e) \right\} + \frac{\delta - \delta p}{1-\delta p} \tilde{u} \geq \bar{u}, \text{ and}$$

$$(A12) \quad e \in \arg \max_{\tilde{e}} \int \dot{b}(a) f(a|\tilde{e}) da - c(\tilde{e}) + \delta p w^s.$$

Therefore, a contract that replaces w^m and $b(a)$ with \dot{w}^m and $\dot{b}(a)$ satisfies all constraints for self-enforcement. Thus, the self-enforcing stationary contract $(w^m + \delta w^s, 0, b(a) - \delta p w^s, e, \pi, u)$ implements the same effort e and gives both parties the same expected per-period payoffs.

Proof of Proposition 3: The optimal contract characterized in proposition 3 can be derived by solving the principal's contract design problem. Denoting the multipliers of the agent's participation and incentive compatibility constraints by λ_1 and λ_2 , respectively, and the

multipliers of the first and second inequalities in the double-sided boundary constraints by $\mu(a)$ and $\psi(a)$, respectively, we can write the Lagrangian L of (P2) as:

$$L(u, e, b(a), \lambda_1, \lambda_2, \mu(a), \psi(a)) = \frac{1-\delta}{1-\delta p} \left\{ \int af(a|e)da - c(e) \right\} + \frac{\delta - \delta p}{1-\delta p} \bar{\pi} - u + \frac{\delta - \delta p}{1-\delta p} \tilde{u} \\ + \lambda_1 [u - \bar{u}] + \lambda_2 \left[\int b(a) f_e(a|e) da - c_e(e) \right] - \int \mu(a) b(a) da + \int \psi(a) \left\{ b(a) + \frac{p\delta}{1-\delta} (u - \tilde{u}) \right\} da$$

The first-order conditions are:

$$(A13) \quad \frac{dL}{de} = \frac{1-\delta}{1-\delta p} \left\{ \int af_e(a|e)da - c_e(e) \right\} + \lambda_2 \left[\int b(a) f_{ee}(a|e) da - c_{ee}(e) \right] = 0$$

$$(A14) \quad \frac{dL}{du} = -1 + \lambda_1 + \frac{p\delta}{1-\delta} \int \psi(a) da = 0$$

$$(A15) \quad \frac{dL}{db(a)} = \lambda_2 f_e(a|e) - \mu(a) + \psi(a) = 0 \text{ for } \forall a \in A$$

$$(A16) \quad \lambda_1 [u - \bar{u}] = 0; \lambda_1 \geq 0; u - \bar{u} \geq 0$$

$$(A17) \quad -\mu(a)b(a) = 0; \mu(a) \geq 0; b(a) \leq 0 \text{ for } \forall a \in A$$

$$(A18) \quad \psi(a) \left[b(a) + \frac{p\delta}{1-\delta} (u - \tilde{u}) \right] = 0; \psi(a) \geq 0; b(a) + \frac{p\delta}{1-\delta} (u - \tilde{u}) \geq 0 \text{ for } \forall a \in A.$$

We will now establish the optimal contractual forms outlined in Proposition 3 by checking all Kuhn Tucker cases.

We begin by examining the case when $\lambda_1 = 0$ (the agent's participation constraint does not bind). This is a sufficient condition for the bonus schedule to take the values, $b(a)=0$ or

$$b(a) = -\frac{p\delta}{1-\delta} (u - \tilde{u}) \text{ for some } a \in A. \text{ To see this, note from (A14) that } \int \psi(a) da = \frac{1-\delta}{p\delta} > 0 \text{ so}$$

$$\text{that } \psi(a) \text{ must be positive for some } a \in A. \text{ Therefore, (A18) implies that } b(a) = -\frac{p\delta}{1-\delta} (u - \tilde{u})$$

for some $a \in A$. Integrating (A15) over a yields:

$$(A19) \quad \lambda_2 \int f_e(a|e)da = \int \mu(a)da - \int \psi(a)da$$

Since $\int f_e(a|e)da = 0$, we have $\int \mu(a)da - \int \psi(a)da = 0$ so that $\int \mu(a)da = \frac{1-\delta}{p\delta} > 0$. Hence,

$\mu(a)$ must be positive for some $a \in A$. Therefore, $b(a)=0$ for some $a \in A$.

Now suppose $\lambda_2 = 0$ in addition to $\lambda_1 = 0$.¹⁸ In addition to the conditions outlined in the previous paragraph, we also have, from (A13), that,

$$(A20) \quad \int af_e(a|e)da - c_e(e) = 0.$$

The effort level that is consistent with (A20) is equal to the first best effort level, e^{FB} , since

(A20) is the first-order condition of the following objective function,

$$(A21) \quad \max_e \frac{1-\delta}{1-\delta p} \left\{ \int af_e(a|e)da - c(e) \right\} + \frac{\delta - \delta p}{1-\delta p} \bar{\pi} + \frac{\delta - \delta p}{1-\delta p} \tilde{u}$$

which maximizes the sum of both parties' expected per-period payoffs. However, we have from

(A15) that $-\mu(a) + \psi(a) = 0 \quad \forall a \in A$, which implies that $\mu(a) = \psi(a) = 0$ since

$\mu(a)$ and $\psi(a)$ cannot be positive simultaneously. But $\mu(a) = \psi(a) = 0 \quad \forall a \in A$ contradicts

$\int \mu(a)da = \int \psi(a)da = \frac{1-\delta}{p\delta} > 0$ which is implied by $\lambda_1 = 0$. Therefore, the case where $\lambda_1 = 0$

and $\lambda_2 = 0$ can be eliminated from consideration.

Now suppose $\lambda_2 > 0$ in addition to $\lambda_1 = 0$. Since $\int b(a)f_{ee}(a|e)da - c_{ee}(e) < 0$ should be satisfied when evaluated at an optimal e , we know from (A13) that $\int af_e(a|e)da - c_e(e) > 0$ at an optimal e . Moreover, by the assumptions of MRLP, CDFC, and the convexity of the effort

¹⁸ If the Lagrangian multiplier of any equality constraint (i.e., the incentive compatibility constraint) is zero in an optimal solution, it means that the maximized value of objective function (i.e., the principal's expected per-period payoff) is not affected by such a constraint. That is, the maximized value of the objective function does not change if such a constraint is excluded from the optimization problem. In the latter part of this proof, one can see that when the first best effort is implemented in an optimal contract, λ_2 is zero.

cost function, $\int af(a|e)da - c(e)$ must be concave so that $e < e^{FB}$. We also examine three sub-cases where either $\mu(a) > 0$ and $\psi(a) = 0$, $\mu(a) = 0$ and $\psi(a) > 0$, or $\mu(a) = 0$ and $\psi(a) = 0$.

From (A15), if $\mu(a) > 0$ and $\psi(a) = 0$ for some $a \in A$ then $f_e(a|e) > 0$ and it follows from (A17) that $b(a) = 0$. If $\mu(a) = 0$ and $\psi(a) > 0$ for some $a \in A$, then we have from (A15)

that $f_e(a|e) < 0$ and it follows from (A18) that $b(a) = -\frac{p\delta}{1-\delta}(u - \tilde{u})$. If $\mu(a) = 0$ and

$\psi(a) = 0$ for some $a \in A$, then it follows from (A15) that $f_e(a|e) = 0$. Hence, $b(a)$ can be any

value between 0 and $-\frac{p\delta}{1-\delta}(u - \tilde{u})$ but we set it to zero arbitrarily. Now let \hat{a} be such that

$f_e(\hat{a}|e)/f(\hat{a}|e) = 0$. Since $f_e(a|e)/f(a|e)$ is increasing in a by MLRP, $f_e(a|e) > 0$ for all

$a > \hat{a}$ and $f_e(a|e) < 0$ for all $a < \hat{a}$. Therefore, the bonus schedule is “one-step” in that

$b(a) = 0$ for all $a \geq \hat{a}$, $b(a) = -\frac{p\delta}{1-\delta}(u - \tilde{u})$ for all $a < \hat{a}$. This establishes that whenever the

agent’s participation constraint does not bind, the optimal contract is a one-step contract, and

implements some effort level $e < e^{FB}$.

Finally, we check the case where $\lambda_2 < 0$ in addition to $\lambda_1 = 0$.

Since $\int b(a)f_{ee}(a|e)da - c_{ee}(e) < 0$ at an optimal e , we know from (A13)

that $\int af_e(a|e)da - c_e(e) < 0$ at an optimal e , which implies that $e > e^{FB}$. Using a sequence of

steps similar to those used in the case where $\lambda_1 = 0$ and $\lambda_2 > 0$, we can derive the bonus

schedule to be $b(a) = -\frac{p\delta}{1-\delta}(u - \tilde{u})$ for all $a > \hat{a}$ and $b(a) = 0$ for all $a \leq \hat{a}$. However, under

this bonus schedule, any positive effort level cannot satisfy the incentive compatibility constraint

since the first term of (ii) in (P2) is always negative and $c_e(e)$ is positive for all $e > 0$. We therefore rule out this case.

To summarize, we have shown part (i) of Proposition 3 to be true by analyzing all cases involving $\lambda_1 = 0$ (a contract promises u greater than \bar{u}). We will now establish part (ii) of the proposition by focusing on all cases where $\lambda_1 > 0$ (the agent's participation constraint binds).

Suppose that $\lambda_1 > 0$. If $\lambda_1 > 1$, then (A14) implies that $\frac{p\delta}{1-\delta} \int \psi(a) da = 1 - \lambda_1 < 0$.

However, this is impossible, since $\psi(a)$ should be non-negative for all a , which implies that

$\frac{p\delta}{1-\delta} \int \psi(a) da$ should be non-negative. Therefore, this case is ruled out.

On the other hand, if $0 < \lambda_1 < 1$, then (A14) implies that $\int \psi(a) da = (1 - \lambda_1) \frac{1-\delta}{p\delta} > 0$.

Following the logic used to analyze the case where $\lambda_1 = 0$, $\psi(a)$ must be positive and

$b(a) = -\frac{p\delta}{1-\delta} (u - \tilde{u})$ for at least one $a \in A$. Also, we know from (A15) and (A19)

that $\int \mu(a) da - \int \psi(a) da = 0$, which implies that $\int \mu(a) da > 0$. Therefore, $\mu(a) > 0$ which implies

that $b(a) = 0$ for at least one $a \in A$. Following the same logic as that used for the case where

$\lambda_1 = 0$, we can exclude the case where $\lambda_2 \leq 0$, and show that, when $\lambda_2 > 0$, some $e < e^{FB}$ can

be implemented by the one-step bonus schedule where $b(a) = 0$ for all $a \geq \hat{a}$ and

$b(a) = -\frac{p\delta}{1-\delta} (\bar{u} - \tilde{u})$ for all $a < \hat{a}$. This establishes the optimal contract when the participation

constraint is binding which proves part (ii) of proposition 3.

To establish part (iii) of proposition 3, consider the case where $\lambda_1 = 1$. We have from

$$(A14) \text{ that } \frac{p\delta}{1-\delta} \int \psi(a) da = 0, \text{ which implies that } \psi(a) = 0 \quad \forall a \in A. \text{ By (A19), } \int \mu(a) da = 0,$$

which suggests that $\mu(a) = 0 \quad \forall a \in A$. Therefore, $b(a)$ might be any value between 0 and

$$-\frac{p\delta}{1-\delta}(\bar{u} - \tilde{u}) \quad \forall a \in A. \text{ We have from (A15) that } \lambda_2 f_e(a|e) = 0 \quad \forall a \in A, \text{ which implies}$$

that $\lambda_2 = 0$. Therefore, $e = e^{FB}$ is implied by (A13). Moreover, any monotone bonus schedule

satisfying the incentive compatibility constraint $\int b(a) f_e(a|e^{FB}) da - c_e(e^{FB}) = 0$ and

$$-\frac{p\delta}{1-\delta}(\bar{u} - \tilde{u}) \leq b(a) \leq 0 \quad \forall a \in A \text{ can be a solution. The monotonicity of bonus schedule}$$

guarantees strict concavity of $\int b(a) f(a|e) da - c(e)$ in the incentive compatibility constraint in

(P1). To show this, using integration by parts, we can rewrite $\int b(a) f(a|e) da - c(e)$ as follows:

$$(A22) \quad \int b(a) f(a|e) da - c(e) = [b(a) F(a|e)]_{\underline{a}}^{\bar{a}} - \int_{\underline{a}}^{\bar{a}} \frac{db(a)}{da} F(a|e) da - c(e) \\ = b(\bar{a}) - \int_{\underline{a}}^{\bar{a}} \frac{db(a)}{da} F(a|e) da - c(e)$$

where the second line uses the fact $F(\underline{a}|e) = 0$ and $F(\bar{a}|e) = 1 \quad \forall e \in E$. Since $c_{ee}(e) > 0$ and

$F_{ee}(a|e) > 0$ by CDFC, (A22) is strictly concave so long as $\frac{db(a)}{da} \geq 0$. By this property, we

know that the level of effort that satisfies $\int b(a) f_e(a|e) da - c_e(e) = 0$ in (P2) is globally optimal in

the agent's optimization problem. In addition, Levin (1999) shows in his proof of his

Proposition 1.4 that if a non-monotone bonus schedule yields a certain level of surplus, there

always exists a monotone bonus schedule that yields at least as much surplus. Therefore, in this

specific case, if a non-monotone bonus schedule can implement e^{FB} , there exists a monotone

bonus schedule that implements e^{FB} . Finally, we can also show that a one-step bonus schedule can also qualify as a solution under certain conditions. When $b(a)$ is set to zero for all $a \geq \hat{a}$ and $b(a)$ is denoted by \underline{b} for all $a < \hat{a}$ in the one-step bonus schedule, the incentive compatibility

constraint, $\underline{b} \int_{\underline{a}}^{\hat{a}} f_e(a | e^{FB}) da + 0 \cdot \int_{\hat{a}}^{\bar{a}} f_e(a | e^{FB}) da - c_e(e^{FB}) = 0$ can be rewritten as

$$\underline{b} F_e(\hat{a} | e^{FB}) - c_e(e^{FB}) = 0. \text{ Then, we have } b(a) = \underline{b} = \frac{c_e(e^{FB})}{F_e(\hat{a} | e^{FB})}, \forall a < \hat{a}. \text{ If } \frac{c_e(e^{FB})}{F_e(\hat{a} | e^{FB})} \geq$$

$$-\frac{p\delta}{1-\delta}(\bar{u} - \tilde{u}), \text{ then this can be an optimal bonus schedule. This establishes part (iii) of}$$

proposition 3.

Q.E.D.

Proof of Proposition 4: The contract $(w^m, 0, b(a), e, \pi, u)$ is derived by solving the principal's maximization problem (P1). When any positive severance payment w^s is imposed on the contract by regulation, the principal faces the new maximization problem (p3)¹⁹,

$$(P3) \quad \max_{\hat{w}^m, \hat{b}(a), \hat{e}} \hat{\pi} = \frac{1-\delta}{1-\delta p} \left\{ \int (a - \hat{b}(a)) f(a | \hat{e}) da - \hat{w}^m \right\} + \frac{\delta - \delta p}{1-\delta p} (\bar{\pi} - (1-\delta)w^s)$$

$$\text{s.t. } \hat{u} = \frac{1-\delta}{1-\delta p} \left\{ \hat{w}^m + \int \hat{b}(a) f(a | \hat{e}) da - c(\hat{e}) \right\} + \frac{\delta - \delta p}{1-\delta p} (\tilde{u} + (1-\delta)w^s) \geq \bar{u}$$

(Participation Constraint)

$$\hat{e} = \arg \max_{\tilde{e}} \int b(a) f(a | \tilde{e}) da - c(\tilde{e}) \quad (IC)$$

¹⁹ The principal's objective function and the agent's participation constraint can be obtained the following recursive equation under the positive severance payments:

$$\hat{u} \equiv (1-\delta) \left\{ \hat{w}^m + \int \hat{b}(a) f(a | \hat{e}) da - c(\hat{e}) \right\} + \delta \left\{ p \hat{u} + (1-p)(\tilde{u} + (1-\delta)w^s) \right\} \text{ and}$$

$$\hat{\pi} \equiv (1-\delta) \left\{ \int (a - \hat{b}(a)) f(a | \hat{e}) da - \hat{w}^m \right\} + \delta \left\{ p \hat{\pi} + (1-p)(\bar{\pi} - (1-\delta)w^s) \right\}.$$

Discretionary payment constraints for both parties under the positive severance payments can be obtained by deleting common terms from:

$$-\hat{b}(a) + p \frac{\delta}{1-\delta} \hat{\pi} + (1-p) \left\{ \frac{\delta}{1-\delta} \bar{\pi} - \delta w^s \right\} \geq p \left\{ \frac{\delta}{1-\delta} \hat{\pi} - \delta w^s \right\} + (1-p) \left\{ \frac{\delta}{1-\delta} \bar{\pi} - \delta w^s \right\} \text{ and}$$

$$\hat{b}(a) + p \frac{\delta}{1-\delta} \hat{u} + (1-p) \left\{ \frac{\delta}{1-\delta} \tilde{u} + \delta w^s \right\} \geq p \left\{ \frac{\delta}{1-\delta} \tilde{u} + \delta w^s \right\} + (1-p) \left\{ \frac{\delta}{1-\delta} \tilde{u} + \delta w^s \right\}.$$

$$-\sup_a \hat{b}(a) + p \frac{\delta}{1-\delta} \hat{\pi} \geq p \left\{ \frac{\delta}{1-\delta} \hat{\pi} - \delta w^s \right\} \quad (\text{Discretionary payment constraint for P})$$

$$\inf_a \hat{b}(a) + p \frac{\delta}{1-\delta} \hat{u} \geq p \left\{ \frac{\delta}{1-\delta} \tilde{u} + \delta w^s \right\} \quad (\text{Discretionary payment constraint for A})$$

where we use the notation $\hat{w}^m, \hat{b}(a)$, and $\hat{e}, \hat{\pi}$ and \hat{u} to distinguish (P3) from (P1). We will also denote an optimal contract from (P3) by $(\hat{w}^m, w^s, \hat{b}(a), \hat{e}, \hat{\pi}, \hat{u})$.

(P3) can be rewritten as (P3'),

$$(P3') \quad \max_{\hat{w}^m, \hat{b}(a), \hat{e}} \hat{\pi} = \frac{1-\delta}{1-\delta p} \left\{ \int (a - \hat{b}(a) + \delta p w^s) f(a | \hat{e}) da - \hat{w}^m - \delta w^s \right\} + \frac{\delta - \delta p}{1-\delta p} \bar{\pi}$$

$$\text{s.t. } \hat{u} = \frac{1-\delta}{1-\delta p} \left\{ \hat{w}^m + \delta w^s + \int (\hat{b}(a) - \delta p w^s) f(a | \hat{e}) da - c(\hat{e}) \right\} + \frac{\delta - \delta p}{1-\delta p} \tilde{u} \geq \bar{u}$$

(Participation Constraint)

$$\hat{e} = \arg \max_{\tilde{e}} \int \hat{b}(a) f(a | \tilde{e}) da - c(\tilde{e}) \quad (\text{IC})$$

$$-\sup_a \hat{b}(a) + \delta p w^s + p \frac{\delta}{1-\delta} \hat{\pi} \geq p \frac{\delta}{1-\delta} \hat{\pi} \quad (\text{Discretionary payment constraint for P})$$

$$\inf_a \hat{b}(a) - \delta p w^s + p \frac{\delta}{1-\delta} \hat{u} \geq p \frac{\delta}{1-\delta} \tilde{u} \quad (\text{Discretionary payment constraint for A})$$

Since (P3) and (P3') are equivalent, an optimal contract from (P3') is also $(\hat{w}^m, w^s, \hat{b}(a), \hat{e}, \hat{\pi}, \hat{u})$.

We define $\hat{\hat{b}}(a) \equiv \hat{b}(a) - \delta p w^s \quad \forall a \in A$ and $\hat{\hat{w}}^m \equiv \hat{w}^m + \delta w^s$. Then, $(\hat{w}^m, w^s, \hat{b}(a), \hat{e}, \hat{\pi}, \hat{u})$ can be rewritten as $(\hat{\hat{w}}^m - \delta w^s, w^s, \hat{\hat{b}}(a) + \delta p w^s, \hat{e}, \hat{\pi}, \hat{u})$. Moreover, (P3') can be rewritten as:

$$(P3'') \quad \max_{\hat{\hat{w}}^m, \hat{\hat{b}}(a), \hat{e}} \hat{\pi} = \frac{1-\delta}{1-\delta p} \left\{ \int (a - \hat{\hat{b}}(a)) f(a | \hat{e}) da - \hat{\hat{w}}^m \right\} + \frac{\delta - \delta p}{1-\delta p} \bar{\pi}$$

$$\text{s.t. } \hat{u} = \frac{1-\delta}{1-\delta p} \left\{ \hat{\hat{w}}^m + \int \hat{\hat{b}}(a) f(a | \hat{e}) da - c(\hat{e}) \right\} + \frac{\delta - \delta p}{1-\delta p} \tilde{u} \geq \bar{u} \quad (\text{Participation Constraint})$$

$$\hat{e} = \arg \max_{\tilde{e}} \int \hat{\hat{b}}(a) f(a | \tilde{e}) da - c(\tilde{e}) \quad (\text{IC})^{20}$$

$$-\sup_a \hat{\hat{b}}(a) + p \frac{\delta}{1-\delta} \hat{\pi} \geq p \frac{\delta}{1-\delta} \hat{\pi} \quad (\text{Discretionary payment constraint for P})$$

²⁰ We omit the term $\delta p w^s$ since it is constant and it does not affect the agent's choice of effort.

$$\inf_a \hat{b}(a) + p \frac{\delta}{1-\delta} \hat{u} \geq p \frac{\delta}{1-\delta} \tilde{u} \quad (\text{Discretionary payment constraint for A})$$

Since (P3'') is equivalent to (P1), we know that $b(a) = \hat{b}(a) \forall a \in A$, $w^m = \hat{w}^m$, $e = \hat{e}$,

$\pi = \hat{\pi}$, and $u = \hat{u}$. Thus, $(\hat{w}^m - \delta w^s, w^s, \hat{b}(a) + \delta p w^s, \hat{e}, \hat{\pi}, \hat{u})$, which represents an optimal contract from (P3), is equivalent to $(w^m - \delta w^s, w^s, b(a) + \delta p w^s, e, \pi, u)$.

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