# Asymmetric information and the termination of contracts in agencies*

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*Abstract.* I consider an agency model in which an agent, having acquired private post-contract predecision information, is allowed to breach the contract by paying the principal predetermined damages. The relationship of this model to the standard no-breach agency model is demonstrated and I argue that simplifying the analysis by restricting attention to no-breach models may yield incorrect conclusions. The shape of an optimal breach contract is then discussed and it is demonstrated that an optimal contract cannot include a severance payment. Next, I consider an alternative contractual arrangement whereby the agent may purchase access to private information prior to contracting. In this case, all the advantages of the breach institution are maintained, while possible exogenous (legal) restrictions on damage payments are avoided. The paper concludes by suggesting implications the study may have for legal research on contracts and judicial systems.

*Résumé.* L'auteur étudie un modèle de relation de mandataire dans lequel le mandataire, ayant acquis de l'information privée après la signature du contrat et avant la prise de décision, est en droit de mettre fin au contrat en réglant au mandant les dommages établis au préalable. L'auteur démontre la relation entre ce modèle et le modèle standard sans convention de rupture et soutient que le fait de simplifier l'analyse en se bornant à étudier les modèles sans convention de rupture peut mener à des conclusions inexactes. La forme du contrat optimal comportant une convention de rupture est ensuite traitée et l'auteur démontre qu'un contrat optimal ne peut inclure d'indemnité de rupture. Il analyse ensuite une disposition contractuelle de rechange selon laquelle le mandataire peut acheter l'accès à de l'information privée avant de s'engager. Dans ce cas, tous les avantages de la convention de rupture sont maintenus, alors que les restrictions exogènes (légales) possibles relativement au règlement de dommages sont évitées. L'auteur conclut en donnant une idée des conséquences que pourrait avoir cette étude pour la recherche en droit portant sur les contrats et les systèmes judiciaires.

## Introduction

Agency theory has provided important insights about optimal contractual arrangements. In its simplest form, a principal-agent relationship can be sketched as follows. A principal (e.g., an owner of an enterprise) delegates control over

* I am grateful to Stefan Reichelstein for many helpful discussions and comments. I also thank the participants of seminars held at various universities, two anonymous referees, A. Beja, J. Demski, R. Dye, H. Falk, J. Greenberg, M. McNichols, J. Patell, S. Penman, M. Scholes, Y. Suh and in particular Mark Wolfson, for their suggestions.

certain operations to an agent (e.g., a manager) who privately takes a personally costly action. The agent's action, together with some exogenous random factors, determines a publicly observed outcome. Subsequently, the agent's compensation is based on that observable outcome and any other possible monitors of the agent's action.

One extension of the basic agency model, particularly popular in accounting literature, incorporates asymmetric predecision information into the model.[1] This extension seems reasonable since, once engaged in a contract, an agent usually learns something about the environment or about the difficulty of his task. Accountants find this extension appealing because it offers a useful framework to address issues of monitoring, auditing, and communication. Examples of agency models with private predecision information include Baiman and Evans (1983), Baron (1982), Baron and Besanko (1987), Christensen (1981, 1982), Demski and Sappington (1986, 1987), Gjesdal (1981), Kanodia (1985), Lambert (1986), Melumad and Reichelstein (1987, 1989), Melumad and Shibano (1988), Penno (1983, 1987), Sappington (1983) and Suh (1988).

Most studies involving predecision information have assumed that the principal always wishes to hire the agent, and that adequate enforcement mechanisms exist to prevent the agent from quitting the contract (e.g., the feasibility of a sufficiently large penalty).[2] In many cases, however, enforcement mechanisms are constrained; for example, the principal may not be able to "penalize" an agent who has not performed because of the latter's limited liability. Sappington (1983) is the first to investigate how an agent's limited liability affects optimal contractual arrangements. Sappington shows that when (1) the principal and the agent are risk neutral, and (2) the agent possesses perfect private information (i.e., the agent knows with certainty the outcome resulting from his action choice), then the optimal contract induces (socially) inefficient action choices. This is in contrast to the case of unlimited liability wherein the optimal contract is the first-best contract.

When enforcement mechanisms are not constrained and, in some instances, when they are constrained, the principal or the privately informed agent may prefer to call off their contractual relationship when the latter observes certain private signals.

These observations have motivated the present study of an agency model in which the agent is permitted to quit (breach) the contract.[3] Since the breach

1 For a discussion and a survey of informational issues in agencies see, respectively, Demski (1980, pp. 81–89) and Baiman (1982).

2 An exception is Baron's (1982) precontract information model, where the probability of offering an agent a contract is endogenously determined.

3 The term "breach of contract" is used in this study to describe the act of quitting a contractual arrangement. This may seem an inappropriate term since "breach" has a negative connotation, while in our breach model, not only do both parties wish sometimes to have the contract breached, they even explicitly allow for it in the contract. However, the terms "breach," "efficient breach," and "alternative performance" are used interchangeably in the legal literature to label such a contractual option. The transfer payment accompanying such a breach is usually labeled "agreed damages," or "liquidated damages." (For a summary and discussion see Calamari and Perrilo (1977, pp. 455–474).) For simplicity of expression, the terms "breach" and "damages" are adopted throughout this work.

decision is jointly observable, it could be contracted upon, subject to possible limitations on allowable transfer payments (damages). Thus, the damages paid to the principal in a case of breach would become an integral part of the agent's contract. To make the description of the breach model complete, we must account for the principal's alternative, that is, the expected utility he earns when the agent does not work for him. As demonstrated later, the principal's alternative, in general, affects the solution to the problem.

The following observations and results emerge from the model in the next section. In the third section the breach model is analyzed. First, I establish the relationship between the breach and the no-breach frameworks. As long as the set of possible damage payments remains "economically consistent" (to be defined) with the set of possible compensations, allowing a breach of contract results in a Pareto improvement. Without economic consistency, however, allowing a breach may cause a welfare loss for the principal. Second, it is argued that, irrespective of the welfare relationship between the two frameworks, characterization results for the standard no-breach agency models do not necessarily transfer to the breach framework. Thus, if we simplify the analysis by restricting attention to no-breach models, we may affect the nature of the derived results. Third, the features of an optimal breach contract are discussed and I show that a severance payment cannot be a part of an optimal solution to the breach model.

The possibility of selling the agent access to private information *prior* to contracting is considered in the fourth section. Here it is demonstrated that all the advantages of the breach institution are maintained, while possible exogenous (legal) restrictions on damage payments are avoided.

Some implications this work may have for legal research on judicial systems and contracts is described in the fifth section followed by a discussion and extensions in the concluding section.

## The model

The following is a one-period model of a principal-agent relationship without communication.[4] In this game the principal moves first by offering the agent a contract represented by the pair $(c, s(\cdot))$. The function $s(x)$ is the agent's compensation based on the observed outcome $x$, and $c$ is the amount of damages the agent pays the principal in case of a breach. If the agent signs the contract, he privately observes a signal regarding the likelihood of different possible outcomes. Subsequently, the agent decides either to stay in the contract and take a productive action, or to breach the contract and incur the predetermined damages $c$.

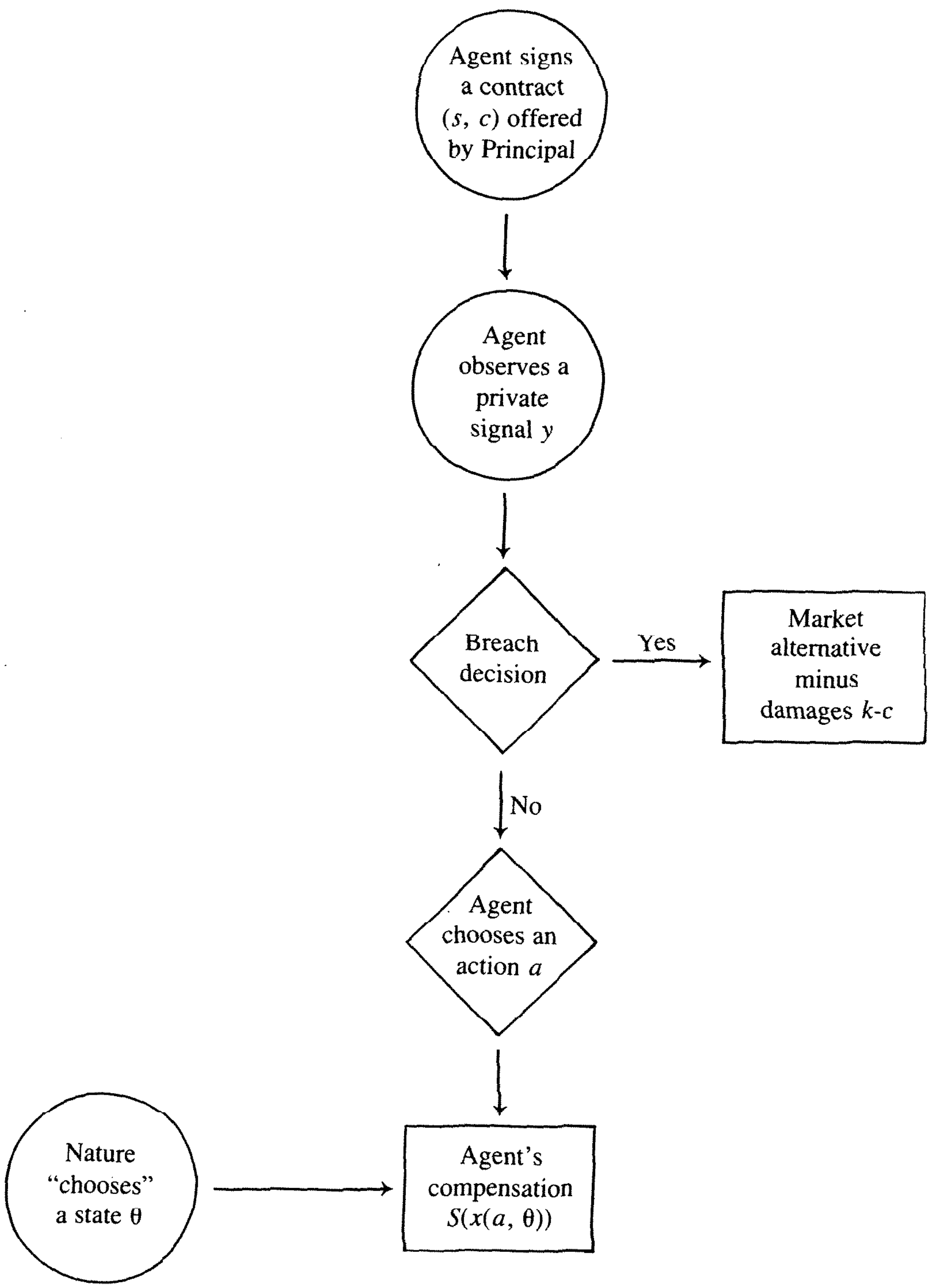
This sequence of events is described in the flow-chart below.

The following assumptions and notations are adopted:

A1. The principal's preferences over wealth are represented by a von Neumann-

4 For simplicity, communication of private information from the agent to the principal is not allowed. As argued in the last section, relaxing this assumption will not qualitatively affect the conclusions.

**Figure 1** Agent's decision making



Morgenstern utility function $G(\cdot)$. $G(\cdot)$ is strictly increasing and (weakly) concave. The principal faces a certain alternative denoted by $r$.[5]

A2. The agent's breach decision set is $B = \{0, 1\}$, where $b = 0$ denotes a no-breach decision, and $b = 1$ denotes a breach decision. The productive action set, $A$, is taken to be an interval on the real line, i.e., $A = [\underline{a}, \bar{a}]$. While the breach decision, $b$, is jointly observable, the productive action choice, $a$, is observable only by the agent. Contracting, therefore, may be contingent upon $b$ but not upon $a$. The agent is risk averse and dislikes taking higher valued actions. His von Neumann-Morgenstern utility is defined over wealth and action and is additively separable in these two arguments; i.e., $H(w, a) = U(w) - V(a)$. The functions $U(\cdot)$ and $V(\cdot)$ are strictly increasing, $U(\cdot)$ is concave, and $V(\cdot)$ is convex. The utility function $H(\cdot, \cdot)$ is scaled such that there is an action $a^0 \in A$ for which $V(a^0) = 0$. The agent faces a certain market alternative, $k$, with a corresponding utility $K = U(k)$; thus, his alternative at the breach decision stage is $U(k - c)$.[6]

A3. The agent's payment as a function of his breach decision and outcome is

$$t(b, x) = \begin{cases} s(x) & \text{for } b = 0 \\ -c & \text{for } b = 1 \end{cases}$$

where $s(x)$ and $c$ are restricted to bounded intervals, that is,

$$s(x) \in S = [\underline{s}, \bar{s}] \ \forall x, \quad \text{and} \quad c \in C = [\underline{c}, \bar{c}].$$

A4. Prior to his breach decision and action choice, the agent (privately) observes a signal $y: y \in Y = [\underline{y}, \bar{y}]$. The prior distribution function of the private information is $L(y)$ with a density function $l(y)$.

A5. The set of possible outcomes is $X \subseteq R$. The conditional distribution function of outcome, induced by the action and the signal, is a convex combination of a discrete and an absolutely continuous probability measure and is denoted by $F(x|a, y)$.[7] An increase in either the action $a$ or the signal $y$ shifts the probability

5 The principal's alternative, $r$, may be thought of as contracting with a second-best agent, renting his capital/enterprise, or being self-employed. In general, this alternative may be stochastic, as well as dependent upon the agent's private information. However, modeling $r$ as a random variable (independent of the agent's information) leaves the results intact, though it requires some modification of proofs. Furthermore, allowing $r$ to be a function of the agent's information does not affect most of the results, as explained in the last section.

6 The agent's alternative, $k$, may be thought of as a second-best employment option or an opportunity cost. As with the principal's alternative, $k$ may be a stochastic function of the agent's private information. Once again, while modeling $k$ as a random variable leaves our results intact, it requires some modification of proofs. Also, allowing $k$ to be a function of the agent's information does not affect most of the results, as explained in the concluding section.

7 In particular, this formulation captures discrete outcome cases (e.g., Grossman and Hart (1983)) as well as continuous outcome cases (e.g., Holmstrom (1979)).

distribution function of $x$ to the right in the sense of first-order stochastic dominance. The support of $F(x|a, y)$ is independent of $a$ and $y$.[8,9]

A6. Solutions to the following two programs exist.[10]

Under the above assumptions, the following two programs describe the principal's optimization problems for the no-breach case (Program 1), and for the case in which a breach of contract is allowed (Program 2).

Let

$$\Phi(\alpha, y) = \int_X U(s(x))\,\mathrm{d}F(x|\alpha, y) - V(\alpha).$$

Then,

Program 1: *Private predecision information: No breach*

$$\max_{a(y),\, s(\cdot)} \int_Y \int_X G(x - s(x))\,\mathrm{d}F(x|a(y), y) l(y)\,\mathrm{d}y$$

subject to

(1) $\int_Y \Phi(a(y), y) l(y)\,\mathrm{d}y \geq K$

(2) $a(y) \in \underset{\alpha \in A}{\operatorname{argmax}}\, \Phi(\alpha, y)\ \forall y \in Y$

(3) $s(x) \in S\ \forall x \in X$.

Let,

$$Y(c) = \{y\colon U(k - c) \leq \Phi(a(y), y)\},$$

$$\bar{Y}(c) = Y \backslash Y(c),$$

$$P(\bar{Y}(c)) = \int_{\bar{Y}(c)} l(y)\,\mathrm{d}y.$$

Then,

Program 2: *Private predecision information and a possible breach*

$$\max_{a(y),\, s(\cdot),\, c} G(r + c) P(\bar{Y}(c)) + \int_{Y(c)} \int_X G(x - s(x))\,\mathrm{d}F(x|a(y), y) l(y)\,\mathrm{d}y$$

8 Therefore, observing $x = 0$ does not imply no agent's performance as in Sappington (1983).

9 When the information set $Y$ includes postcontract predecision information relevant only to the agent (e.g., information regarding his alternative employment opportunities), the requirement that an increase in the signal shifts the probability distribution of outcomes, will not be met for some signals. We note, however, that this assumption is not crucial to establishment of the Lemma, Observations 1 and 2, and Propositions 1, 2 and 3 below. Note also that the standard no-breach models assume private information sets similar to the one of this study.

10 The existence of an optimal (possibly nondifferentiable) $s(\cdot)$ can be established for the case in which the optimization is carried out over the set of bounded and measurable functions on $X$. For a discussion of the issue see Holmstrom (1977).

subject to

(1) $U(k - c)P(\bar{Y}(c)) + \int_{Y(c)} \Phi(a(y), y)l(y)\, dy \gtrsim K$

(2) $a(y) \in \underset{\alpha \in A}{\operatorname{argmax}}\ \Phi(\alpha, y)\ \forall y \in Y(c)$

(3) $c \in C$ and $s(x) \in S\ \forall x \in X$.

In subsequent sections, Program 1 is referred to as the no-breach model while Program 2 is referred to as the breach model. In both programs the first constraint guarantees the agent at least his alternative expected utility. This constraint is termed the Individual Rationality (IR) constraint. The second constraint set reflects the fact that the productive action of the self-interested agent is not observable by the principal, and consequently the agent maximizes his own expected utility. This set of constraints is termed the Incentive Compatibility (IC) constraints. The third constraint is the Feasibility constraint. If the optimal solution is such that either $s(x) = \underline{s}$ for some $x$ (in either the breach or the no-breach model), or $c = \bar{c}$ (in the breach model), we say that there is a binding Limited Liability (LL).

**Analysis**

In this section I argue that simplifying the analysis of agency relationships by restricting attention to no-breach models may yield characterization results and conclusions which are not valid in the breach model. Then the relation between the model and the no-breach models is studied. Finally, I investigate the possibility of severance payments, i.e., a negative transfer $c$. I start with the following useful Lemma.

*Lemma*: In both programs, at least one of the following is true: (i) the Individual Rationality constraint is binding; (ii) the Limited Liability is binding.

*Proof*: We prove the result for Program 2. The proof for Program 1 is a special case of this proof. Assume, to the contrary, that at the optimal $(c, s(x))$ neither the IR constraint nor the LL is binding. It is shown that in such a case that the principal can increase his expected utility by a proper reduction in $s(x)$ while not violating the IR constraint as well as not affecting the set of signals for which a breach occurs. This implies that $s(x)$ cannot be optimal.

Let $\hat{\epsilon} > 0$ denote the difference between the two sides of the IR constraint, $\epsilon'$ satisfy

$$U\left\{\min_{x}\,(s(x))\right\} - U(\underline{s}) = \epsilon',\ \epsilon'' = U(k - c) - U(k - \bar{c})$$

and $\epsilon = \min\{\hat{\epsilon}, \epsilon', \epsilon''\}$. By assumption $(c, s(\cdot))$ is everywhere interior; therefore $\epsilon'$, $\epsilon''$, and as a result, $\epsilon$, are positive.

Consider the pair $(\tilde{c}, \tilde{s}(\cdot))$, where $\tilde{c} = k - U^{-1}\{U(k - c) - \epsilon\}$, and $\tilde{s}(x) =$

$U^{-1}\{U(s(x)) - \epsilon\}\ \forall x$. This pair is feasible by construction. Let

$$\Phi(\alpha, y) = \int_X U(s(x))\, \mathrm{d}F(x|\alpha, y) - V(\alpha)$$

and

$$\tilde{\Phi}(\alpha, y) = \int_X U(\tilde{s}(x))\, \mathrm{d}F(x|\alpha, y) - V(\alpha).$$

Observe that $\tilde{\Phi}(\alpha, y) = \Phi(\alpha, y) - \epsilon$, which implies that

$$\operatorname*{argmax}_{\alpha \in A} \tilde{\Phi}(\alpha, y) = \operatorname*{argmax}_{\alpha \in A} \Phi(\alpha, y). \tag{1}$$

Therefore

$$\tilde{\Phi}(a(y), y) = \Phi(a(y), y) - \epsilon. \tag{2}$$

Also note

$$U(k - \tilde{c}) = U(k - c) - \epsilon. \tag{3}$$

Equations (2) and (3) imply that $\tilde{\Phi}(a(y), y) = U(k - \tilde{c})$ if and only if $\Phi(a(y), y) = U(k - c)$ and therefore $Y(\tilde{c}) = Y(c)$. Thus, the agent's expected utility with $(\tilde{c}, \tilde{s}(\cdot))$ is

$$U(k - \tilde{c})P(\bar{Y}(\tilde{c})) + \int_{Y(\tilde{c})} \tilde{\Phi}(a(y), y)l(y)\, \mathrm{d}y$$
$$= U(k - c)P(\bar{Y}(c)) + \int_{Y(c)} \Phi(a(y), y)l(y)\, \mathrm{d}y - \epsilon \geq K,$$

while the principal's expected utility is greater with $(\tilde{c}, \tilde{s}(\cdot))$ than with $(c, s(\cdot))$. This contradicts the assumed optimality of $(c, s(\cdot))$. Q.E.D.

An immediate implication of the Lemma is the following.

*Observation 1*: If in Program 2 the Limited Liability is not binding and the breach option is exercised for some $y$ (i.e., $Y(c) \neq Y$), then the compensation component of the optimal solution to Program 2 must be different from the optimal compensation in Program 1.

*Proof*: Denote by $s(x)$ the optimal compensation in Program 1 and suppose that it is also optimal in Program 2. Since $Y(c) \neq Y$,

$$U(k - c) > \int_{\bar{Y}(c)} \Phi(a(y), y)l(y)\, \mathrm{d}y$$

implying that the IR constraint in Program 2 is not binding, contradicting the Lemma. Thus, $s(x)$ cannot be optimal in Program 2. Q.E.D.

Observation 1 suggests that characterization results for standard Program 1-type agency models do not necessarily transfer to the often more applicable breach framework. Therefore, simplifying the analysis by restricting attention to no-breach models may affect the nature of the derived results.

The exact impact of permitting a breach of contract on the optimal compensation scheme cannot be uniquely determined. On one hand, as shown in the proof of the Lemma above, any action schedule induced in a no-breach setting can be implemented in the breach model via a less costly, as well as *less steep*, compensation scheme.[11] On the other hand, in the breach model the principal can more sharply distinguish between bad and good performance, since the likelihood of attaining a good outcome (when the agent does not breach) increases relative to the no-breach model. This may suggest that the optimal compensation scheme in the breach model is *steeper* than in an equivalent no-breach model. The net effect of these two factors depends on the functions and parameters involved; we can construct examples in which the optimal contract in a breach model is either steeper or flatter than that in the parallel no-breach model.

I now discuss the welfare relation between the breach model and the no-breach model. Intuitively, it seems obvious that adding contracting alternatives without affecting the attainability of existing arrangements yields a (weak) Pareto improvement. Nonetheless, one must verify that there exists a feasible transfer payment in the breach model that results in the same welfare levels of the parallel no-breach model. As it turns out, when the set of possible transfer payments is not "economically consistent" (to be defined below) with the set of compensation schemes, allowing a breach of contract may result in a welfare loss for the principal.

The lower bound on the set of permissible compensation schemes, and the upper bound on the set of permissible transfer payments, may result from distinctly different institutional restrictions (e.g., on one hand, the minimum wage may reflect the political power of the workers' union, while, on the other hand, maximum damages for breach may represent some social notion of "fairness"). Alternatively, these two bounds may be generated by the same economic phenomena (e.g., limited resources). When the latter is the case, let $c^e = k - \underline{s}$ be the upper bound on $C$, implying that even if the agent breaches the contract, he cannot be made worse off than $H(\cdot, \cdot) = U(k - c^e) = U(\underline{s})$. We shall say that $C$ is economically consistent with $S$ if $\bar{c} = c^e$. Note that in a standard no-breach model, one tacitly assumes the existence of a commitment mechanism which ensures that the agent will perform once he has signed the contract. In other words, the standard no breach models assume there exists a penalty sufficiently high to guarantee nonbreaching behavior. In comparison, economic consistency, when met, implies the feasibility of such a "penalty" in the breach model.

With economic consistency, we immediately have the following.

*Observation 2*: As long as the set of feasible transfer payments $C$ is economically consistent with the set of feasible compensation schemes $S$, Program 2 weakly Pareto-dominates Program 1.

11 It is easily verified that any optimal no-breach compensation $s(x)$ is steeper than the compensation function $\tilde{s}(x) = U^{-1}\{U(s(x)) - \epsilon\}$ (proposed in the Lemma for the breach case), since $U^{-1}(\cdot)$ is increasing and convex.

*Proof*: Obvious.

In Proposition 1 below, a strict Pareto improvement induced by allowing a breach of contract is demonstrated. This result is based on endogenous requirements regarding the solution to Program 1. Later, I verify that these requirements are feasible.

Let the principal's conditional (on $y$) expected utility given the optimal $a(\cdot)$ and $s(\cdot)$ be

$$\Psi(y) = \int_X G(x - s(x))\, \mathrm{d}F(x|a(y), y).$$

Then,

*Proposition 1*: Let $C$ be economically consistent with $S$ and assume that the Limited Liability is not binding in both programs. Then, sufficient conditions for Program 2 to strictly Pareto dominate Program 1 are that in Program 1: (i) the principal's alternative is no smaller than his conditional expected utility at the worst signal, i.e., $G(r) > \Psi(\underline{y})$; and (ii) the agent's conditional expected utility $\Phi(a(y), y)$ is increasing in $y$.

*Proof*: Let $y^0 = \inf\{y|y \in Y, \Phi(a(y), y) \geq K\}$. Condition (ii), the assumption that the LL is not binding, and the Lemma imply that $\Phi(a(\underline{y}), \underline{y}) < K < \Phi(a(\bar{y}), \bar{y})$. Thus $y^0 \in (\underline{y}, \bar{y})$. Let $y' = \inf\{y|y \in Y, \Psi(y) \geq G(r)\}$. Condition (i), combined with the fact that G(r) must be smaller than $\Psi(\tilde{y})$ for some $\tilde{y} \in Y$ (otherwise the principal would not have hired the agent), guarantees that $y' \in (\underline{y}, \bar{y})$. There are two cases to be considered:

*Case (1)*: $y' \geq y^0$

It is shown that the principal is better off letting the agent breach at zero damages. Since $\Phi(a(y), y)$ is increasing in $y$, the agent will breach as long as the revealed signal $y$ is smaller than $y^0$. The principal's expected utility in this "free" breach case is

$$G(r)L(y^0) + \int_{y^0}^{\bar{y}} \Psi(y)l(y)\, \mathrm{d}y,$$

which is larger than his expected utility under no-breach, since $G(r) > \Psi(y)$, $\forall y < y^0$.

*Case (2)*: $y' < y^0$

In this case, if the principal lets the agent breach at zero damages he may be worse off. Since the agent breaches for $y \leq y^0$, the principal enjoys a welfare gain for $y \leq y'$, but possibly suffers a welfare loss for $y$: $y' < y \leq y^0$. The net effect of allowing a "free" breach of contract is not clear. The principal thus has to assure, via a proper choice of damages, that the agent will not breach for $y > y'$ while respecting the IR and IC constraints. This is achieved by setting $c' = k - U^{-1}(\Phi(a(y'), y'))$. Note that $c' > 0$ since, by the definition of $y^0$, $k -$

$U^{-1}(\Phi(a(y^0), y^0)) > U^{-1}(\Phi(a(y'), y'))$. The principal's expected utility is

$$G(r + c')L(y') + \int_{y'}^{\bar{y}} \Psi(y)l(y)\, dy,$$

which is larger than his expected utility in the no-breach case since $G(r) > \Psi(y)$, $\forall y < y'$, and $c' > 0$.[12] Q.E.D.

The conditions of Proposition 1 are endogenous conditions which characterize the solution to Program 1. To guarantee that these conditions are meaningful, we must verify that they are met in some instances. For any set of functions and parameters (other than $r$), there exists some principal's alternative, $r$, such that condition (i) is met. Condition (ii) is guaranteed for the two-outcome case (see Appendix 1). For the continuous case, Observation 3 below provides sufficient conditions for the increase of $\Phi(a(y), y)$. Proposition 1 thus demonstrates a non-trivial strict Pareto improvement.

The conditions of Proposition 1 are sufficient, but in no way necessary, for Program 2 to dominate Program 1. It is easy to construct examples in which $G(r) < \Psi(y)$ for some lower-tail interval, even though Program 2 strictly dominates Program 1. Alternatively, when the principal's alternative is so unattractive that he never wants the agent to quit, and when economic consistency is met, Program 2 becomes equivalent to Program 1. Obviously, in such cases, conclusions based on a no-breach model are valid in the parallel breach framework.

The following property of substitution between actions and signals (in terms of their effect on the conditional probability distribution of outcomes) is useful in establishing sufficient conditions for the increase of $\Phi(a(y), y)$ in $y$.

*Definition*: The conditional distribution function $F(x|a, y)$ *admits substitution* if for all interior $(a, y)$ there exists a neighborhood of $y$, $\eta(y)$, such that for all $y' \in \eta(y)$ there is some $a' \in (\underline{a}, \bar{a})$ such that, $F(x|a, y) = F(x|a', y')\ \forall x$.[13,14]

*Observation 3*: In Program 2, the agent's conditional expected utility $\Phi(a(y), y)$ is strictly increasing in $y$ if either: (i) the conditional distribution function $F(x|a, y)$ admits substitution and the optimal action 2 is greater than the least productive action $\underline{a}$ for all $y \in Y(c)$; or (ii) the optimal compensation is increasing in $x$.

*Proof*: Part (i) Let $a(y)$ be the maximizer of $\Phi(\alpha, y)$ for a given $y$: $y < \bar{y}$. Consider a sufficiently small increase in $y$ to $y'$ such that $y' \in \eta(y)$. Then, by A5 and condition (i) above, there is some $a'$ which satisfies $a(y) > a' > \underline{a}$ such that

12 Note that the suggested pairs $(s(x), 0)$ and $(s(x), c')$ are feasible, but not optimal in Program 2, as implied by the Lemma.

13 For example, let the conditional density be exponential with a parameter

$$\lambda: \frac{1}{\lambda} = y + a.$$

14 The assumption of admissible substitution is more appealing than the assumption that $s(x)$ is increasing in $x$ (which is also shown below to yield the desired property), since it specifies exogenous characteristics rather than endogenous ones.

$F(x|a', y') = F(x|a(y), y)\,\forall x$. This implies that

$$\int_X U(s(x))\,\mathrm{d}F(x|a', y') = \int_X U(s(x))\,\mathrm{d}F(x|a(y), y),$$

while $V(a') < V(a(y))$, and therefore, $\Phi(a', y') > \Phi(a(y), y)$. The increase of $\Phi(a(y), y)$ immediately follows since $\Phi(a(y'), y') \geq \Phi(a', y')$. Part (ii) Obvious. Q.E.D.

When $\Phi(a(y), y)$ is increasing in $y$, the breach set $\bar{Y}(c)$ is a lower-tail interval $[\underline{y}, y^*]$ (where $y^* \in [\underline{y}, \bar{y}]$), and thus there is a one-to-one correspondence between $c$ and $y^*$. This property proves useful when the First Order Approach is valid (for a discussion of the FOA see Grossman and Hart (1983) and Rogerson (1985b)). Specifically, it allows us to simplify the statement of Program 2, and it yields a further characterization of the optimal solution (see Appendix 2).

Consider now the case in which the economic-consistency requirement is not met. In such a case, allowing a breach of contract may result in a welfare loss to the principal. A simple example is the case in which $\Psi(y)$ and $\Phi(a(y), y)$ are increasing in $y$ (as in the two outcome case; see Appendix 1), $G(r) < \Psi(\underline{y})$, $U(k) > \Phi(a(\underline{y}), \underline{y})$, and $C = \{0\}$.

Note that both the formulation of the breach model and the characterization results of this study are independent of the welfare relationship between the breach and the no-breach models.

Next I raise the following question: under which conditions is the optimal transfer payment, $c$, negative (i.e., a severance pay)? It may seem reasonable that when the principal wishes the agent to quit in more instances than the agent finds worthwhile, he should make the agent's alternative more attractive by paying him a bonus for breaching the contract. The following proposition demonstrates that this argument is incorrect. The intuition behind this result is that as long as the compensation remains interior, the principal has a less costly mechanism that induces the agent to breach more frequently: by reducing the agent's compensation in a "utility-parallel" manner, the principal makes the agent's alternative (relatively) more attractive without affecting the induced incentives.

*Proposition 2*: If the Limited Liability is not binding, then the optimal transfer payment $c$ is never negative. Moreover, when the breach set $\bar{Y}(c)$ is nonempty, $c$ is strictly positive.

*Proof*: By the Lemma,

$$U(k - c)P(\bar{Y}(c)) + \int_{Y(c)} \Phi(a(y), y)l(y)\,\mathrm{d}y = K.$$

Assume to the contrary that the optimal $c$ is negative. This implies $U(k - c) > K$. In addition, by definition, $\Phi(a(y), y) \geq U(k - c)$, $\forall y \in Y(c)$, and therefore

$$U(k - c)P(\bar{Y}(c)) + \int_{Y(c)} \Phi(a(y), y)l(y)\,\mathrm{d}y > K$$

in contradiction to the Lemma. Q.E.D.

**Precontract private information**

In the preceding section, the private information was acquired by an agent *after* contracting with a principal. In some cases, an agent already possesses private information *prior* to contracting (see for example Baron (1982), Melumad and Reichelstein (1989), and Sappington (1984)). It is conceivable that, prior to contracting, a principal has some control over a potential agent's access to private information (e.g., an expert may need the permission of a potential employer to examine different aspects of a future job interpretable only by this expert). In such a case, should the principal let the agent acquire his private information prior to contracting? Clearly a postcontract information acquisition weakly dominates a precontract one, because the solution to the latter can always be attained in a postcontract information framework. Moreover, as demonstrated in the Lemma above, the existence of a transfer payment conditioned upon a breach enables the principal to extract some of the informational rent from the agent by paying him, in some states, below his alternative. In contrast, in a precontract information model, the agent has to be paid at least his market alternative for each signal. This fact, combined with the incentive role of compensation, generally results in paying the agent more than his alternative (in expected utility terms). The above arguments imply that the principal is better off delaying the availability of private information to the agent.

However, should the principal control the agent's access to private information prior to contracting (but not after contracting), he may consider selling the right to access the information system. This alternative will be referred to as the sale model. I now show that selling this right to the agent makes the breach and sale alternatives essentially equivalent.

To make this comparison meaningful, the permissible values of the optimization variables should be compatible. Let $H = [\underline{h}, \bar{h}]$ and $P = [\underline{p}, \bar{p}]$, respectively, be the sets of permissible compensation payments and prices for the sale model; recall that the equivalent sets for the breach model are $S = [\underline{s}, \bar{s}]$ and $C = [\underline{c}, \bar{c}]$. The two models are Economically Compatible if the bounds on the permissible sets of the sale model are $\underline{p} = \underline{c}$, $\bar{p} = \bar{c}$, $\underline{h} = \underline{s} + \underline{c}$, and $\bar{h} = \bar{s} + \bar{c}$. The intuition behind this requirement is that in the sale model a price $p$ is paid in all states and thus the agent's *net* compensation is $h(x) - p$. Therefore, the above requirement assures that in the sale model the minimum (maximum) feasible net compensation is $\underline{s}$ ($\bar{s}$), as in the breach model.[15]

15 The following result is very general. It only requires the existence of solutions to the two programs.

*Proposition 3*: Allowing an agent to purchase access to a private information system *prior* to contracting is equivalent to allowing him to breach a contract after he acquires private *postcontract* information, as long as the two alternatives are economically compatible.

*Proof*: (1) First it is demonstrated that the performance corresponding to a solution to the breach program can be attained in the sale program. Denote by $(c, s(x))$ the solution to the breach model. In the sale model, charge the agent a price $p = c$ for the right to access the information system, and let his compensation, if he signs the contract, be $h(x) = s(x) + c$. It is easily verified that the above pair is feasible and results in utility levels identical to those of the breach model.

(2) I now argue that the performance corresponding to a solution to the sale program can be attained in the breach program. Denote by $(p, h(x))$ the solution to the sale model and, in the breach model, let $c = p$ and $s(x) = h(x) - p$. In a manner similar to (1), this pair is feasible and results in the same utility levels as the solution to the sale program. Q.E.D.

The above result implies that in the presence of exogenous (e.g. legal) restrictions on damage payments (but not on sale prices) a principal may feasibly implement the optimal *nonrestricted* breach contract by selling a potential agent access to the private information system prior to contracting. Moreover, an early sale of the private information entails no utility gain compared to an unrestricted breach contract.

**Implications for legal research**

The analysis has implications for two areas of legal research. The first implication concerns the design of optimal judicial systems. Barton (1972) has hypothesized that "Completion of a contract according to its terms is often not optimal ..." and that "Between parties with equivalent and substantial knowledge of the risks involved in the transaction as a whole, any bargained-for allocation of risks ... should be enforced in a commercial contract." He has proposed that a judicial process should be such that "If the contract defines the relevant allocation of risks or measure of damages, the judge should enforce the contract as written." In my model, the two parties are assumed to have full knowledge of "the risks involved in the transaction" at the time it is initiated, i.e., both the principal and the agent know all the possible signals and agree on their informativeness with respect to the stochastic outcome. In the context of this model, support of Barton's hypotheses is provided since it is demonstrated that for unfavorable signals both parties may be better off by halting the contractual arrangement between them and by enforcing a predetermined damage payment $c$. Furthermore, since the optimal damage payment is independent of "actual" damages, courts' paternalistic tendency to overrule excessive damage provisions (anticipated by both parties) would inevitably lead to a strict Pareto loss.

The second implication pertains to legal research on contracts. In cases where a contract is breached and a legal dispute arises regarding the precision of the (*ex-ante*) assessment of damages in an explicit damage provision, courts tend to adopt the predetermined provision assessment as long as these damages do not significantly exceed the actual damage (for discussion see Murray (1965, pp. 276–297)). Clearly the amount of damages is easier to assess after a breach has occurred than prior to contracting. Nevertheless, many contracts include explicit damage provisions.

The legal literature has recognized three possible explanations for the existence of damage provisions in contracts: (i) to coerce a promisor (an agent) into performing in accordance with the contract; (ii) to provide an efficient method of determining the amount of damages; and (iii) to put a limit on the amount of loss to be borne by the promisor in case of loss (limited liability). Economists have suggested that the damage provisions are a means of overcoming an inability (or inefficiency) of specifying the contract requirements for all possible future states (see, e.g., Posner (1977, pp. 88–98), Png (1984) and Shavell (1980)).[16] Also, as argued by Diamond and Maskin (1979), a damage provision may be written into a contract to affect incentives to search for another contract. The analysis in this paper suggests a further explanation for the existence of damage provisions: in the presence of moral hazard and asymmetric information, an explicit damage provision may induce desired breach decisions more efficiently than a compensation scheme.

**Discussion and extensions**

In a framework that involves communication, the compensation scheme is based on the observed outcome, as well as on a message – regarding the agent's private information – sent by the agent to the principal. Although not analyzed here, a model involving communication would yield results similar to those obtained in my no-communication model. Further, the communication results of Christensen (1981), Penno (1983), Melumad and Reichelstein (1989) and Picard (1987) are applicable to my model for the cases in which the agent finds it worthwhile to comply with the contract. I have chosen the no-communication framework for its expositional simplicity. In a model that involves communication, the Revelation Principle assures that only considering truth-inducing compensation schemes results in no loss of generality (in a performance sense). It may be argued, then, that in a communication-based framework the breach decision has no information which is not already contained in the communicated message. Consequently, the optimal compensation scheme $s(x, y)$ in a no-breach model would not be affected by permitting a breach. This argument is incorrect because the possibility of breach reduces the number of truthful reporting constraints; thus when a

16 The breach contract could also be viewed as a way of mitigating enforcement problems by anticipating some future events where the agent would want to quit and by writing a corresponding breach provision into the contract. I thank an anonymous reviewer for making this point.

breach is allowed, the principal has greater flexibility in designing the compensation scheme and is, in general, better off. My results, in fact, carry over to the communication framework with minor modifications.

Two extensions of the breach model have been studied. First, the information regarding the principal's alternative, which is implicit in a breach decision, has been incorporated into the analysis. In the above model, I assume the principal's alternative is independent of $y$ (e.g., the alternative is renting the principal's capital). In general, however, the principal's alternative depends on the predecision information in a nontrivial manner (i.e., $r = r(y)$). It turns out that most of the results are unaffected by this extension. As long as the set of permissible damages is economically consistent with the set of permissible compensation payments, Program 2 is Pareto superior to Program 1. Analogously to Proposition 1, a strict dominance relation is achieved when the following requirements are met: (i) $G(r(y))$ is larger than $\Psi(y)$; (ii) $\Phi(a(y), y)$ is increasing in $y$; and (iii) $U(k)$ is larger than $\Phi(a(\underline{y}), \underline{y})$. The remaining results are unchanged.

The second extension incorporates the information content of the agent's private information regarding his alternative $k$. In my breach model, the agent's alternative is assumed to be independent of his private signal $y$. Such an assumption is reasonable when the private information is project specific. In general, however, $k(y) = k$ for all $y$ cannot be easily justified. When the agent's alternative depends on $y$, Program 2 remains Pareto superior to Program 1, as long as the upper bound on the set of permissible damages, $\bar{c}$, is such that

$$\bar{c} \geq \max_{y} k(y) - \underline{s}.$$

The economic consistency interpretation, however, is no longer applicable. As in the previous extension, the remaining results are unaffected.

Recent important developments in agency theory are multiagent models (Demski and Sappington (1984) and Mookherjee (1984)) and multiperiod models (Radner (1981), Lambert (1983), Rogerson (1985a), and Holmstrom and Milgrom (1987)). In any of these multiagent or multiperiod models, when an agent is allowed to breach the contract, his breaching decision provides information about the performance of other agents. These other agents may be currently employed (a multiagent setting), or possibly hired in future periods (a multiperiod setting). The extent to which the breach extension affects the results of the above agency models has yet to be explored.[17]

17 I wish to make one observation regarding the special case of a large competitive homogeneous labor market with instantaneous-costless (re)negotiations and no discounting. Here, the principal can costlessly find an arbitrarily small interval which contains the private signal by offering the first agent a contract that is accepted by him only when his private signal $y$ is such that $y \geq \bar{y} - \epsilon$. If this contract is rejected, another (identical) agent is offered a contract which is acceptable only when $y \geq \bar{y} - 2\epsilon$ and so on. Note, however, that when there is zero probability of renegotiation with the same agent, and communication between the principal and the breaching agent is allowed, the principal can find the private $y$ by simply asking the agent to report his signal.

## Appendix 1

*The two-outcome case*

This appendix demonstrates that for the case of two outcomes and a risk neutral principal, the optimal compensation scheme is increasing in outcome in both the breach and no-breach models. This implies that the agent's expected utility is also increasing in $y$, and thus the endogenous requirement (ii) of Proposition 1 is met.

Let $x_1$ and $x_2$ ($x_2 > x_1$) be the outcomes and denote $p_2(a, y) = p(x_2|a, y)$. Analogously to A5, assume that

$$\text{A5}'. \quad \frac{\partial p_2(a,y)}{\partial a} > 0 \ \forall a,\ y, \quad \text{and} \quad \frac{\partial p_2(a,y)}{\partial y} > 0 \ \forall a,\ y.$$

Also assume:

A1′. The principal is risk neutral.

Now the optimal compensation function can be further characterized.

*Proposition 4*: Suppose that in the two-outcome case the optimal $s_1$ and $s_2$, in either the breach or no-breach model, are strictly interior. Then $s_2 > s_1$, and $x_2 - s_2 > x_1 - s_1$.

*Proof*: The following proof is for the breach model. The proof for the no-breach model is a special case of the proof below. Assume the contrary. Then either of two cases is possible:

*Case (i)*: the optimal $s_i$ satisfies $x_2 - s_2 < x_1 - s_1$.

Reduce $s_i$ by $\delta(s_i) = s_i - U^{-1}(U(s_i) - \epsilon$; change the transfer payment from $c = k - U^{-1}(\Phi(y^*))$ to $c' = k - U^{-1}(\Phi(y^*)) - \epsilon)$, and pay the agent a lump sum $U^{-1}(\epsilon)$, where $\epsilon$ is an arbitrarily small positive scalar such that $\delta(s_i)$ is feasible. Note that $\delta(s_1) > \delta(s_2)$, since $s_2 > s_1$, and therefore the difference between $x_1 - s_1$ and $x_2$ is reduced. It is now shown that these changes keep the agent's expected utility and action choice unchanged, while increasing the principal's expected utility. This contradicts the optimality of a strictly interior $s_i$ such that $x_2 - s_2 < x_1 - s_1$. Since $y^*$ is unchanged by the proposed changes, it is easy to verify that the agent's expected utility is unchanged. The change in the principal's expected utility is,

$$(c' - c)L(y^*) + \int_{y^*}^{\bar{y}} \{\{U^{-1}(U(s_1)) - U^{-1}(U(s_1) - \epsilon)\}(1 - p_2(a, y)) \\ + \{U^{-1}(U(s_2)) - U^{-1}(U(s_2) - \epsilon)\}p_2(a, y)\}l(y)\,\mathrm{d}y - U^{-1}(\epsilon) > 0.$$

The above inequality is due to the convexity of $U^{-1}(\cdot)$. This contradicts the assumption of case (i).

*Case (ii)*: the optimal $s_i$ satisfies $s_2 < s_1$.

By changes opposite to those of case (i), the principal is made better off and the agent's expected utility is unchanged while the difference between $s_2$ and $s_1$ is reduced. This establishes the contradiction for case (ii).

The above proposition implies that the principal's, as well as the agent's, conditional (on $y$) expected utility is increasing in $y$ for both the breach and the no-breach models. Thus, the requirements of Proposition 1 are feasible. This proposition generalizes, via a breach extension, a similar result in Grossman and Hart (1983).

## Appendix 2

*The breach framework under the first-order approach*

In this appendix we adopt few additional assumptions in order to gain mathematical tractability. I restate Program 2, and present, as well as interpret, the first order conditions for an optimal solution.

A7. The conditional distribution function $F(x|a, y)$ admits substitution.

A8. A solution to Program 2 can be found by the so-called first order approach which involves weakening the incentive compatibility constraint to the requirement that the agent's utility at his action choice is at a stationary point.

While Mirrlees (1975) has demonstrated the general invalidity of this assumption, Grossman and Hart (1983) and Rogerson (1985b) have identified specific sufficient conditions – the monotone likelihood ratio and the concavity of the distribution function – for its validity.

Let $\Phi(y) \equiv \Phi(a(y), y)$. Then assume,

A9. $\Phi(y)$ is continuous in $y$.

This assumption is adopted to assure a one-to-one correspondence between $y^*$ and $c$. (The following proofs can be generalized for a discontinuous case.)

Assumptions A1 to A9, together with Observation 2, yield the following restatement of Program 2.

Program 2a

$$\underset{a(\cdot), s(\cdot), y^*}{\text{Max}} \; G(r + c(y^*))L(y^*) + \int_{y^*}^{\bar{y}} \int_X G(x - s(x)) \, \mathrm{d}F(x|a(y), y) l(y) \, \mathrm{d}y$$

s.t.

$$(1) \quad U(k - c(y^*))L(y^*) + \int_{y^*}^{\bar{y}} \left\{ \int_X U(s(x)) \, \mathrm{d}F(x|a(y), y) - V(a(y)) \right\} l(y) \, \mathrm{d}y \geq K$$

(2) $\int_X U(s(x))\, dF_a(x|a(y), y) = V'(a(y))\ \forall y > y^*$

where: $c(y^*) = k - U^{-1}(\Phi(y^*))$

$$F_a(\cdot) = \frac{\partial F(\cdot)}{\partial a}$$

$$V'(a) = \frac{dV(a)}{da}\ .$$

Note that the one-to-one correspondence between $c$ and $y^*$ allows the consideration of $y^*$ instead of $c$ as a decision variable.

A characterization of the optimal solution to Program 2a is given in the following proposition.

*Proposition 5*: Assume A1 to A9. Then the first order conditions for Program 2a give rise to the following characterization of the optimal contract.

$$\frac{G'(x - s(x))}{U'(s(x))} = \lambda + \frac{\int_{y^*}^{\bar{y}} \mu(y) f_a(x|a(y), y) l(y)\, dy}{\int_{y^*}^{\bar{y}} f(x|a(y), y) l(y)\, dy}\quad \forall x \in X \tag{A2-1}$$

and the optimal $y^*$ is characterized by

$$l(y^*)\{G(r + c(y^*)) - \Psi(y^*)\} + L(y^*)c'(y^*)\{G'(r + c(y^*)) - \lambda U'(k - c(y^*))\} = 0 \tag{A2-2}$$

(where a prime denotes a first derivative).

*Proof*: The Lagrangian corresponding to Program 2a is,

$$\begin{aligned} L(a(y), s(x), y^*, \lambda, \mu(y)) &= G(r + c(y^*))L(y^*) \\ &+ \int_{y^*}^{\bar{y}} \int_X G(x - s(x))\, dF(x|a(y), y) l(y)\, dy \\ &+ \lambda \left\{ U(k - c(y^*))L(y^*) + \int_{y^*}^{\bar{y}} \left\{ \int_X U(s(x))\, dF(x|a(y), y) \right.\right. \\ &\left.\left. - V(a(y)) \right\} l(y)\, dy - K \right\} + \int_{y^*}^{\bar{y}} \mu(y) l(y) \\ &\times \left\{ \int_X U(s(x))\, dF_a(x|a(y), y) - V'(a(y)) \right\} dy. \end{aligned} \tag{A2-3}$$

Expression (A2-1) is the first order condition for $s(x)$ to maximize the Lagrangian

(A2-3). Expression (A2-2) is the first order condition for $y^*$ to maximize the Lagrangian (A2-3), incorporated with the fact that

$$\frac{\partial U(k-c)}{\partial y^*} = -U'c',$$

and (by construction)

$$U(k-c) = \Phi(a(y^*), y^*) = \int_X U(s(x))\,\mathrm{d}F(x|a(y^*), y^*) - V(a(y^*)).$$

Similarly to no-breach agency models, the second term in expression (A2-1) indicates a deviation from the first-best solution. This deviation is determined by the weighted average of the incentive effects in different signals. The weight is $\mu(y)l(y)$, and it depends on the shadow cost associated with $a(y)$, and the likelihood of $y$. Because of the complex structure of the second term in expression (A2-1), a standard monotone likelihood ratio assumption for the conditional density function does not imply that $s(x)$ is an increasing function of $x$, as it does for the symmetric information case.

The term $\{G(r + c(y^*)) - \Psi(y^*)\}$ in expression (A2-2) describes a discontinuity in the conditional (on $y$) expected utility of the principal at $y = y^*$. This discontinuity corresponds to the income effect of the damage payment $c$.

Expression (25) in Holmstrom (1979) may be considered a special case of the above proposition for which $y^* = y$.

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