Contract Damages and Investment Dynamics

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ABSTRACT

The present article provides an economic analysis to examine how contract damages affects both breach and investment decisions over time. Unlike the standard static model, this article studies a model in which, upon signing a contract, a seller invests over two periods, and a buyer may breach anytime. The dynamic structure of the model allows us to investigate investment dynamics under alternative contract damages. First, under expectation damages, the seller has an incentive to invest only in the first period (front-loading of investment). Second, under reliance damages, a similar front-loading of investment occurs, and the degree of front-loading is excessive relative to the expectation damages. Third, under restitution damages, the seller has an incentive to invest only in the second period. We also examine efficiency properties of new hybrid measures of damages in which damages depend on the timing of breach.

1. Introduction

Parties to a contract often take actions in advance of performance that will enhance the contract's value to them. In a contract for production of a specialized machine, a seller can prepare for the manufacturing of the good by making a blue print, hiring workers, and purchasing materials. A buyer expecting to receive the machine can train her employees to use it, and advertise the final product that can be made by using the machine. Such value-enhancing investments are relationship-specific when investments create more surpluses within the relationship than without. In the law and economics literature, specific investment is called reliance, because they are taken in reliance on performance.

There is a sizable literature studying how alternative contract damages for breach affect incentives for breach decision and investment decision. While the literature has shown many important insights, the underlying models abstract from realistic investment dynamics inherent in many business relationships. Specifically, in the literature, all investments are made only once at a particular stage, and then contractual uncertainty is resolved at the next stage.

In practice, however, investment can be made anytime after a contract is signed and before the contract is completed (that is, before an actual production of the machine). Investments may also take several stages. For example, in a defense procurement of a new weapons system, a contractor's research and development may take several years. In such a circumstance, contractual uncertainty can be realized before all investments are made. For example, a buyer of the specialized machine may receive information on the true value of the machine before the seller makes all investments. The buyer who finds out a low demand for the final product may want to breach the contract after the seller made some (but not all) investments.

The present article provides an economic analysis to examine how contract damages affects both breach and investment decisions over time. In particular, this article investigates whether an efficient time pattern of investment can be induced by contract damages. It also studies investment dynamics under alternative contract damages, and under a new hybrid measure of damages in which the size of damages depend on the timing of breach.

Suppose the buyer observes the true value of the machine either in the first period or the second period. The buyer may breach the contract in the first period (early breach) or in the second period (late breach). The seller makes cost-reducing investment at the beginning of each period. Assume that the first-period investment will be more effective than the second-period investment in reducing the cost of production in terms of marginal benefit. The socially efficient level of the first-period investment will balance between its higher efficiency (than the second-period one) and the probability that the first-period investment may not have any value due to an early breach. Given the efficient first-period investment, the efficient second-period investment can be identified to balance between the marginal benefit of the cost-reducing second-period investment and the marginal cost of it. The equilibrium levels of investment under alternative contract damages are not likely efficient. We focus both the total level of investment and how it is allocated across two periods under standard damages measures.

The basic measure of damages for breach is the expectation measure -- the amount that will put the seller (the victim of breach) in the same position he would have enjoyed had the contract been carried out. Define the ED rule as the rule applying the expectation measure when a breach occurs, regardless of its timing. Since the seller expects to have full benefit of the contract regardless of whether and when the contract is breached, the ED rule induces excessive total investment. The over-investment result is standard in the existing literature. It is shown in the present article that, under the ED rule, the seller has an incentive to invest only in the first period (front-loading of investment). Since the seller is implicitly insured with expectation damages, the seller will take only the first-period investment that is more effective than the second-period one.

Another standard measure of damages is reliance measure that compensates the victim of the breach for his reliance expenditure (investment cost) – so that the party is restored to the position he had before he made the contract. Define the RD rule as the rule applying the reliance measure when a breach occurs, regardless of its timing. Reliance measure of damages is ordinarily less than the expectation measure and thus it will result in more frequent breach than does the expectation measure. Since the seller will be made worse off if there is a breach under the RD rule, the seller will want to reduce the likelihood of breach by increasing investment and thereby the amount of damages. It is well established in the existing literature that the level of investment under the RD rule is more excessive than investment is under the ED rule. The same argument applies to the model of this article. It is shown in the present article that, under the RD rule, the seller has an incentive to invest only in the first period (front-loading of investment), and that the level of investment under the RD rule is more excessive than investment is under the ED rule.

The third standard measure of damages is restitution measure that requires the breaching party to give back what he or she took from the victim. Restitution measure is a minimal remedy because it does not compensate the victim of breach for expectation or reliance. From an incentive perspective, however, restitution measure may be able to reduce the excessive investment problem under the ED and RD rule. Define the ND rule as applying restitution damages when a breach occurs. It is shown that under the ND rule the seller has an incentive to invest only in the second period. Given that the buyer does not compensate the seller for his breach under the ND rule, it will result in more frequent breach than does the expectation measure. That implies that there will be less than efficient level of total investment under the ND rule. Furthermore, there is no incentive to invest in the first period since there is no compensation for investment in case of breach and there is excessive breach.

Those standard measures of damages are time-independent, as the same measure of damages is applied regardless of the time of a breach. For example, under the expectation damage measure, the seller would be fully compensated with expected profit either when the buyer breaches in an early stage or when the buyer breaches at a late stage. In the dynamic model of the present paper, however, we can investigate the efficiency of new hybrid rules under which different measures of damages are applied depending on the timing of breach. For instance, the courts may award reliance damages if a breach occurs in an early stage, while they award expectation damages for late breach.

Our study of such hybrid rules reveals that the total level of investment depends on the damages rule for late breach, and the composition of investments across time depends on the damages rule for early breach. Therefore, hybrid rules based on standard damage measures would not improve efficiency relative to the time-independent damage measures.

It would be interesting to investigate whether efficiency can be improved by stipulated damages – damages stipulated in the contract by the contracting parties. We show that perfect expectation damages can induce the first-best outcomes. Perfect expectation damages equal the damages needed to restore the victim of breach who invested efficiently to the position he would have enjoyed had the contract been carried out. A potential problem with perfect expectation damages is that informational requirement in calculating them is quite demanding.

[Literature survey here]

2. Model

The basic model involves two parties: a buyer and a seller (producer). Both parties are assumed to be risk neutral. At time t = 0, the parties agree on a contract with a contract price $P \in R_{++}$. The contract price is assumed to be paid by the buyer to the seller at the time of performance at t = 3. The sequence of moves is illustrated in Table 1.

The seller will make relationship-specific investments that reduce the cost of production. The investments are specific since there are no outside markets for these investments. Production occurs at the final stage of action. To study the dynamics of investment, consider a model in which the seller invests over two periods. Let e_1 denote the first-period investment made at t = 1. If the contractual relationship continues without the buyer's breach, then the seller makes the second-period investment e_2.

An exogenous public signal is generated with probability π at the end of the first period (that is, after e_1 is sunken).[i] Let $V \in R_+$ denote the value of the product to the buyer. V is stochastic and distributed with the cumulative distribution function F(V). If a signal is generated (that is, V is realized), then the buyer will decide whether he wants to continue to next stage or to breach and terminate the contractual relationship. If he breaches, he has to compensate the seller with damages D_1 according to a prevailing legal rule. If no signal is generated, the buyer does not change belief and proceed to the next stage.

At t = 2, the seller will invest e_2 if the other party did not breach earlier. If a signal was generated in the previous period and the buyer did not breach, then the seller know the buyer's valuation of the good is higher than the pre-agreed price and there is no risk of breaching in the future. On the other hand, if a signal was not generated, the seller knows he may need to be relatively conservative when investing.

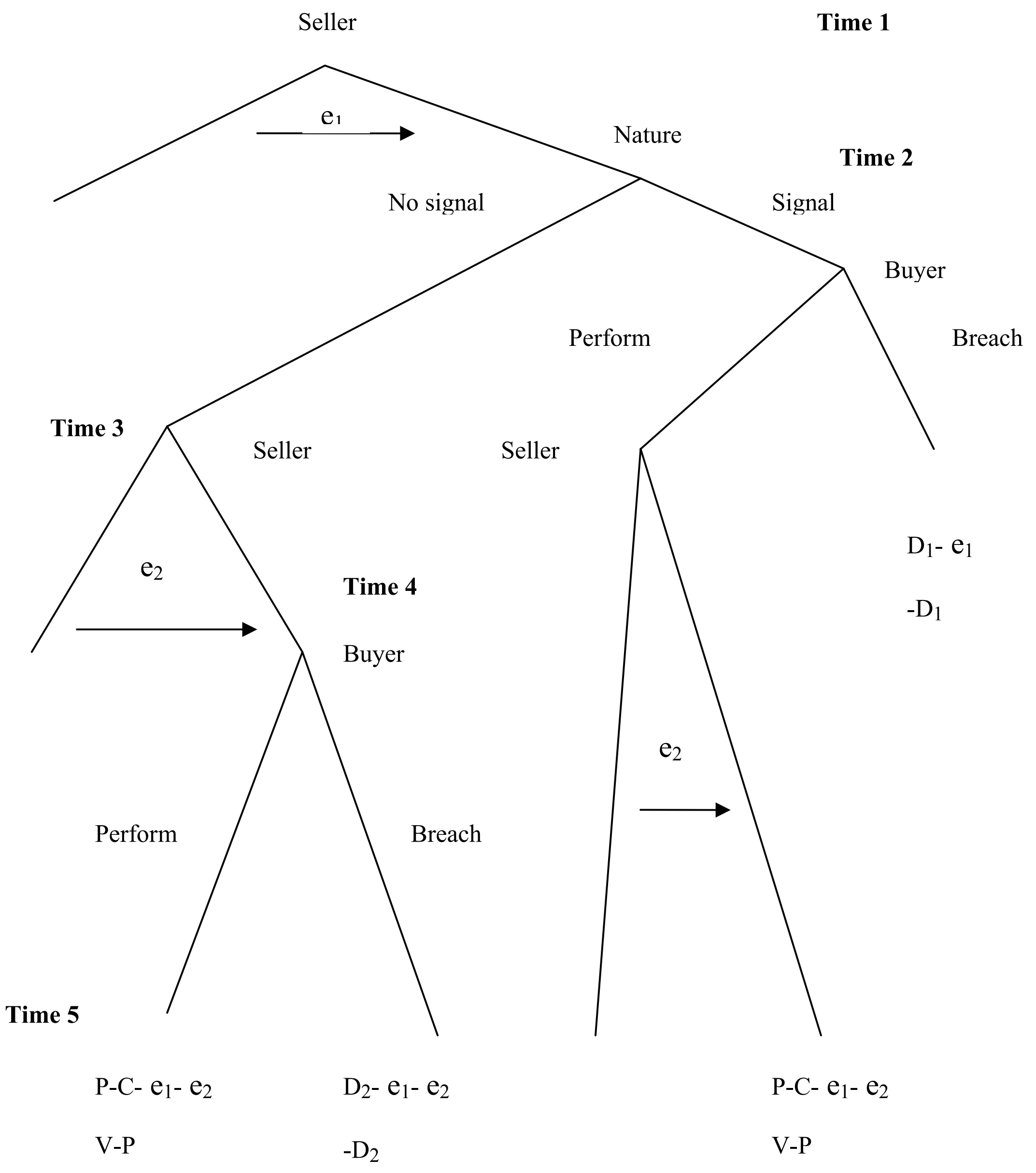
At the end of the second period, V is known publicly. The buyer decides whether to honour the contract or paying damages. At this stage, the amount of damages denoted by D_2 may be different from D_1. We will focus on the situation in which the amount of damages increases over time, $D_2 \geq D_1$. This assumption is made to guarantee that the buyer will breach only in the first given opportunity. For example, if a very low V is realised in the first period, the buyer will breach the contract at $t = 1$. It does not pay for the buyer to wait until the second period to announce his breach.

If the contract has not been breached before, production takes place at $t = 3$. The cost to the seller of production is $C(e_1, e_2)$. To compare the size of investment under alternative legal rules, we assume $C(e_1, e_2) = C(\alpha e_1 + e_2)$, where $\alpha \geq 1$. The parameter α can be viewed as an efficiency-enhancing factor for the early investment.[ii] The idea is that early preparation for contractual performance would be beneficial. It does not necessarily imply that the efficient pattern of investment requires investing only on the first period, because the buyer may breach the contract at the end of the first period.

Table 1 Sequences of moves

Time t	Activities
0	A contract is signed with a fixed price, P.
1	Seller invests cost reducing investment e_1.
2	V is known with probability π First breaching opportunity for buyer.
3	Seller invests cost reducing investment e_2.
4	V is realized with probability $1-\pi$ Final breaching opportunity for buyer.
5	Production may take place at cost of $C(e_1, e_2)$

Figure 1: Extensive Form Game



3. Analysis

3.1 First-best outcome

The first-best efficient outcome is identified as a benchmark by solving the model backward.

<u>Buyer's decision: Efficient breach</u>

Fix any given e_1.

If V is known at the end of the second period (with probability $1-\pi$),

At t = 2 : Perform if $V \geq C(\alpha e_1+e_2)$; Breach otherwise

If V is known at the end of the first period, (with probability π)

At t = 1 : Perform if $V \geq C(\alpha e_1+ \tilde{e}_2^*) + \tilde{e}_2^*$; Breach otherwise, where $\tilde{e}_2^*$ is the efficient level of second period investment if the signal arrived in the first period.

<u>Seller's decision: Efficient investment</u>

At t = 2: <u>Case A: (V is known in time 1)</u>

Let e_1^* be the efficient first-period investment level.

Let $\tilde{e}_2^*$ be the efficient investment level if V is known at time 1.

Given a favourable signal, i.e. $V - C(e_1^*, \tilde{e}_2^*) - e_1^* - \tilde{e}_2^* \geq 0$, the seller solves

$\text{Max}_{e_2} \{V - C(\alpha e_1^*+e_2) - e_1^* - e_2\}$

F.O.C. $-C'(\alpha e_1^*+ \tilde{e}_2^*) = 1$ (1)

Otherwise, $\tilde{e}_2^*=0$.

<u>Case B: (V is known in time 2)</u>

Let $\hat{e}_2^*$ be the efficient investment level if V is only known at time 2. The seller solves

$$\text{Max}_{e_2} \{\int_{V \geq C(\alpha e1^*+e2)} [V - C(\alpha e_1^*+e_2)]\, dF(V) - e_1^* - e_2\}$$

F.O.C. $-C'(\alpha e_1^*+ \hat{e}_2^*)(1- F(C(\alpha e_1^*+ \hat{e}_2^*))) = 1$ (2)

Lemma 1: Given identical previous investments, the first best outcome requires larger subsequent investment after realization of a favourable V.

Proof: from (1) $-C'(\alpha e_1^*+ \tilde{e}_2^*) = 1$

from (2) $-C'(\alpha e_1^*+ \hat{e}_2^*)(1- F(C(\alpha e_1^*+ \hat{e}_2^*))) = 1$

➔ $-C'(\alpha e_1^*+ \tilde{e}_2^*) < -C'(\alpha e_1^*+ \hat{e}_2^*)$

➔ $C'(\alpha e_1^*+ \tilde{e}_2^*) > C'(\alpha e_1^*+ \hat{e}_2^*)$

➔ $\alpha e_1^*+ \tilde{e}_2^* > \alpha e_1^*+ \hat{e}_2^*$

➔ $\tilde{e}_2^* > \hat{e}_2^*$ □

At time 1: $\text{Max}_{e_1} \{\pi \int_{V \geq C(\alpha e1+\tilde{e}2^*)+\tilde{e}2^*} [V - C(\alpha e_1+ \tilde{e}_2^*) - \tilde{e}_2^*]\, dF(V)$

$+ (1-\pi)[\int_{V \geq C(\alpha e1+\hat{e}2^*)} [V - C(\alpha e_1+ \hat{e}_2^*) - \hat{e}_2^*]\, dF(V)\} - e_1$

F.O.C. By envelope Theorem,

$\pi\alpha[-C'(\alpha e_1^*+ \tilde{e}_2^*)][1- F(C(\alpha e_1^*+ \tilde{e}_2^*) + \tilde{e}_2^*)]$

$$+ (1-\pi)\alpha[-C' (\alpha e_1{}^{*}+ \hat{e}_2{}^{*})] [1-F (C (\alpha e_1{}^{*}+ \hat{e}_2{}^{*})]\} - 1 = 0$$

Substituting in equation (1) and (2),

We get $\pi\alpha [1- F(C (\alpha e_1{}^{*}+ \tilde{e}_2{}^{*}) + \tilde{e}_2{}^{*})] + (1-\pi)\alpha = 1$

$$\Rightarrow \quad \alpha [1- \pi F(C (\alpha e_1{}^{*}+ \tilde{e}_2{}^{*}) + \tilde{e}_2{}^{*})] = 1 \qquad (3)$$

In order to guarantee an interior solution, we make the following assumption.

Assumption: $\alpha [1- \pi F(C (\alpha e_1{}^{*}+ \tilde{e}_2{}^{*}) + \tilde{e}_2{}^{*})] = 1.$

Intuitively, $F(C (\alpha e_1+ \tilde{e}_2{}^{*}) + \tilde{e}_2{}^{*})$ is the probability of breaching given a signal in time 1 which arrives with probability π. In other words, $[1- \pi F(C (\alpha e_1+ \tilde{e}_2{}^{*}) + \tilde{e}_2{}^{*})]$ is the probability of contract being honoured. α is the efficiency enhancing factor of early investment. Therefore, the left side of the equation is equivalent to the expected marginal benefit of early stage investment. This equals the marginal cost of investment, which is 1.

Note that the value of total investment ($\alpha e_1+ e_2$) is important. If the contract is not breached in time 1, e_2 will be adjusted in order to achieve the appropriate total investment value.

Consider the special case with the values of investments are identical across time (α=1), first best require e_1= 0 and investing only in the second period. Intuitively, if there is no gain in early investments, the seller should wait till the last stage to invest. This is the stage where most information is available and the seller will be able to make more accurate investments.

Proposition 1: Assuming an interior solution, the first best outcome (e_1^*, $\tilde{e}_2^*$, $\hat{e}_2^*$) is characterized by

(i) $\alpha\,[1-\pi F(C(\alpha e_1^* + \tilde{e}_2^*) + \tilde{e}_2^*)] = 1$

(ii) $\begin{cases} -C'(\alpha e_1^* + \tilde{e}_2^*) = 1 & \text{if the contract is honoured in time 1.} \\ \tilde{e}_2^* = 0 & \text{otherwise} \end{cases}$

(iii) $-C'(\alpha e_1^* + \hat{e}_2^*)\,[1-F(C(\alpha e_1^* + \hat{e}_2^*))] = 1$

3.2 Equilibrium

There are usually three types of possible remedies awarded by:

Expectation damages (ED)

Reliance damages (RD)

Restitution damages (ND)

In our model, $D_1^{ED} = P - C(\alpha e_1 + e_2^*) - e_2^*$ $\quad D_2^{ED} = P - C(\alpha e_1 + e_2)$

$D_1^{RD} = e_1$ $\quad D_2^{RD} = e_1 + e_2$

$D_1^{ND} = 0$ $\quad D_2^{ND} = 0$

The court may award different damages if breaching occurs in different stages (Hybrid rules). We will analyze the following four cases (as illustrated in Table 2).

Table 2: Possible combinations of damages rule.

Damages rule design	Time 1 (D_1)	Time 2 (D_2)
ED rule	ED	ED
RD rule	RD	RD

ND rule	ND	ND
Hybrid rule 1	RD	ED

Lemma 2: If the buyer did not breach after realizing V, the seller will invest efficiently such that $\tilde{e}_2$ solves C' ($\alpha e_1 + \tilde{e}_2$) = 1. This is independent on the choice of default rules.

On the other hand, if the buyer breach after realizing V, the seller will not invest.

Proof: Given the buyer did not breach after realizing V in time 2, the buyer will definitely honour the contract. Therefore, independent on default rules, the objective functions for the seller are:

$$\text{Max}_{e_2} \{P - C(\alpha e_1 + e_2) - e_1 - e_2\}$$

$$\text{F.O.C.} \qquad -C'(\alpha e_1 + \tilde{e}_2) = 1 \qquad (4)$$

It is obvious that if the buyer breach, seller should not invest again.

What Lemma 2 tells us is that we do not need to calculate $\tilde{e}_2$ in every case. Instead, we concentrate on calculating e_1 and $\hat{e}_2$.

<u>Case 1: Expectation damages rule</u>

The court essentially assigns all risks to the buyer. Regardless of time of breach, ED will be applied. The seller will always get his expected value.

<u>Buyer's decision:</u>

At time 2 : Perform if $V \geq C(\alpha e_1 + e_2)$; Breach otherwise

At time 1 : Perform if $V \geq C(\alpha e_1 + \tilde{e}_2) + \tilde{e}_2$; Breach otherwise

<u>Seller's decision:</u>

At time 2 (V is not known):

Let e_1^{ED} be the equilibrium early-investment.

Let $\hat{e}_2^{ED}$ be the equilibrium late-investment if V is unknown.

$$\text{Max } e_2 \ \{[P - C(\alpha e_1^{ED} + e_2)] - e_1^{ED} - e_2\}$$

F.O.C. $$-C'(\alpha e_1^{ED} + \hat{e}_2^{ED}) = 1 \qquad (5)$$

It is noted that the second period investment (condition on e_1) is larger than optimum in this situation.

At time 1: This is the seller's problem.

$$\text{Max } e_1 \ \{\pi\ [P - C(\alpha e_1 + \tilde{e}_2^{ED}) - \tilde{e}_2^{ED}]$$
$$+ (1-\pi)[P - C(\alpha e_1 + \hat{e}_2^{ED}) - \hat{e}_2^{ED}]\} - e_1$$

From equation (4) and (5), $\tilde{e}_2^{ED} = \hat{e}_2^{ED}$. Thus the seller's problem can be rewritten as:

$$\text{Max } e_1 \ [P - C(\alpha e_1 + e_2^{ED}) - e_2^{ED}]$$

F.O.C. $$-\alpha C'(\alpha e_1^{ED} + e_2^{ED}) = 1 \qquad (6)$$

Equation (6) and (5) contradicts as $\alpha > 1$. This implies that there is no interior solution for e_{1ED}'. The corner solution requires the seller to invest everything in the first period. Since there is no risk for the seller, the sole objective for him is to reduce the cost of production and not worry about the breach. Investing early is more efficient than investing late. This gives incentive for the seller to invest only in the most efficient time, which is the first investment stage. Seller will invest too much prematurely.

Proposition 2: The seller will only invest in the first period under expectation damages rule. The seller's investment is excessive under expectation damages rule relative to the first-best one.

Case 2: Reliance damages rule

All the buyer needs to do is to compensate only the reliance expense of the seller. The risk is distributed between the two parties.

Buyer's decision:

At time 2 : Perform if $V \geq P - e_1 - e_2$; Breach otherwise

At time 1 : Perform if $V \geq P - e_1$; Breach otherwise

Seller's decision:

At time 2 (V is not known):

Let $\hat{e}_2^{RD}$ be the efficient investment level at time 2 if V is only known at time 2.

$$\text{Max}_{e_2} \{\textstyle\int_{V \geq P - e1RD' - e2} [P - C(\alpha e_1^{RD} + e_2) - e_1^{RD} - e_2]\, dF(V)\}$$

$$= \text{Max}_{e_2} \{[P - C(\alpha e_1^{RD} + e_2) - e_1^{RD} - e_2]\,[1 - F(P - e_1^{RD} - e_2)]\}$$

F.O.C.

$$[-C'(\alpha e_1^{RD} + \hat{e}_2^{RD}) - 1]\,(1 - F(P - e_1^{RD} - \hat{e}_2^{RD})) + [P - C(\alpha e_1^{RD} + \hat{e}_2^{RD}) - e_1^{RD} - \hat{e}_2^{RD}]\, f(P - e_1^{RD} - \hat{e}_2^{RD}) = 1 \qquad (7)$$

At time 1: This is the seller's problem.

$$\text{Max}_{e_1}\ \{\pi\,[P - C(\alpha e_1 + \tilde{e}_2^{RD}) - \tilde{e}_2^{RD} - e_1]\,[1 - F(P - e_1)]$$

$$+ (1-\pi)\,[P - C(\alpha e + \hat{e}_2^{RD}) - \hat{e}_2^{RD} - e_1]\,[1 - F(P - e_1 - \hat{e}_2^{RD})]\}$$

F.O.C.

$$\pi\,[P - C(\alpha e_1^{RD} + \tilde{e}_2^{RD}) - \tilde{e}_2^{RD} - e_1^{RD}]\,f(P - e_1^{RD})$$

$$+ \pi\,[-\alpha C'(\alpha e_1^{RD} + \tilde{e}_2^{RD}) - 1]\,[1 - F(P - e_1^{RD})]$$

$$+ (1-\pi)\,[P - C(\alpha e_1^{RD} + \hat{e}_2^{RD}) - \hat{e}_2^{RD} - e_1]\,f(P - e_1^{RD} - \hat{e}_2^{RD})$$

$$+ (1-\pi)\,[-\alpha C'(\alpha e_1^{RD} + \hat{e}_2^{RD}) - 1]\,[1 - F(P - e_1^{RD} - \hat{e}_2^{RD})]$$

$$= \pi\,[P - C(\alpha e_1^{RD} + \tilde{e}_2^{RD}) - \tilde{e}_2^{RD} - e_1^{RD}]\,f(P - e_1^{RD})$$

$$+ \pi\,[\alpha - 1]\,[1 - F(P - e_1^{RD})]$$

$$+ (1-\pi)\,[1 - (\alpha - 1)\,C'(\alpha e_1^{RD} + \hat{e}_2^{RD})\,[1 - F(P - e_1^{RD} - \hat{e}_2^{RD})] \tag{8}$$

It is noted that equation (8) is always positive. This means that corner investment will occur. Intuitively, if there is a breach, the seller will get a profit of zero. If a contract is honoured, the seller will get a positive surplus. It is obvious that the seller's objective is to minimize the chance of breaching. Investing early will decrease the chance of breaching in the early stage. At the same time, early investments are more efficient. Thus, it makes sense for seller to invest in the first period.

Proposition 3: Seller will only invest in the first period under the RD rule. The seller's investment under the RD rule is more excessive than his investment under the ED rule.

<u>Case 3: Restitution damages rule</u>

The buyer is not responsibility for any damages while the seller is the entire risk bearer.

<u>Buyer's decision:</u>

At time 2 : Perform if $V \geq P$; Breach otherwise

At time 1 : Perform if $V \geq P$; Breach otherwise

<u>Seller's decision:</u>

At time 2 (V is not known):

Let $\hat{e}_2^{ND}$ be the investment level if V is only known at time 2.

$$\text{Max}_{e_2} \{\{\int_{V \geq P} [P - C(\alpha e_1^{ND} + e_2)]\, dF(V) - e_1^{ND} - e_2\}\}$$

F.O.C. $$-C'(\alpha e_1^{ND} + \hat{e}_2^{ND})(1-F(P)) = 1 \quad (9)$$

At time 1: This is the seller's problem.

$$\text{Max}_{e_1} \{\pi \int_{V \geq P} [P - C(\alpha e_1 + \tilde{e}_2^{ND}) - \tilde{e}_2^{ND}]\, dF(V)$$
$$+ (1-\pi)[\int_{V \geq P} [P - C(\alpha e_1 + \hat{e}_2^{ND}))]\, dF(V) - \hat{e}_2^{ND}] - e_1\}$$

differentiate with respect to e_1 gives

$$\pi\alpha[-C'(\alpha e_1 + \tilde{e}_2^{ND})]\,[1-F(P)]$$
$$+ (1-\pi)\alpha[-C'(\alpha e_1 + \hat{e}_2^{ND})]\,[1-F(P)]\alpha - 1$$

Substituting in equation (4), (9), we get:

$$\pi\alpha[1-F(P)] + (1-\pi)\alpha - 1$$

$$= \alpha - \pi\alpha F(P) - 1$$

$$= \alpha(1-\pi F(P)) - 1 \quad (10)$$

Note that $P - C(\alpha e_1^* + \tilde{e}_2^*) - \tilde{e}_2^* > 0$ since the left-hand side is the seller's expected profit when the efficient investments are made and the contract is completed. Then, $\alpha(1-\pi F(P)) - 1 < \alpha[1-\pi F(C(\alpha e_1^* + \tilde{e}_2^*) + \tilde{e}_2^*)] - 1 = 0$ from Assumption 3. Since the sign of the equation (10) is negative, the seller will invest only in the second period.

Proposition 4: The seller will only invest in the second period under pure restitution damages rule.

Given the above results, three standard measures of damages do not create efficient patterns of investments. It would be interesting to examine whether making damages depend on time of breach can improve incentives for investments.

Case 4: Hybrid Rule 1 (RD for early breach and ED for late breach)

This is one of the interesting scenarios and it has not been explored in the literature. The damages rule is time-dependent. This means that the court will allow reliance damages at an early stage of contractual relationship and expectation damages at a later stage.

Buyer's decision:

At time 2 : Perform if $V \geq C(\alpha e_1 + e_2)$; Breach otherwise (ED)

At time 1 : Perform if $V \geq P - e_1$; Breach otherwise (RD)

Seller's decision:

At time 2 (When V is not known)

Let $e_1^{R\&E}$ be the investment level at time 1.

Let $\hat{e}_2^{R\&E}$ be the investment level if V is known at time 2.

Max e_2 $\{P - C(\alpha e_1^{R\&E} + e_2) - e_1^{R\&E} - e_2\}$

F.O.C. $-C'(\alpha e_1^{R\&E} + \hat{e}_2^{R\&E}) = 1$ (11)

By total differentiation, we get: $\frac{d\hat{e}_2^{R\&E}}{de_1^{R\&E}} = -\alpha$

At time 1: This is the seller's problem.

Max e_1 $\{\pi \int_{V \geq P - e1} [P - C(\alpha e_1 + e_2^{R\&E}) - \tilde{e}_2^{R\&E} - e_1]\, dF(V)$

$+ (1-\pi) \int_{V \geq P - e1 - \hat{e}2} [P - C(\alpha e_1 + \hat{e}_2^{R\&E})]\, dF(V) - \hat{e}_2^{R\&E} - e_1]$

➔ Max e_1 $\{\pi [P - C(\alpha e_1 + e_2^{R\&E}) - \tilde{e}_2^{R\&E} - e_1](1-F(P- e_1))$

$+ (1-\pi)[P - C(\alpha e_1 + \hat{e}_2^{R\&E})] (1-F(P- e_1 - \hat{e}_2^{R\&E}))$

$- (1-\pi)\hat{e}_2^{R\&E} - (1-\pi)e_1\}$

Differentiate with respect to e_1:

$\{\pi [P - C(\alpha e_1 + e_2^{R\&E}) - \tilde{e}_2^{R\&E} - e_1] (f(P- e_1))$

$+\pi [-C'(\alpha e_1 + e_2^{R\&E}) (\alpha - \alpha) + \alpha - 1](1-F(P- e_1))$

$+ (1-\pi)[P - C(\alpha e_1 + \hat{e}_2^{R\&E})] (f(P- e_1 - \hat{e}_2^{R\&E})(-1+ \alpha)$

$+ (1-\pi)[-C(\alpha e_1 + \hat{e}_2^{R\&E})(\alpha - \alpha)] (1-F(P- e_1 - \hat{e}_2^{R\&E})$

$- (1-\pi)(-\alpha) - (1-\pi)$

$=$ $\pi [\alpha - 1](1-F(P- e_1)) + (1-\pi)(1-F(P- e_1 - \hat{e}_2^{R\&E})$

$+ (1-\pi)(\alpha - 1) > 0$ (12)

It is noted that equation (12) is non zero. This means that investment will only occur in one of the periods. In other words, this will generate the same outcome as expectation damages rule. In other words, there is no need to consider implementing reliance damages in the early stage and expectation damages at the later stage. Pure expectation damages rule will generate identical results.

Proposition 5: Hybrid Rule 1 (RD for early breach and ED for late breach generates the same outcome as the ED rule.

Case 5: Hybrid Rule 2 (ND for early breach and ED for late breach)

We will explore another time-dependent damages rule. In this situation, the court will allow restitution damages at an early stage of contractual relationship and expectation damages at a later stage.

Buyer's decision:

At time 2 : Perform if $V \geq C(\alpha e_1 + e_2)$; Breach otherwise

At time 1 : Perform if $V \geq P$; Breach otherwise

Seller's decision:

At time 2(V is not known):

Let $e_1^{N\&E}$ be the equilibrium early-investment.

Let $\hat{e}_2^{N\&E}$ be the equilibrium late-investment if V is unknown.

$$\text{Max}_{e_2} \{[P - C(\alpha e_1^{N\&E} + e_2)] - e_1^{N\&E} - e_2\}$$

F.O.C. $$-C'(\alpha e_1^{N\&E} + \hat{e}_2^{N\&E}) = 1 \qquad (13)$$

It is noted that the second period investment (condition on e_1) is larger than optimum in this situation.

At time 1: This is the seller's problem.

$$\text{Max } e_1 \; \{\pi \; [1\text{-}F(P)] \, [P - C(\alpha e_1 + e_2^{N\&E}) - \tilde{e}_2^{N\&E}] - \pi e_1$$

$$+ (1\text{-}\pi) \, [P - C(\alpha e_1 + \hat{e}_2^{N\&E}) - \hat{e}_2^{N\&E} - e_1] \}$$

$$\text{F.O.C. } \pi (1\text{-}F(P)) (-\alpha C'(\alpha e_1^{N\&E} + \tilde{e}_2^{N\&E})) - \pi$$

$$+ (1\text{-}\pi)(-C'(\alpha e_1^{N\&E} + \hat{e}_2^{N\&E}) - 1)) \qquad (14)$$

$$= \quad \pi (1\text{-}F(P)) (\alpha) - \pi$$

$$= \quad \pi (\alpha - \alpha F(P) - 1) \qquad \text{Independent of e}$$

We will probably have a non-zero constant. This implies the seller will also invest in one of the periods. Under this situation, the seller will only invest in the latter stage. Intuitively, the seller will not invest early as he bears all risks even early investment is more efficient. This creates the same investment pattern as the pure restitution damages rule. However, the total amount of investment equals the pure expectation damages rule. In other words, this hybrid rule encourage investing late.

Proposition 6: Hybrid Rule 2 (ND for early breach and ED for late breach generates the same weighted aggregate as the pure ED rule. However, the timing is reversed.

<u>Case 6: Hybrid Rule 3 (ND for early breach and RD for late breach)</u>

Under Hybrid Rule 3, the court will allow restitution damages for early breaches and reliance damages for late breaches.

<u>Buyer's decision:</u>

At time 2 : Perform if $V \geq P - e_1 - e_2$; Breach otherwise

At time 1 : Perform if $V \geq P$; Breach otherwise

<u>Seller's decision:</u>

Let $e_1^{N\&R}$ be the equilibrium early-investment.

Let $\hat{e}_2^{N\&R}$ be the equilibrium late-investment if V is unknown.

Let $\hat{e}_2^{N\&R}$ be the efficient investment level if V is only known at time 2.

At time 2 (V is not known):

$$\text{Max } e_2 \ \{[P - C(\alpha e_1^{N\&R} + e_2) - e_1^{N\&R} - e_2]\,[1-F(P - e_1^{N\&R} - e_2)]\}$$

F.O.C.

$$[-C'(\alpha e_1^{N\&R} + \hat{e}_2^{N\&R}) - 1]\,(1-F(P - e_1^{N\&R} - \hat{e}_2^{N\&R}))$$
$$+ [P - C(\alpha e_1^{N\&R} + \hat{e}_2^{N\&R}) - e_1^{N\&R} - \hat{e}_2^{N\&R}]\, f(P - e_1^{N\&R} - \hat{e}_2^{N\&R})$$
$$= 1 \qquad (15)$$

At time 1: This is the seller's problem.

$$\text{Max } e_1 \ \{\pi\,[P - C(\alpha e_1 + \tilde{e}_2^{N\&R}) - \tilde{e}_2^{N\&R}]\,[1-F(P)] - \pi e_1$$
$$+ (1-\pi)\,[P - C(\alpha e + \hat{e}_2^{N\&R}) - \hat{e}_2^{N\&R} - e_1]\,[1-F(P - e_1 - \hat{e}_2^{N\&R})]\}$$

F.O.C.

$$\pi\,[-\alpha C'(\alpha e_1^{N\&R} + \tilde{e}_2^{N\&R})]\,[1-F(P)] - \pi$$
$$+ (1-\pi)\,[P - C(\alpha e_1^{N\&R} + \hat{e}_2^{N\&R}) - \hat{e}_2^{N\&R} - e_1^{N\&R}]\,[f(P - e_1^{N\&R} - \hat{e}_2^{N\&R})]$$
$$+ (1-\pi)\,[-\alpha C'(\alpha e_1^{N\&R} + \hat{e}_2^{N\&R}) - 1]\,[1-F(P - e_1^{N\&R} - \hat{e}_2^{N\&R})]\}$$

$$= \pi\,[\alpha]\,[1-F(P)] - \pi$$

$$+ (1-\pi) [1 + (1-\alpha C'(\alpha e_1^{N\&R} + \hat{e}_2^{N\&R}) [1-F (P- e_1^{N\&R} - \hat{e}_2^{N\&R})] \quad (16)$$

Equation 16 is positive. We will have another corner solution. In this situation, sellers will wait in the early periods and invest only at the later stage. Intuitively, the seller will choose to invest in the stage where there is the least amount of risk even though it is not very effective. It is noted that the total amount of weighted investment is identical to the pure RD rule. Therefore, politicians can defer investment timing by introducing this hybrid rule.

Proposition 7: Hybrid Rule 3 (ND for early breach and RD for late breach generates the same weighted aggregate as the pure RD rule. However, the timing is reversed.

3. Extensions

1) Possibility of Renegotiation

Note that ED rule guarantees efficient breach decisions. Thus, the possibility of ex post renegotiation does not affect the outcome of the ED rule. The RD rule and ND rule do not generate efficient breach decisions.

2) Imperfect courts and transactions costs

We have assumed so far that the buyer's breach immediately terminates the contract and that litigation takes place without cost and instantaneously.

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[i] This is public information in that both seller and buyer know if the signal is available or not.

[ii] Note that there is no discounting.