Chapter 3
Bilateral Self Investments, One-sided Informational Asymmetry, Simple Contracts and the Breach Remedies

3.1 Introduction:

Economic analysis of contract law has shown (e.g. Shavell (1980, 2004)) that in an environment with unilateral reliance investment and ex post symmetric information, there will be incentives toward excessive reliance both under the expectation measure and reliance measure. It has also been argued that when there is no explicit damage payment, the victim of breach has an incentive to under-invest in reliance. Edlin and Reichelstein (1996, hereafter ER), however, called the overreliance result in question. In a setting of continuous quantity choice, they showed that the expectation or specific damage measure provides efficient incentives iff the reliance investment is one-sided, the contract specifies some suitable intermediate quantity of trade as a performance obligation and the inefficient performance choices are costlessly renegotiated ex post. They find that a continuous quantity in the contract is a powerful tool to adjust incentives. But when both the parties invest, using a deterministic and linear cost function ER show that it is not possible to achieve the first best with expectation damages, (at least not for all types of payoff functions). They also observe that Specific performance remedy induces a symmetry that allows simple contracts to obtain the first best for a particular class of payoff functions.
The present analysis is a natural extension of the basic unilateral investment model discussed in the previous chapter. This chapter analyses the literature on optimal remedies for contract breach in a variety of settings. Here a setting of two-sided reliance investments is explored when one of the contracting parties later receives information about his or her utility, profit or cost function that remains hidden to the other party and to courts. Investments are specific to the relationship, but not contractible, and a party's investment does not directly affect the other party's payoff, only indirectly via the optimal quantity which is higher the more the parties invest. As for the quantity choice of the specific commodity, we start with a model of binary performance choice but later extend the analysis to allow for continuous choice. It adds more realism to the analysis as many bilateral trade relationships involve trading divisible goods and agents can have general utility and cost functions. More importantly, this general treatment helps uncover the fundamental forces that shape optimal contracts as well as the optimal damage remedy in this canonical contracting problem.

All the usual court-imposed damage measures are systematically explored. It begins with a standard analysis of the behavioural effects of restitution, reliance and expectation damages when the losses to the victim of contract breach can be thoroughly assessed by court. It then discusses the application of these damage measures in situations when courts cannot perfectly assess the victim's valuations of the contract (as it is private information to concerned party).

When both the parties make (selfish) investments into the individual valuation function and thereby augment the social surplus, any damage measure - to be optimal - should induce efficient ex ante reliance investments for both the parties as well as ex post alloca-
tive efficiency. One might conjecture that mutual reliance will produce a confidence building effect ["hostage-taking" balance], through which the under-investment problem will be eliminated automatically. The analysis shows, however, that mutual reliance by both the parties indeed helps to increase the level of reliance for each of them to some extent but the conjecture is not valid entirely. It is observed that when the parties write a fixed-price contract non-availability of any damage measure leads both the parties' reliance incentives to be held-up. It is also noticed that the reliance damage remedy, as usual, not only fails to restore allocative efficiency but also renders both the parties with inefficient incentives to rely: victim of breach over-invests whereas breacher under-invests.

Whether expectation damage provides efficient incentives or not, for being granted, it must be verified in front of courts. We segregate two cases – whether the victim's expectancy is ex post verifiable or not. When the valuation of the victim of breach is observable and verifiable to court, our analysis, in a setting of binary performance choice, shows that while allocative efficiency is achieved under expectation damage remedy, it leads both the parties to rely excessively. On the other hand, if the victim of breach has private information, then the expectation damage is difficult to assess and so the court may deny recovery to the party claiming exposure to breach. When problems of assessing the valuation are extreme, the courts may turn to alternative remedies, or the parties may attempt to solve the problem themselves through liquidated damages clauses. The analysis also considers whether these solutions to the valuation problem alleviate or exacerbate opportunistic behaviour by the parties.
Thus we render a special focus on the issue of assessing expectation damages under asymmetric information. We use a particular class of revelation mechanisms of the Clarke-Groves type that would assess expectation damages correctly, further we show that this mechanism generally achieves the first best.

As it turns out, assessing expectation damages correctly comes at a price in terms of efficiency loss. It is shown that mechanisms assessing expectation damages correctly will implement performance decisions only that are constant over states. Typically, such outcomes fail to be ex post efficient, since asymmetric information (ex post) is a source of transaction costs and, hence, the Coase Theorem may fail to hold, as shown by the impossibility result of Myerson and Satterthwaite (1981). Therefore, assessing expectation damages correctly is at odds with ex post efficiency. In any case, renegotiations under asymmetric information, if at all possible, cannot be expected to restore ex post efficiency as would have been the case under symmetric information of Edlin and Reichelstein.

Thus, while expectation damages may work well under symmetric information, at least given a continuous performance choice, the performance of expectation damages as well as other court-imposed damages under asymmetric information falls short of what more general mechanisms and party designed liquidated damage may achieve.

3.2 The Model: Bilateral Reliance Investments and One-sided Private Information
3.2 The Model:

3.2.1 General Setting:

Let us consider a particular contract where there is a single (male) buyer, B, who
contracts to purchase one unit of an indivisible specific good from a single (female) seller
S. Both are risk-neutral. The parties enter into a simple fixed-price contract at Time 1. At
the time of contracting, the parties are in a bilateral bargaining situation. The seller then will
produce the good and will deliver it to the buyer at some future date. The buyer’s valuation
is dependent on the level of investment he undertakes and denoted by \( v = V(r^b) \) of reliance
investments with maximum \( \bar{V} = \max_{r^b \in R} V(r^b) \) and \( \underline{V} = \min_{r^b \in R} V(r^b) \). We assume that
\( V(r^b) \) is monotonically increasing and strictly concave: \( V'(r^b) > 0 \) and \( V''(r^b) < 0 \), where
\( r^b \) is the investment by buyer. In a similar fashion the seller also undertakes investment to
reduce her cost of production. To accommodate this feature we need to ascribe a special
structure on the seller’s cost. The sole source of uncertainty in this model comes from the
future fluctuation that hovers around the seller’s production cost, denoted by \( \tilde{C} \in [\underline{C}, \bar{C}] \),
which may be due to potential fluctuations in the market prices for the inputs. We hereby
denote the seller’s production cost as \( \tilde{C} = C(r^s) + \theta \), where the expected value of is
denoted by \( E(\tilde{C}) \) and \( E(\tilde{C}) = C(r^s) \), so that \( E(\theta) = 0 \) when \( \theta \) is a random variable which
is distributed in the interval \([ -a, a ]\) with \( a > 0 \), according to a cumulative distribution
function denoted by \( F(\theta) \) with positive continuous density function \( f(\theta) > 0 \) with zero
mean and variance \( \sigma_\theta^2 \). The uncertainty parameter \( \theta \) is private information to the seller,
which she learns after the initial contract has been signed. The distribution \( F(\theta) \) is common
knowledge. Moreover, we make the standard assumptions to get a “well behaved” problem,
\( C'(r^s) < 0, C''(r^s) > 0 \). At this point we simply assume that these reliance investments
are ex ante indescribable and thus non-contractible. In case they are verifiable ex post in the court, then reliance damage may be applicable. The rest of the assumptions related to contract price and others are just the same as in the previous model in chapter 2.

### Periodic Structure for the Contract Model

<table>
<thead>
<tr>
<th>Time 1</th>
<th>Time 2</th>
<th>Time 4</th>
<th>Time 4</th>
<th>Time 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Parties enter into contract</td>
<td>Both parties invest</td>
<td>Seller learns new info, uncertainty resolves</td>
<td>Seller performs or breaches</td>
<td>Court decides and parties obey</td>
</tr>
</tbody>
</table>

The sequence of events can be summarised as follows:

The parties sign a contract and specify the delivery price \( p \) at Time 1 → Both the buyer and the seller make reliance investment at Time 2 → The seller observes her cost of production \( C \) at Time 3 as uncertainty resolves → The seller decides whether to perform the contract or repudiate at Time 4 → If the seller breaches, the buyer files a lawsuit at no cost in between Time 4 & 5 → The court awards damages of \( D \), which may be a function of investments and \( p \) at Time 5.

### 3.2.2 The Analysis: First Best

The first best is achieved if the ex ante investment decision and the ex post trade decision are efficiently made. The ex post efficient trade decision is to exchange the specific good whenever the seller’s Time-4 costs are less than the buyer’s valuation, while ex ante efficient level of investment maximises the total expected surplus including both the buyer’s and the seller’s investment costs, given the ex post efficient trade decision.
3.2 The Model:

Thus in an ex post sense (ignoring the “sunk costs” of investments), contract breach is efficient iff: \( v < \tilde{C} \); otherwise performance is efficient.

Thus, \( \Pr[\text{performance}] = \Pr[\tilde{C} \leq V(r^b)] = \Pr[C(r^s) + \theta \leq V(r^b)] \)
\[ = \Pr[\theta \leq V(r^b) - C(r^s)] = F[V(r^b) - C(r^s)] \quad (3.1) \]

And \( \Pr[\text{breach}] = 1 - \Pr[\text{performance}] = 1 - F[V(r^b) - C(r^s)] \) \quad (3.2)

Thus Expected Joint Payoff would be –

\[
EPJ = F(\cdot).\{V(r^b) - r^b - p\} + \{p - E(\tilde{C}|\tilde{C} \leq V(r^b)) - r^s\}
+ \{1 - F(\cdot)\}.\{0 + 0 - r^b - r^s\}
\]
\[ = F[V(r^b) - C(r^s)].\{V(r^b) - E(\tilde{C}|C(r^s) + \theta \leq V(r^b))\} - r^b - r^s \]
\[ = F[\cdot].V(r^b) - F[\cdot].E[C(r^s) + \theta|C(r^s) + \theta \leq V(r^b)] - r^b - r^s \quad (3.3) \]

To check the investment incentives for the contracting parties, we differentiate the above expression and obtain the following expressions:

for the buyer,

\[
EPJ'(r^b) = f(\cdot).V'(r^b).V(r^b) + F(\cdot).V'(r^b) - f(\cdot).V'(r^b).V(r^b) - 1 = 0
\]
\[ \Rightarrow F[V(r^b) - C(r^s)].V'(r^b) = 1 \]
\[ \Rightarrow V'(r^b) = \frac{1}{F[V(r^b) - C(r^s)]]} > 1, \ \because V'(r^b) > 0, V''(r^b) < 0 \quad (3.4) \]

for the seller,

\[
EPJ'(r^s) = f(\cdot).(-C'(r^s)).V(r^b) - f(\cdot).(-C'(r^s)).V(r^b) + F(\cdot).(-C'(r^s)) - 1 = 0
\]
\[ \Rightarrow F[V(r^b) - C(r^s)].C'(r^s) = -1 \]
\[ \Rightarrow C'(r^s) = \frac{1}{F[V(r^b) - C(r^s)]]} > 1, \ \because C'(r^s) < 0, C''(r^s) > 0 \quad (3.5) \]
The term \( F[V(.) - C(.)] \) in the first order equilibrium condition reflects the probability that the specific investment actually pays off and the efficient level of investment is an increasing function of this probability.

\[ \Box \]

### 3.3 Court-imposed Remedies for Breach of Contract

Given the conditions for socially optimal breach and investments, we now turn to assess the impact of available remedies. We start with Reliance and Restitution damages.

#### 3.3.1 Reliance and Restitution Damage Measures:

Since we consider here a case of unilateral breach by the seller, let us denote the reliance damage to the buyer by \( D_r = \beta r^b \), where \( \beta \in [0, 1] \) is that part of the entire reliance undertaken by the buyer which is ex post verifiable into the court, (but put off the debate on verifiability of reliance for the time being). Notice here, we have identified a relation between the reliance damage and restitution damage measures through the variation in the value of \( \beta \); when \( \beta = 1 \), full reliance cost is recoverable; and when \( \beta = 0 \), no damage is recovered which is synonymous with restitution damage.

Now the seller's payoff when the contract is honoured is: \( P - \tilde{C} \); and when she breaches her wealth: \( -D_r \). Thus the seller chooses to perform when: \( P - \tilde{C} \geq -D_r \), i.e. \( P + \beta r^b \geq \tilde{C} \), otherwise breaches. So the seller breaches too frequently relative to the first best level.

Therefore, \( \Pr[\text{performance}] = \Pr[\tilde{C} < P + \beta r^b] = F[P + \beta r^b - C(r^*)] \)
Now the buyer’s expected payoff would be –

\[ EP_B = F(.)[V(r^b) - r^b - P] + \{1 - F(.)\} \{\beta r^b - r^b\} \] (3.6)

The first order condition for buyer’s payoff maximisation can be derived as –

\[ EP_B'(r^b) = f(.)\beta [V(r^b) - P - \beta r^b] + F(.)V'(r^b) - (1 - \beta) - F(.)\beta = 0 \]

Thus at the efficient level of reliance by the buyer, we get the following –

\[ \Rightarrow V'(r^b) = (1 - \beta)/F(.) + \beta - \beta[V(r^b) - P - \beta r^b].f(.)/F(.) \; \text{if} \; 0 < \beta < 1 \]

\[ = 1 - \frac{[V(r^b) - P - r^b].f[P + r^b - C(r^s)]}{F[P + r^b - C(r^s)]}, \quad \text{if} \; \beta = 1 \]

\[ = \frac{1}{F[P - C(r^s)]}, \quad \text{if} \; \beta = 0, \text{[this equals Restitution damage]} \]

Similarly, the seller’s expected payoff would be –

\[ EPS = F(.)[P - r^s - E(\hat{C} | \hat{C} \leq P + \beta r^b)] + \{1 - F(.)\}[-\beta r^b - r^s] \]

The first order condition for seller’s payoff maximisation can be derived as –

\[ EPS'(r^s) = F[P + \beta r^b - C(r^s)].[-C'(r^s)] - 1 = 0 \]

thus we get the following –

\[ \Rightarrow -C'(r^s) = \frac{1}{F[P + \beta r^b - C(r^s)]}, \quad \text{if} \; 0 < \beta < 1 \]

\[ = \frac{1}{F[P + r^b - C(r^s)]}, \quad \text{if} \; \beta = 1 \]

\[ = \frac{1}{F[P - C(r^s)]}, \quad \text{if} \; \beta = 0, \]

We now compare the reliance levels by the buyer and the seller under the two different remedies with those chosen in the first best setting –
3.3 Court-imposed Remedies for Breach of Contract

**Under Restitution Measure** (when \( \beta = 0 \)):

Note that, since \( V(r) > p \), we must have \( F[P - C(r^*)] < F[V(r^b) - C(r^s)] \), and so:

For the buyer,

\[
V'(r^b) = \frac{1}{F[P - C(r^s)]} > \frac{1}{F[V(r^b) - C(r^s)]}
\]  

(3.7)

⇒ The buyer under invests in reliance compared to the first best.

For the seller,

\[
-C'(r^s) = \frac{1}{F[P - C(r^s)]} > \frac{1}{F[V(r^b) - C(r^s)]}
\]  

(3.8)

⇒ The seller also makes less investment with respect to the first best. \( \Box \)

Comparing (3.4) with (3.7) and (3.5) with (3.8), we can establish the following proposition (the “hold-up” consequence for both the parties):

**Proposition 3.1**: In a fixed-price contract under a regime of no contractual damage liability, each party chooses a level of reliance investment that is less than first best level, given the other party’s investment.

**Remarks:**

1. **Divergence between Private and Social Gain**: The distorted investment result arises from the divergence between a party’s private gain and the social benefit from reliance. From the social point of view, the buyer should raise \( r^b \) as long as the benefit, in terms of increased surplus, exceeds the marginal cost of 1. From the buyer’s private point of view, however, it pays to raise \( r^b \) as long as his private benefit, in terms of the fraction of the surplus he can extract, exceeds his marginal cost of 1. Since the buyer in this case has to internalise the social cost of breaching and he expects to be “held up”, namely, he does
not capture the full benefit of her reliance, but only a fraction of it, the buyer is led to strike a suboptimal balance.

2. The seller would also undertake less investment compared to the first best. This is because – first, in case of breach she does not need to make any monitory payment; and secondly, as she breaches to too frequently given a contractually specified low price, her motivation to investment in reducing the cost does not get the required encouragement.

3. Note that in case the seller, during the bargaining of contractual price, is capable of raising it, then the reliance investments by both party would increase accordingly.

4. The under-investment problem basically stems from ex post allocative inefficiency, which in turn depends on the initial contractual price.

**Under Reliance Measure** (when $\beta = 1$):

For the buyer, 
\[
V'(r^b_R) = 1 - \left[ V(r^b_R) - P - r^b_R \right] \frac{F[P + r^b_R - C(r^a_R)]}{F[P + r^b_R - C(r^a_R)]} 
\]
\[
\leq 1 < \frac{1}{F[V(r^{b\ast}) - C(r^{a\ast})]} 
\]

$\Rightarrow$ Thus the buyer would over-invest compared to first best.

And for the seller, 
\[
-C'(r^a_R) = \frac{1}{F[P + r^b_R - C(r^a_R)]} > \frac{1}{F[V(r^{b\ast}) - C(r^{a\ast})]} 
\]

$\Rightarrow$ The seller still be investing less relative to the first best; but the amount is higher when compared to the no-damage situation, as $F[P - C(r^a_R)] < F[P + r^b_R - C(r^a_R)]$.

We summarise the above results in the form of following proposition –
Proposition 3.2: With a fixed-price contract under a regime of reliance damage liability, the uninformed victim (here the buyer) will over-invest in reliance (given the level of reliance by the other party), whereas the other party i.e. the informed breacher would under-invest in reliance always irrespective of the level of reliance by the buyer.

Remarks: Intuition – Under reliance damages, the victim party (buyer) can shift the cost of reliance to the other party only in the event that the contract is breached, because this is the contingency where the seller has to pay $r^b$. At the same time, the benefit to him from increasing its investment is greater than merely the incremental value created; the benefit also includes the increased likelihood that the contract will be performed rather than breached. This induces the seller to raise her level of investment, so as to reduce the likelihood of suffering the cost of increased damages. With higher level of precautions, the buyer would be more likely to receive $V(r^b)$, rather than just $r^b$, and we know that $V(r^b) > r^b$. The seller under-invests in reliance because she has to protect against only part of the loss that may occur. Although the total loss from breach is $V(r^b)$, the seller would sustain only a fraction of it, which is $r^b$. Note also that the reliance investments by both the parties tend to increase as contracted price increase.

3.3.2 Expectation Damage:

Expectation damages are measured ex post and are calculated to make the injured party exactly as well off as if the contract were fully performed. As before, the Expectation damage would be measured as: $D_e = V(r^b) - p$. Therefore, the seller would perform only
when \( p - \tilde{C} \geq -D_e \) i.e. \( \tilde{C} \leq V(r^b) \), otherwise she would like to breach the contract.

Now, \( \Pr[\text{performance}] = F[V(r^b) - C(r^s)] \).

Thus the buyer’s expected payoff becomes –

\[
EPB_e = F(.)[V(r^b) - r^b - p] + [1 - F(.)][D_e - r^b]
\]

\[
= V(r^b) - r^b - p, \quad \text{Replacing } D_e = V(r^b) - p.
\]

Therefore the F.O.C. gives us, \( V'(r^b_E) = 1 \). \hspace{1cm} (3.11)

\( \Rightarrow \) the buyer makes over-investment in reliance.

Similarly, the seller’s expected payoff becomes –

\[
EPS_s = F(.)[p - E(\tilde{C} | \tilde{C} \leq V(r^b)) - r^s] + [1 - F(.)][D_e + p - r^s]
\]

\[
= p - r^s - V(r^b) + F(.)V(r^b) - F(.)E(\tilde{C} | \tilde{C} \leq V(r^b)).
\]

The F.O.C. implies that –

\[
EPS'_s(r^s) = -1 + f(.)(-C'(r^s)).V(r^b) - f(.)(-C'(r^s)).V(r^b) - F(.).C'(r^s) = 0
\]

\( \Rightarrow \) \( F[V(r^b) - C(r^s)].C'(r^s) = -1 \)

\[
\Rightarrow - C'(r^s_E) = \frac{1}{F[V(r^b_E) - C(r^s_E)]} < \frac{1}{F[V(r^b^*) - C(r^{s*})]} = -C'(r^{s*}) \quad (3.12)
\]

\( \Rightarrow \) The seller makes over-investment in reliance. \( \blacksquare \)

**Observations:**

1. The promisee (buyer) would over-invest in reliance.

*Intuition: Suppose that the buyer can make an investment that will increase value only if the parties trade. If the trade turns out to be inefficient i.e. the seller’s production cost exceeds the buyer’s value, the investment will have been wasted. The buyer, in choos-
ing an investment level, thus should consider the return on the investment in states of the world in which the parties trade – positive, and the return on the investment in states of the world in which the parties do not trade – zero. Contract law, however, awards the buyer the difference between the buyer’s valuation given his investment and the price when the parties do not trade; the buyer thus is fully insured against lost valuations regardless of the investment level he chose. The buyer thus invests too much.

2. The promisor (seller) undertakes over-investment in reliance.

**Intuition:** The reason for this excessive reliance by the seller is: Under the expectation measure, the buyer chooses an excessive level of reliance, and the seller has to fully internalise the buyer’s actual loss from breach. This makes the breach contingency more costly for the seller than it would have been under optimal reliance. Hence, the seller increases her investments, to reduce the likelihood of sustaining this enhanced cost.

3. It would be quite interesting to analyse the case when the buyer makes selfish investment and the seller undertakes reliance investment that only augments the buyer’s value of performance (cooperative investment). It may well be socially beneficial for the seller to undertake that reliance, but her incentive to do so may be limited if this were to increase the damages she would have to pay under the expectation measure. These issues are left open for future research.

4. With the help of the following corollary, we establish that when one of the two contracting parties, possessing ex post private information, simultaneously controls reliance decision and the breach decision, then the first best solution can be achieved un-
der expectation damage with a fixed-price contract in a unilateral investment framework, provided trade is a binary choice i.e. \{0,1\}.

**Corollary 1:** (Case of Unilateral Investment by promisor)

*In a unilateral investment case, expectation damage induces first best investment and breach (even in a binary trading choice) when the informed party explicitly controls breach and investment decisions.*

**Proof:** As before, when \( r^b = 0 \), the expectation damage would be measured as \( D_e = V(0) - p \). Therefore, the seller would perform only when \( p - \tilde{C} \geq -D_e \) i.e. \( \tilde{C} \leq V(0) \), otherwise she would like to breach the contract.

Thus, \( \Pr[\text{efficient performance}] = F[V(0) - C(r^s)] \).

Therefore the buyer's expected payoff becomes

\[
EPB_e = F(.)[V(r^b) - r^b - p] + [1 - F(.)][D_e - 0] = V(0) - 0 - p, \tag{3.13}
\]

Similarly, the seller's expected payoff becomes

\[
EPS_s = F(.)[p - E(\tilde{C} | \tilde{C} \leq V(0)) - r^s] + [1 - F(.)][-D_e + p - r^s] \\
= p - r^s - V(0) + F(.)V(0) - F(.)E(\tilde{C} | \tilde{C} \leq V(0)) \tag{3.14}
\]

The F.O.C. implies that

\[
EPS'_e(r^s) = -1 + f(.)\{ -C'(r^s) \}.V(0) - f(.)\{ -C'(r^s) \}.V(0) - F(.)C'(r^s) = 0 \\
\Rightarrow C'(r^s) = -1/F[V(0) - C(r^s)] \tag{3.15}
\]

This exactly corresponds to the first best condition when we insert \( r^b = 0 \) in equation (3.5). This means the seller makes efficient investment again when only she invests. \( \blacksquare \)
**Remark:** In a unilateral investment case, our result is more general in the sense that even with binary quantity choice expectation damage induces efficient investment. Edlin et. al. (1996) established the efficiency of expectation damage in a divisible and continuous trading choice (with the help of renegotiation). The seller, whose cost is uncertain and non-verifiable, controls both the breach decision and reliance. To see why control matters, suppose that \( g \) is the expectation return of victim and denote the surplus under a contract as \( W \); the surplus is the sum of the parties’ profits. The breaching party thus receives the amount \((W - g)\), the surplus that remains after compensating the victim. Suppose that this party could make a self investment. The investment benefits her by increasing the total surplus but the investment (being selfish) does not directly affect the victim’s return \( g \). The breaching party thus is the full residual claimant and so she makes investments whose return exceeds the cost.

We can establish following important claim from the above discussions –

**Claim 3.1:** In case of one-sided asymmetry under a fixed price incomplete contract with a binary trading choice: (a) one-sided investment: if only the breaching party (who has ex post private information) invests then the expectation damage remedy would induce efficient reliance investment (b) bilateral investment: the expectation damage remedy would induce both the parties to over invest. Efficient breach is always achieved.

**Note:** Thus when the parties form a contract they should choose the price in such a way that the party who is investing and has uncertainty related to its valuation becomes
the potential breacher. This would ensure efficiency not only in performance but also in reliance. In the subsection 3.4.3 (case SB) we shall deal with these issues in more detail.

3.4 Further on Private Information, Expectation Damage and the Investment Incentives: A Mechanism Design Approach

So far we have been considering a case of where the informed party chooses to breach the contract; so that assessing the expectation interest of the victim by court was possible. In this subsection we rather permit the breach by either of the two parties irrespective of whether it holds private information or not. This allows a more general treatment. A setting of two-sided reliance investment is explored where one of the two parties receives information about his/her valuation or cost function that remains hidden to the other party and to courts. When the non-breaching party holds the private information, the verification of expectation damage is difficult. In this situation, he may be denied the recovery of expectation damage as the courts may be unable gauge it correctly. This has a direct implication for the incentives to the parties under expectation damage.

3.4.1 The general setting

As before, a buyer (B) and a seller (S), both risk-neutral, after signing a contract choose to make reliance investments $r_b, r_s \in R^+ = [0, \infty)$ before nature reveals the value of parameter $\theta$ from an interval $\Theta = [\theta_L, \theta_H]$ where $\theta_H > \theta_L \geq 0$; where $\theta$ is a random variable and its realisation is observed only by one party and is thereby not contractible. The other party has a prior probability distribution over $\theta$. After $\theta$ is realised, the perfor-
mance decision \( q \in Q \) is made. In the present setting, \( Q \) is assumed to be a subset of the positive real line of an interval \( Q = [q_L, q_H] \).

Notice here, so far we have been using a binary choice model in the same ethos as Shavell (1980) whereas Edlin and Reichelstein (1996) deal with continuous performance choice. [We shall make necessary comments related to binary setting at relevant places.]

Say, ex post trading surplus amounts to –

\[
G_B(r^b, r^s, \theta, q) = V(r^b, \theta, q) - C(q, r^s), \text{ if } B \text{ holds private information,}
\]

and

\[
G_S(r^b, r^s, \theta, q) = V(r^b, q) - C(q, \theta, r^s), \text{ if } S \text{ holds private information;}
\]

where \( V(\cdot) \) denotes the buyer's valuation function and \( C(\cdot) \) the seller's cost function.

In either case, at the investment stage, the effect of reliance investments on social surplus is uncertain due to the presence of uncertainty factor \( \theta \). We shall be treating these two cases separately. Keeping with flow of current analysis here we shall take up the case when only the seller holds the private information but either party can unilaterally choose to breach.

We shall demonstrate the buyer's private information case in the appendix of this chapter.

We require the following assumptions for optimal and interior solutions.

**Assumptions:**

(a). \( V(\cdot) \) is increasing and strictly concave in \( q \); i.e. if \( q < q' \) then \( V(\cdot, q) < V(\cdot, q') \).

(b). \( C(\cdot) \) is increasing and strictly convex in \( q \); i.e. if \( q < q' \) then \( C(\cdot, q) < C(\cdot, q') \).

(c). If \( \theta < \theta' \), then \( V(\cdot, \theta') > V(\cdot, \theta), \forall r^b, q \).

(d). If \( \theta < \theta' \), then \( C(\cdot, \theta') < C(\cdot, \theta), \forall r^s, q \).

45 Alternatively it may be just binary \( Q = \{q_L, q_H\} \), equivalently \( \{0, 1\} \) i.e. \( q_L = 0 \) stands for not perform and \( q_H = 1 \) means perform. In the case of continuous performance choice, \( q \) can be thought of as the quantity or quality of a divisible good to be exchanged.
**Explanation:** Assumption (a) requires that the buyer's payoff net of investment costs to be strict monotonically increasing and concave as a function of performance choice. Assumption (b) requires that seller's payoff net of investment costs to be monotonically increasing (and concave). Assumption (c) guarantees that buyer's payoff increases with respect to increase in \( \theta \) i.e. private information. Similarly, assumption (d) requires that as private information factor rises for the seller, her cost decreases.

### 3.4.2 The First Best:

We construct the first best solution through backwards induction, as a reference point. The ex post socially best response performance choice exists and which is 
\[
q^+(r^b, r^s, \theta) \in \arg \max_{q \in Q} G_S(r^b, r^s, \theta, q)
\]
that maximises social surplus at the performance stage (ex post) where reliance investment and the move of nature are given. Note that this performance choice is unique\(^\text{46}\) for each type. Correspondingly, we define the social surplus net of investment costs as follows –

\[
W(r^b, r^s, \theta, q^+) = V(r^b, q^+) - C(r^s, \theta, q^+) - r^b - r^s. [S \text{ holds private information}]
\]

Thus efficient reliance investments are then defined as –

- for the buyer,

\[
r^{b*} \in \arg \max_{r^b \in R} E_\theta[W(r^b, r^s, \theta, q^+(r^b, r^s, \theta))],
\]

- and for the seller,

\[
r^{s*} \in \arg \max_{r^s \in R} E_\theta[W(r^b, r^s, \theta, q^+(r^b, r^s, \theta))]
\]

\(^{46}\) Uniqueness of efficient trades simplifies the exposition, but all results can be restated for multiple efficient trades. Indeed, note that Lemma 2 (see infra) holds with multiple maximizers, for any selection of maximizers. One way to ensure single-valuedness is by assuming that \( W(r^b, r^s, \theta, q) \) is strictly concave in \( q \), which is actually done here.
that maximise the ex ante expected social surplus. Now folding back these efficient reliance choices into the socially best performance decision, we therefore define the efficient performance choice as $q^*(\theta) = q^+(r^{b*}, r^{s*}, \theta)$, i.e. this is the socially best response to efficient reliance investments. It then follows that –

$$r^{b*} \in \arg \max_{r^b \in R} E_\theta[W(r^b, r^s, \theta, q^*(\theta))]$$  \hspace{1cm} (3.16)

and

$$r^{s*} \in \arg \max_{r^s \in R} E_\theta[W(r^b, r^s, \theta, q^*(\theta))]$$  \hspace{1cm} (3.17)

must also hold. □

Before proceeding further we establish three important auxiliary results for later reference. We use a tool known as “monotone comparative statics”, which investigates the optimum points of a system with respect to changes in the parameters in a monotonic way (i.e., the solution is always either non-increasing or non-decreasing in the parameter).

The key to ensure monotone comparative statics is the following: [Note here that we use a discrete type just for analytical convenience.]

**Assumptions:**

**(e).** For the function $W(.)$, if $\theta < \theta'$, then $\{W(r^b, r^s, \theta', q) - W(r^b, r^s, \theta, q)\}$ is strictly monotonically increasing as a function of $q \in Q$. [SCP]

**(f).** For the function $W(r^b, r^s, \theta, q)$, $\forall q'' > q'$ such that $q'', q' \in Q$, the difference $\{W(., \theta, q'') - W(., \theta, q')\}$ is strictly increasing in $\theta \in \Theta$. [ID]

**(g).** If $q < q'$ then the difference $\{W(r^b, r^s, \theta, q') - W(r^b, r^s, \theta, q)\}$ is monotonically increasing as a function of $r^j$, $\forall j = b, s$. 

Explanation: The condition (e) is well-known 'single-crossing property' in mechanism design. Similarly, (g) means that, net of investment costs, the marginal social product is an increasing function of investments. This means that investments are specific. And finally, assumption (f) is known as 'Increasing Difference'. It turns out that the analysis of contracting is dramatically simplified when the Agent's types can be ordered so that higher types choose a higher consumption.

We now establish following three important lemmata for future reference.

**Lemma 3.1.** If $W(r^b, r^s, \theta, q)$ is continuously differentiable and satisfies SCP, and $Q$ is an interval, then $W(r^b, r^s, \theta, q)$ satisfies ID.

**Proof.** For $\theta'' > \theta'$, $[\forall \theta'', \theta' \in \Theta]$

$$W(r^b, r^s, \theta'', q'') - W(r^b, r^s, \theta'', q') = \int_{q'}^{q''} W_q(r^b, r^s, \theta'', q) dq$$

$$> \int_{q'}^{q''} W_q(r^b, r^s, \theta', q) dq$$

$$= W(r^b, r^s, \theta', q'') - W(r^b, r^s, \theta', q').$$

Note that if the Agent's value function $V(., \theta, q)$ satisfies ID, then the indifference curves for two different types of the Agent, $\theta'$ and $\theta'' > \theta'$, cannot intersect more than once. Indeed, if they intersected at two points $(q', t')$, $(q'', t'')$ with $q'' > q'$, this would mean that the benefit of increasing $q$ from $q'$ to $q''$ exactly equals $\{t' - t''\}$ for both types $\theta'$ and $\theta''$, which contradicts ID. This observation justifies the name of "single-crossing property".

---

47 In a differentiable setting, this would hold if the second derivative $W_{\theta q} > 0$ is positive. The Single-Crossing Property was first suggested by Spence (1972) and Mirrlees (1971). Our definition is a simplified version for preferences that are quasi-linear in transfers $t$. Our SCP was introduced by Edlin and Shannon [1998] under the name "increasing marginal returns".

48 This property is more precisely called strictly increasing difference, see e.g. Topkis [1998].
A key result in monotone comparative statics says that when the objective function satisfies ID, maximisers are non-decreasing in the parameter value \( \theta \). Moreover, if SCP holds and maximisers are interior, they are strictly increasing in the parameter. Formally,

**Lemma 3.2.**: Under the single-crossing property, the socially best response performance choice is in the interior of \( Q \) and is a monotonically increasing function of private information held by the contracting parties; i.e. ex post efficient performance choice will typically be state-contingent and interior.

In other words:

Let \( \theta' > \theta \), \( q^+(r^b, r^s, \theta') \in \text{arg max}_{q \in Q} W(r^b, r^s, \theta', q) \) \& \( q^+(r^b, r^s, \theta) \in \text{arg max}_{q \in Q} W(r^b, r^s, \theta, q) \).

Thus, (a) if \( W(., \theta, q) \) satisfies ID, then \( q^+(r^b, r^s, \theta') \geq q^+(r^b, r^s, \theta) \).

(b) if, moreover, \( W(., \theta, q) \) satisfies SCP, and either \( q^+(r^b, r^s, \theta) \) or \( q^+(r^b, r^s, \theta') \) is in interior of \( Q \) [i.e. \( q_l(r^b, r^s, \theta) \leq q^+(r^b, r^s, \theta) \leq q_h(r^b, r^s, \theta) \)], then \( q^+(r^b, r^s, \theta') > q^+(r^b, r^s, \theta) \); where \( q_l \) and \( q_h \) are respectively some low level and high level of quantities.

**Proof**: We prove the lemma in two steps. In the first step we show that the ex post performance choice is state contingent; and our second step proves that the socially best response quantity choice is an interior solution for a given realisation of information parameter. In this regard, without any loss of generality we suppress the reliance arguments for notational simplicity.

**STEP-1**: Following revealed preference, by construction we have –

\[
W(., \theta, q^+(., \theta)) \geq W(., \theta, q^+(., \theta'))
\]

and,

\[
W(., \theta', q^+(., \theta')) \geq W(., \theta', q^+(., \theta)).
\]
Adding up vertically and rearranging the terms we have –

\[ W(., \theta', q^+ (., \theta')) - W(., \theta', q^+ (., \theta')) \geq W(., \theta, q^+ (., \theta')) - W(., \theta, q^+ (., \theta')). \]

Notice here that this is the same condition as our ID. By ID, this inequality is only possible when \( q^+(r^b, r^s, \theta') > q^+(r^b, r^s, \theta) \). Hence proved.

In a similar vein, we can further prove that –

\[ W(., \theta', q^+ (., \theta')) > W(., \theta, q^+ (., \theta')) , \]

and,

\[ W(., \theta, q^+ (., \theta')) < W(., \theta', q^+ (., \theta')) . \]

⇒ Ex post efficient performance choice is positively dependent on private information. ■

**STEP-2:** For some performance decision \( q_h(r^b, r^s, \theta) > q^+(r^b, r^s, \theta) \), by assumption (e), we then have –

\[ W(., \theta', q^+ (., \theta')) - W(., \theta, q^+ (., \theta')) \leq W(., \theta', q_h(., \theta')) - W(., \theta, q_h(., \theta)) \]

and, hence,

\[ W(., \theta, q_h(., \theta)) < W(., \theta, q^+ (., \theta)) - \{W(., \theta', q^+ (., \theta)) - W(., \theta', q_h(., \theta))\} \]

\[ \leq W(., \theta, q^+ (., \theta)) . \]

⇒ For a particular realisation of \( \theta \), there is no performance decision in the range above \( q^+(r^b, r^s, \theta) \) that maximises \( W(r^b, r^s, \theta, q) \). In a similar fashion, we can also prove that for any performance choice in the range below \( q^+(r^b, r^s, \theta) \) [i.e. say, \( q_l(r^b, r^s, \theta) < q^+(r^b, r^s, \theta) \)] the welfare \( W(r^b, r^s, \theta, q) \) won't be maximised, and, hence, one part of Lemma 2 is hereby established.
Alternatively, suppose for definiteness that $q^+ (., \theta)$ is in the interior of $Q$. Then the following first order condition must hold:

$$W_q (., \theta, q^+ (., \theta)) = 0.$$ 

But then by SCP we have

$$W_q (., \theta', q^+ (., \theta)) > W_q (., \theta, q^+ (., \theta)) = 0,$$

and therefore $q^+ (., \theta)$ cannot be optimal for parameter value $\theta'$, a small increase in $q$ would increase $W (.)$. Since by assumption (a), $q^+ (., \theta') \geq q^+ (., \theta)$, we must have

$$q^+ (., \theta') > q^+ (., \theta).$$

Note: In a differentiable setting where the socially best response is an interior solution, the socially best response quantity (performance) choice will be strictly monotonically increasing as a function of private information. In particular, ex post efficient performance choice will typically be state-contingent.

**Lemma 3.3.:** There exist some constant contractual performance decisions [other than $q^+ (.)$] such that the ex ante optimal reliance investments turn out to be lower or higher, when compared to first best efficient level of investments.

Alternatively, suppose assumption (g) is met, then there's an optimal level of reliance for each quantity choice.

Alternatively, suppose assumption (g) is met. Then, for all $i = L, H$ and $j = b, s$; there exists a choice of reliance, $r^j_i \in \arg \max_{r^j_i \in R} E_\theta [W (r^b, r^s, \theta, q_i)]$ such that $r^j_L \leq r^j_* \leq r^j_H$ corresponding to $q_L \leq q^* \leq q_H$. 
Proof. Given \( b^* \) and any contractual performance choice \( q_L \) (where \( q_L < q_L^* \)), for any investment by the seller \( r^* > r^{**} \), following the assumption \((f)\) we have that

\[
W(r^{b*}, r^{s*}, \theta, q^*(\theta)) - W(r^{b*}, r^{s*}, \theta, q_L) \leq W(r^{b*}, r^*, \theta, q^*(\theta)) - W(r^{b*}, r^*, \theta, q_L)
\]

Now taking expectation on both sides and changing sides we get that –

\[
E_\theta[W(r^{b*}, r^*, \theta, q_L)] \leq E_\theta[W(r^{b*}, r^{s*}, \theta, q_L)] - E_\theta\{W(r^{b*}, r^{s*}, \theta, q^*(\theta)) - W(r^{b*}, r^*, \theta, q^*(\theta))\}
\]

must hold. Therefore, \( E_\theta[W(r^{b*}, r^*, \theta, q_L)] \) attains a maximum in the range \( r^* \leq r^{**} \) and the first claim of Lemma is established. The second claim of Lemma can be established in the similar way.

Observe, if the difference in assumption \((b)\) is strictly monotonically increasing in \( r^j \) and if efficient performance is inner (i.e. \( q^*(\theta) \in [q_L, q_H] \)) with positive probability then the claims of Lemma 3 would hold for any \( r^*_j \in \arg\max_{r^*_j \in R} E_\theta[W(r^{b*}, r^*, \theta, q_i)] \).

Note here, in a differentiable setting with continuous performance choice, it follows from Lemma 3 that an intermediate performance decision \( q_{oo} \in Q \) [i.e. \( q_L < q_{oo} < q_H \)] exists such that \( r^{j*} \in \arg\max_{r^*_j \in R} E_\theta[W(r^{b*}, r^*, \theta, q_{oo})] \), \( \forall j \) holds. Moreover, it follows from the assumed structure of social surplus that

\[
\arg\max_{r^*_b \in R} E_\theta[W(r^{b*}, r^*, \theta, q_{oo})] = \arg\max_{r^*_b \in R} [V(r^{b*}, q_{oo}) - r^b], \quad (3.18)
\]

and

\[
\arg\max_{r^*_b \in R} E_\theta[W(r^{b*}, r^*, \theta, q_{oo})] = \arg\max_{r^*_b \in R} \{E_\theta[C(r^*, \theta, q_{oo})] - r^s\} \quad (3.19)
\]

must hold if it is the seller who obtains private information.
3.4.3 Mechanisms under the shadow of expectation damages:

When one of the two parties' valuations is private information, it may be particularly difficult for the courts to award the correct amount of damages in case the party with private information turns out to be the victim of contract breach. The parties, when confronted with such problems of hidden information, may take resort to the sophisticated revelation mechanisms. The general setting as introduced earlier allows us to implement the first best solution with a mechanism of the Clarke-Groves type. The transfer payments under a revelation mechanism, that implement the efficient ex post breach and the efficient ex ante reliance investments by the parties, however turn out to be notably different from that of correct ex post expectation damages.

Thus we would rather inspect the provisions that would allow awarding the correct expectation damages even under asymmetric information. In other words, we shall investigate the class of mechanisms that reflect expectation damages along the equilibrium path correctly. Following Shavell (1980) and Edlin and Reichelstein (1996), the initial contract \([q^0, T^0]\) categorically specifies the parties contractual obligations – the seller's choice of performance is fixed at \(q^0 \in Q\), and upon this performance the buyer must pay \(T^0\) to the seller. The two cases will be distinguished according to which party obtains private information and which party considers breaching the contract.

(i) Case SB

In the case SB, it is the seller who obtains private information but it is the buyer who considers breach. Suppose, just before the seller's starts production, the buyer notifies the seller to accept delivery of some quantity \(q \leq q^0\) only. So he breaches for the remaining
quantity and therefore owes a compensation to the seller according to expectation damage. But, in principle, the seller must grant a reduction of payments in the amount of his cost savings \[C(r^s, \theta, q^o) - C(r^s, \theta, q)\]. Due to hidden information, however, courts may no longer be able to administer such a price reduction correctly.

Had it been properly administered, suppose we are in a situation when the information is symmetric between the parties, then the seller’s payoff would have been

\[
\Psi(r^b, r^s, \theta, q) = T^o - C(r^s, \theta, q) - r^s - [C(r^s, \theta, q^o) - C(r^s, \theta, q)]
\]

\[
= T^o - C(r^s, \theta, q^o) - r^s .
\]

Thus the seller in the face of anticipatory breach by the buyer is as well off as the contract is honoured when compensated through actual expectation damage. In that case, the seller’s final payoff strictly depends on the initial contractual quantity choice which is \(q^o\).

The seller would thus choose her investment according to

\[
r^s_E \in \arg \max_{r^s \in R} E_\theta[\Psi(r^b, r^s, \theta, q^o)]
\]

\[
\neq \arg \max_{r^s \in R} E_\theta[W(r^b, r^s, \theta, q^+((r^b, r^s, \theta))] = r^{s*}.
\]

And hence she would have an incentive to rely higher or lower than the socially best level which crucially depends upon the initially contracted higher or lower performance choice \(q^o\). In this case, the first best solution can be implemented by just requiring the parties to specify a suitable initial contractual quantity choice \(q^o = q^{o\theta}(\text{in the light of Lemma 3})\) and the buyer to mitigate damages as per actual expectancy of the seller resulting from breach.
If the buyer announces anticipatory breach \( q \leq q^o \), upon receiving the benefit of reduction in payment to the tune of \( [C(r^b, \theta, q^o) - C(r^b, \theta, q)] \), his payoff amounts to –

\[
\Phi(r^b, r^s, \theta, q) = V(r^b, q) - T^o - r^b + [C(r^s, \theta, q^o) - C(r^s, \theta, q)]
\]

\[
= [V(r^b, q) - C(r^s, \theta, q) - r^b - r^s] - [T^o - C(r^s, \theta, q^o) - r^s]
\]

\[
= W(r^b, r^s, \theta, q) + [C(r^s, q^o) + r^s - T^o]
\]

and is, up to the first term, dependent on actual performance and equal to social surplus.

Hence, the buyer’s performance choice in equilibrium solves

\[
q^+(r^b, r^s, \theta) \in \arg \max_{q \in Q} \Phi(r^b, r^s, \theta, q) = \arg \max_{q \in Q} W(r^b, r^s, \theta, q)
\]

and coincides with the socially best response i.e. \( q^+(r^b, r^s, \theta) \). Anticipating such a performance choice at the investment stage, the buyer would have the incentive for efficient reliance investments, as –

\[
r^{bs} \in \arg \max_{r^{bs} \in R} E_\theta[\Phi(r^b, r^{bs}, \theta, q^+(r^b, r^s, \theta))]
\]

\[
= \arg \max_{r^{bs} \in R} E_\theta[W(r^b, r^{bs}, \theta, q^+(r^b, r^s, \theta))]
\]

provided the seller invests efficiently.

Note here, the expectation damages remedy entails asymmetric treatment of the contract breacher and the victim of breach. This asymmetry creates a tension between providing efficient incentives for one party and providing incentives for the other. Because damages give the injured party exactly her expectancy, only she is overcompensated for her investment; the breacher winds up with the residual, and so receives exactly the social return to her investment at the margin.
The analysis above works efficiently in a symmetric/complete information framework, but ceases to work in the presence of asymmetric information as the state contingent actual compensation is not possible. The buyer's choice of quantity will not be state contingent but arbitrarily depending upon how the court settles the expectancy of the seller. So anticipating his choice of ex post (inefficient) quantity (corresponding to the court's arbitrary compensation choice) he will undertake a level of investment which will be anything but efficient. However, the preceding analysis uncovers an insight that helps us to design a mechanism using a message game between the parties which ensures efficiency.

- **The Revelation Principle**

To be able to deal with hidden information, we conjecture that the informed party, here the seller, would communicate a message \( m \) out of a set of alternative messages \( M \) once her private information \( \theta \in \Theta \) is realised, but before the performance choice \( q \in Q \) by the buyer is conveyed. The message is expected to affect the net payment (transfer), which the buyer owes to the seller and which may further depend on the seller's actual reliance investments as well as on the buyer's performance decision.

**Definition 1:** A transfer is a function \( T(\cdot) \) which specifies the payments that the buyer has to make in order to receive different amounts \( q \in Q \) of the good.

Depending upon the verifiability of the reliance actions, the transfer schedule can be denoted either by \( T(r^b, r^e, m, q) \) if reliance investments are observed by the parties and verifiable in front of court (i.e. information structure is Partial Private Information, hereafter PPI) or by \( T(m, q) \) if investments are hidden action (environment is CPI). The
incentives provided by each of the aforementioned transfer schedules can be calculated by backwards induction. We consider the PPI environment case first.

\( PPI \text{ Environment (} \theta \text{ is private information but investments are observable):} \) At the performance stage (ex post), when the actual reliance investments and the message are known, the buyer will choose his performance decision according to –

\[
q_B(r^b, r^s, m) \in \arg\max_{q \in Q} \{V(r^b, q) - T(r^b, r^s, m, q)\}.
\]

By anticipating the buyer’s performance choice (for a particular message sent by her), the seller upon realising her private information \( \theta \) would then send a message –

\[
m_S(r^b, r^s, \theta) \in \arg\max_{m \in M} \{T(r^b, r^s, m, q_B(r^b, r^s, m)) - C(r^s, \theta, q_B(r^b, r^s, m))\},
\]

that maximises her payoff. Therefore, folding back this \( m_S(.) \) into the earlier expression of \( q_B(.) \), we denote the resultant equilibrium performance choice by the buyer, along the equilibrium path, as a function of reliance investments of both parties and the private information of the seller,

\[\eta(r^b, r^s, \theta) = q_B(r^b, r^s, m_S(r^b, r^s, \theta)),\]

and thereby the corresponding net transfer will amount to

\[\tau(r^b, r^s, \theta) = T(r^b, r^s, m_S(r^b, r^s, \theta), \eta(r^b, r^s, \theta)),\]

such that the informed party seller’s payoff will be

\[I(r^b, r^s, \theta) = \tau(r^b, r^s, \theta) - r^s - C(r^s, \theta, \eta(r^b, r^s, \theta)).\]
This state-contingent payoff (and the underlying transfer schedule) is said to reflect expectation damages correctly if

\[ I(r^b, r^s, \theta) = T^o - r^s - C(r^b, \theta, \eta(r^b, r^s, \theta)) \]

holds for all information parameters \( \theta \). In fact, the seller would then be awarded with correct expectation damages, at least along the equilibrium path.

Reflecting the correct expectation damages comes at a cost, as our next proposition shows. While it may still be feasible to provide efficient reliance incentives, in the light of Lemma 3, the solution will typically fail to be ex post efficient.

**Definition 2:** Any mechanism to be efficient must satisfy that

(a). the participation constraints are met. \([IR]\)

(b). the incentive constraints are met. \([IC]\)

Let us explain the process. Suppose the transfer schedule \( T(r^b, r^s, m, q) \) gives rise, in equilibrium, to the performance choice \( \eta(r^b, r^s, \theta) \) and the transfer payment \( \tau(r^b, r^s, \theta) \). Notice that disallowing a certain performance \( q \) is equivalent to setting \( T(r^b, r^s, m, q) = +\infty \), and since the agent always has the option to reject the tariff, without loss of generality we constrain the Principal to offer \( T(r^b, r^s, m, q = 0) = 0 \), and assume that the Agent always accepts. Thus, the contractual form of a tariff is quite general, and as we will later see we lose nothing by restricting attention to this form of a contract. Therefore the following two inequalities must hold \( \forall \theta, \theta' \in \Theta \) –

\[ [IR] : \tau(r^b, r^s, \theta) - r^s - C(r^s, \theta, \eta(r^b, r^s, \theta)) \geq C(r^s, \theta, q = 0), \quad \text{and} \]
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\[ [IC] : \tau(r^b, r^s, \theta) - r^s - C(r^s, \theta, \eta(r^b, r^s, \theta)) \geq \tau(r^b, r^s, \theta') - r^s - C(r^s, \theta, \eta(r^b, r^s, \theta')) \]

i.e. \( \tau(r^b, r^s, \theta') - \tau(r^b, r^s, \theta) \geq C(r^s, \theta, \eta(r^b, r^s, \theta)) - C(r^s, \theta, \eta(r^b, r^s, \theta')) \).

Note here, (IR) stands for the familiar Individual Rationality (or Participation) constraints. The (IR) inequality reflects the fact that the agent of type \( \theta \) has the option of choosing performance \( \eta(r^b, r^s, \theta) = 0 \), i.e., rejecting the tariff, but prefers to choose \( \eta(r^b, r^s, \theta) \) which is meant for his type. (IC) stands for incentive-compatibility or self selection or truth telling. The inequalities (IC) reflect the fact that the agent of type \( \theta \) has the option of choosing \( \eta(r^b, r^s, \theta') \), which is the equilibrium consumption of type \( \theta' \), but prefers to choose \( \eta(r^b, r^s, \theta) \).

Now consider a different mechanism in which the principal asks the agent to make an announcement \( \theta' \) and then supplies the agent with the quantity \( \eta(r^b, r^s, \theta') \) in exchange for the payment \( t(., \theta') \). Since the inequalities (IC) are satisfied, each agent will prefer to announce his true type \( \theta' = \theta \), rather than lying. Since the (IR) inequality is satisfied, each type of agent will accept this mechanism.

Before proceeding further, using the definition 2, we derive the following lemma:

**Lemma 3.4:** Suppose SCP is met for \( W(., q, \theta) \) then by construction the negative of the seller’s valuation i.e. \( -C(., q, \theta) \) also satisfies SCP. Then, for all \( \theta, \theta' \in \Theta \), the seller’s incentive constraint requires that

\[ C(r^s, \theta, \eta(r^b, r^s, \theta)) - C(r^s, \theta', \eta(r^b, r^s, \theta)) \leq I(r^b, r^s, \theta') - I(r^b, r^s, \theta) \]

\[ \leq C(r^s, \theta, \eta(r^b, r^s, \theta')) - C(r^s, \theta', \eta(r^b, r^s, \theta')). \]
Moreover, if \( \theta < \theta' \) then \( \eta(r^b, r^s, \theta) \leq \eta(r^b, r^s, \theta') \) i.e. the equilibrium performance choice is a monotonically increasing function of private information.

**Proof:** Since the message sent by the informed party maximises his payoff, then it follows that for a given level of reliance investments and a \( \theta \) we have:

\[
I(r^b, r^s, \theta) = T(r^b, r^s, m_S(r^b, r^s, \theta), q_B(r^b, r^s, m_S(r^b, r^s, \theta)))
\]

\[
- C(r^s, \theta, q_B(r^b, r^s, m_S(r^b, r^s, \theta))) - r^s
\]

\[
= \tau(r^b, r^s, \theta) - C(r^s, \theta, \eta(r^b, r^s, \theta)) - r^s
\]

\[
\geq T(r^b, m_S(r^b, r^s, \theta), q_B(r^b, r^s, m))) - C(r^s, \theta, q_B(r^b, r^s, m)) - r^s
\]

must hold for any other message \( m \neq m_S(\cdot) \); \( \forall m, m_S \in M \). In particular, this must be true for the message \( m = m_S(r^b, r^s, \theta') \) that the seller would have sent in equilibrium after having obtained private information \( \theta' \). It follows that:

\[
I(r^b, r^s, \theta) \geq T(r^b, r^s, m_S(r^b, r^s, \theta'), q_B(r^b, r^s, m_S(r^b, r^s, \theta')))
\]

\[
- C(r^s, \theta, q_B(r^b, r^s, m_S(r^b, r^s, \theta'))) - r^s
\]

\[
= \tau(r^b, r^s, \theta') - C(r^s, \theta, \eta(r^b, r^s, \theta')) - r^s
\]

from which the second inequality of the lemma follows easily.

The first inequality follows from a similar argument for the situation where the true information is \( \theta' \) but the informed party has revealed \( \theta \) instead. Moreover, the monotonicity of performance choice as a function of private information follows from the single-crossing property (assumption (e)) and the two inequalities that have just been established.  \( \square \)
Proposition 3.4: Suppose assumptions (a), (b) and (e) are met. If the transfer schedule \( T(r^b, r^s, m, q) \) reflects correct expectation damages along the equilibrium path then the seller will meet her obligation, i.e. \( \eta(r^b, r^s, \theta) \equiv q^o \) even if it were efficient to breach. Moreover, the buyer has the incentive for reliance investments: \( r^b \in \arg \max_{r^b \in R} [V(r^b, q^o) - T^o - r^b] \), and the seller has the incentive for reliance investments: \( r^s \in \arg \max_{r^s \in R} E_{\theta}[T^o - C(r^s, \theta, q^o) - r^s] \), which are efficient under a contract stipulating \( q^o = q^{oo} \) (if \( q^{oo} \) exists).

Proof: Let \( \theta^o = \sup \{ \theta \in \Theta : \eta(r^b, r^s, \theta) \leq q^o \} \) under which the performance choice does not exceed the quantity specified in the contract. It then follows from the monotonicity established in Lemma 3 that, for any \( \theta < \theta^o \), we have \( \eta(r^b, r^s, \theta) \leq q^o \).

Moreover, if \( \theta' < \theta'' < \theta^o \), then we have –

\[
C(r^s, \theta', \eta(r^b, r^s, \theta')) - C(r^s, \theta'', \eta(r^b, r^s, \theta'')) \\
\leq C(r^s, \theta', q^o) - C(r^s, \theta'', q^o) \\
\leq C(r^s, \theta', \eta(r^b, r^s, \theta'')) - C(r^s, \theta'', \eta(r^b, r^s, \theta''));
\]

because, in this range of information parameters, the seller’s payoff is the same as if the buyer had met his obligation. It then follows from SCP that \( \eta(r^b, r^s, \theta') \leq q^o \leq \eta(r^b, r^s, \theta'') \) must hold for any two information parameters \( \theta' < \theta'' < \theta^o \).

For any \( \theta < \theta^o \), consider two information parameters \( \theta' < \theta < \theta'' < \theta^o \) from this range and apply the above findings pair wise. In particular, \( \eta(r^b, r^s, \theta') \leq q^o \leq \eta(r^b, r^s, \theta) \) and \( \eta(r^b, r^s, \theta) \leq q^o \leq \eta(r^b, r^s, \theta'') \) must both hold, from which it follows that \( \eta(r^b, r^s, \theta) = q^o \) must be constant over the range \( (\theta_L, \theta^o) \).

Next, consider information parameters from the range \( \theta^o < \theta < \theta_H \). For such parameters, \( q^o < \eta(r^b, r^s, \theta) \) must hold as follows from the monotonicity of the equilibrium.
performance choice. Moreover, in this range, the net payoff of the seller amounts to

\[ I(r^b, r^s, \theta) = T^0 - C(r^s, \theta, \eta(r^b, r^s, \theta)) - r^s, \]

which, combined with the incentive constraints from Lemma 3, is leading to

\[ C(r^s, \theta', \eta(r^b, r^s, \theta')) - C(r^s, \theta'', \eta(r^b, r^s, \theta')) \]

\[ \leq C(r^s, \theta', \eta(r^b, r^s, \theta'')) - C(r^s, \theta'', \eta(r^b, r^s, \theta'')) \]

\[ \leq C(r^s, \theta', \eta(r^b, r^s, \theta'')) - C(r^s, \theta'', \eta(r^b, r^s, \theta')) , \]

for any two information parameters in the range \( \theta^0 < \theta' < \theta'' < \theta_H \) and, hence, to

\[ C(r^s, \theta'', \eta(r^b, r^s, \theta')) \geq C(r^s, \theta', \eta(r^b, r^s, \theta'')) \]

and, \( C(r^s, \theta', \eta(r^b, r^s, \theta'')) \geq C(r^s, \theta', \eta(r^b, r^s, \theta')) \).

It then follows from the monotonicity of utility as a function of performance choice (assumption (d)), that equilibrium performance choice \( \eta(r^b, r^s, \theta'') = \eta(r^b, r^s, \theta') = q' \) will be constant in this range as well.

Consider, finally, an information parameter \( \theta < \theta^0 < \theta' \) from each range. It then follows from the monotonicity of performance choice that

\[ \eta(r^b, r^s, \theta) = q^0 \]

\[ \leq \eta(r^b, r^s, \theta') = q' ; \]

and from the incentive constraints we have that

\[ I(r^b, r^s, \theta') - I(r^b, r^s, \theta) = C(r^s, \theta, q') - C(r^s, \theta', q^0) \]

\[ \leq C(r^s, \theta, \eta(r^b, r^s, \theta')) - C(r^s, \theta', \eta(r^b, r^s, \theta')) \]

\[ = C(r^s, \theta, q') - C(r^s, \theta', q^0); \]
and, hence, that \( C(r^\sigma, \theta, q') \geq C(r^\sigma, \theta, q^o) \) must hold. By making use of the monotonicity of utility as a function of performance choice, it follows that \( q^o = q' \) must hold. The Proposition 4 is thus established. \( \square \)

Recall from the previous section that, under suitable differentiability, \( q_{oo} \) will exist if performance choice is continuous. If, however, performance choice is binary then underinvestment and overinvestment would result from a contract specifying \( q^o = q_L \) and \( q^o = q_H \), respectively, as follows from Lemma 3.

**CP1 Environment:** The next proposition shows a transfer schedule \( T^*(m, q) \) to exist that leads to the first best solution even if reliance investments are hidden action. However, as follows from Proposition 4, the efficient transfer schedule \( T^*(m, q) \) cannot reflect expectation damages correctly.

**Proposition 3.5:** A message space \( M \) and a transfer schedule \( T^*(m, q) \) exist that lead, in equilibrium, to the first best solution.

The proof of Proposition 5 will be given at the end of the analysis of Case BB in the appendix. The efficient price schedule will be based on the direct, incentive-compatible mechanism that follows from the analysis of case BB as a by-product.

**Remarks:**

To conclude this subsection, let us briefly compare the present findings that were derived under asymmetric information with those that would hold if the information parameter could be verified and, hence, correct damages according to equation (3.20) could be administered by courts. Suppose that the assumptions (a) and (e) are met. If the contract
specifies high performance \( q^o = q_H \) then the seller has the incentive to take the socially best response as his performance choice and ex post efficiency would be ensured: yet, both facing excessive incentives for reliance investments as follows from Lemma 3 and equation (3.18).

If, at the other extreme, the contract specifies low performance \( q^o = q_L \) then the buyer would stick to the contract. If such an outcome is anticipated under complete information, the parties would be able to renegotiate to a performance choice that is ex post efficient. Since the buyer would obtain only a fraction of, say, half of the renegotiation surplus, the buyer’s incentives for reliance investments would be suboptimal. In a similar vein, as ex post efficient performance through renegotiation is anticipated by the seller thus her investment would be optimal.

In Shavell’s setting of binary performance choice, only the high performance contract is available (the low performance contract would be equivalent to no contract) and would provide the buyer with excessive incentives for reliance investments. In the Edlin and Reichelstein setting of continuous performance choice, however, there exist intermediate levels of performance choice that would provide efficient reliance incentives. In this sense, Shavell’s overreliance result is due to binary performance choice and not to a basic defect of expectation damages.

In the case SB, assessing exact expectation damage is not only difficult but comes at price in terms of efficiency loss.
(ii). Case SS

In case SS, it is the seller who obtains private information and who considers whether or not to breach. This case is similar to the model we have been originally dealing with in a binary performance choice framework. After having obtained her private information, the seller may announce that she is only going to deliver a quantity \( q \leq q^o \). Since, at the time of performance, the seller chooses to deliver \( q \leq q^o \) and breaches for the rest of the quantity then following the expectation damage rule she owes damages \( D(r^b, q) = \max[V(r^b, q^o) - V(r^b, q); 0] \) to the buyer. This compensation then make the buyer at least as well off as if seller had met her obligation. More precisely, if \( V(r^b, q^o) - V(r^b, q) \geq 0 \) then he would be exactly as well off, well in line with expectation damage remedy; whereas otherwise, in case \( V(r^b, q^o) - V(r^b, q) < 0 \) he even enjoys a windfall gain from seller’s neglecting her obligation. Common legal practice allows the buyer to keep such windfall gains for free. Since buyer does not obtain private information, such damages can be verified in front of courts provided that reliance investments are observable.

The seller’s payoff then amounts to –

\[
\Psi(r^b, r^s, \theta, q) = T^o - C(r^s, \theta, q) - r^s - \max[V(r^b, q^o) - V(r^b, q), 0].
\]

And therefore the seller chooses the performance according to –

\[
q_S(r^b, r^s, \theta) \in \arg \max_{q \in \mathcal{Q}} \Psi(r^b, r^s, \theta, q).
\]

We now segregate the two possible cases according to the values that damage remedy can take and treat them separately for purposive analytical results and definite conclusion.
First: $D(r^b, q) \neq 0$

If the contract specifies a delivery choice $q^o$ such that windfall gains to the buyer will never arise then the seller’s payoff

$$\Psi(r^b, r^s, \theta, q) = [V(r^b, q) - C(r^s, \theta, q) - r^s - r^b] + [T^o - V(r^b, q^o) + r^b]$$

$$= W(r^b, r^s, \theta, q) + [T^o - V(r^b, q^o) + r^b]$$

which is, up to the first term, dependent on actual performance choice and equal to the social surplus.; and, hence, the seller takes performance decision

$$q_S(r^b, r^s, \theta) \in \arg \max_{q \in Q} \Psi(r^b, r^s, \theta, q) = \arg \max_{q \in Q} W(r^b, r^s, \theta, q)$$

and coincides with the socially best response performance choice i.e. $q^+(r^b, r^s, \theta)$.

If the seller announces breach $q \leq q^o$, upon receiving the expectation damage payment the buyer’s payoff amounts to

$$\Phi(r^b, r^s, \theta, q) = V(r^b, q) - T^o - r^b + [V(r^b, q^o) - V(r^b, q)]$$

$$= [V(r^b, q^o) - C(r^s, \theta, q^o) - r^b - r^s] - [T^o - C(r^s, q^o) - r^s]$$

$$= W(r^b, r^s, \theta, q^o) + [C(r^s, q^o) + r^s - T^o]$$

and is, up to the first term independent of actual performance, equal to social surplus corresponding to the initial contractual quantity choice $q^o$ and that does not depend on ex post actual state contingent performance choice by the seller. Anticipating such a payoff, at the investment stage the buyer would have the incentive for reliance investments, as

$$r^b_E \in \arg \max_{r^b \in R} E_\theta[\Phi(r^b, r^s, \theta, q^o)] = \arg \max_{r^b \in R} E_\theta[W(r^b, r^s, \theta, q^o)]$$

$$\neq \arg \max_{r^b \in R} E_\theta[W(r^b, r^s, q^+(r^b, r^s, \theta))] = r^b^*$$
would hold. As a consequence, the buyer would have the incentive to choose a level of reliance which is higher than the socially optimal level (unless and until, the initial contractual quantity $q^o = q^{oo}$ in the light of Lemma 3; in that case there would be efficient investment by the buyer).

Given the buyer's investment choice $r^b_E$, anticipating this the seller would thus choose her investment level according to:

$$r^s_E \in \arg \max_{r^s \in R} E_{\theta}[\Psi(r^b_E, r^s, \theta, q^+(r^b, r^s, \theta))]$$

$$= \arg \max_{r^s \in R} E_{\theta}[W(r^b_E, r^s, \theta, q^+(r^b, r^s, \theta))]$$

$$\neq \arg \max_{r^s \in R} E_{\theta}[W(r^b, r^s, \theta, q^+(r^b, r^s, \theta))] = r^s*.$$

And hence she would have an incentive to rely higher than the socially best level which crucially depends upon the buyer's reliance choice, as the seller has to fully internalise the cost of breach under expectation damage remedy.

In this case, the first best solution can be implemented by just requiring the parties to specify a suitable initial contractual quantity choice $q^o = q^{oo}$ (in the light of lemma 3) and the seller to mitigate damages as per actual expectancy of the buyer resulting from breach.

**Second: $D(r^b, q) = 0$**

Then the seller's payoff would be–

$$\Psi(r^b, r^s, \theta, q) = T^o - C(r^s, \theta, q) - r^s$$

$$= [V(r^b, q) - C(r^s, \theta, q) - r^b - r^s] + [T^o - V(r^b, q) - r^b]$$

$$= W(r^b, r^s, \theta, q) + [T^o - V(r^b, q) - r^b].$$
And hence she will breach whenever her ex post cost (net of investment) is higher than the contractual price. Now the buyer's payoff in this case is –

\[
\Phi(r^b, r^s, \theta, q) = V(r^b, q) - T^o - r^b
\]

\[
= [V(r^b, q) - C(r^s, \theta, q) - r^b - r^s] - [T^o - C(r^s, \theta, q) - r^s]
\]

\[
= W(r^b, r^s, \theta, q) + [C(r^s, \theta, q) + r^s - T^o].
\]

Note here that since both the parties’ payoffs, upto the first term in their respective expressions above, are dependent on the ex post actual performance choice, thus it can easily be shown that both of them (automatically) undertake socially efficient investments.

Such practice gives rise to a direct and efficient mechanism, which is incentive compatible and which works even if reliance investments are hidden action. Under this mechanism, the informed party (seller) is directly asked to reveal his private information. This direct mechanism is of the Clarke-Groves type. We shall prove this in the appendix as a by-product from the analysis of case BB. Please note that the very same mechanism has been used in the next subsection (3.5) of liquidated damage in a more concrete set up.

### 3.5 Party Designed Liquidated Damage:

In the light of preceding analysis, just like the previous model here in this case also the buyer and the seller can keep a provision for a breach of contract by including a liquidated damage clause in their contract agreement. There could be three different contracting scenarios to provide a diverse range of environments for analysis. First, the buyer may propose the contract to the seller, and the seller may accept or reject it. Second, the seller may
propose the contract, and the buyer may accept or reject it. Finally, an uninformed broker may design a contract that maximises the joint surplus from trade between the parties. We take the usual route, as familiar in the contract theory literature, of uninformed party – here the buyer – designs the contract. We now study the impact of this remedy.

The sequence of events:

The parties at Time 1 sign a contract and specify the fixed delivery price \( p \) and the liquidated damage payment, \( D_L \) → in the interim of Time 1 and Time 2, both the buyer and the seller make reliance investments of \( r^b, r^s > 0 \), given \( p \) and \( D_L \) → at Time 2, the seller observes his cost of production → given \( p \), \( D_L \), the seller decides whether to perform the contract or breach the contract → If the seller breaches, the buyer files a suit and the court awards him with the liquidated damages \( D_L \) at Time 3.

The seller's breach decision is subjected to her realised cost, and contractually agreed \( p \) and \( D_L \). The seller will perform only when: \( p - \tilde{C} \geq -D_L \) or if: \( \tilde{C} \leq p + D_L \).

For further reference, it is useful to define \( T \) as the sum of the price and the liquidated damage clause: \( T \equiv p + D_L \). We will refer to \( T \) as the promisor's "total breach cost" when leaving the existing contract consisting of his opportunity costs \( p \) and the damage \( D_L \).

Thus, the probability of efficient performance by the seller is:

\[
\Pr[C(r^s) + \theta \leq p + D_L] = \Pr[\theta \leq p + D_L - C(r^s)] = F[p + D_L - C(r^s)].
\]

Given the probability performance, the buyer's expected payoff is:

\[
EP^b_L = F[p + D_L - C(r^s)] \cdot [V(r^b) - p] + (1 - F[p + D_L - C(r^s)]).D_L - r^b.
\]
3.5 Party Designed Liquidated Damage:

And the seller’s expected payoff is:

\[ EP^s_L = F[p + D_L - C(r^s)] \cdot [p - E[C \mid C \leq p + D_L]] + \{1 - F[p + D_L - C(r^s)]\} \cdot (D_L - r^s) \]

\[ = F[\cdot](p + D_L) - F[\cdot]E(C(r^s) + \theta|C(r^s) + \theta \leq p + D_L) - D_L - r^s. \]

Therefore, \( EP^b_L + EP^s_L = F[\cdot]\{V(r^b) - E(C(r^s) + \theta|C(r^s) + \theta \leq p + D_L)\} - r^b - r^s. \)

We obtain the following lemma –

**Lemma 3.5:** For any given \( T = p + D_L \) and \( p > 0 \), the buyer can always be made strictly better off by increasing \( D_L \) and decreasing \( p \) by the same amount, thereby keeping \( T \) constant.

**Proof.** Simply note that the buyer’s expected payoff can also be written as:

\[ EP^b_L = F[T - C(r^s)] \cdot V(r^b) + D_L - F[T - C(r^s)] \cdot T - r^b \]

which is strictly increasing in \( D_L \).

The lemma implies that, for \( T \) given, buyer prefers to offer a price \( p \) as low as possible to the seller. Although \( p \) and \( D_L \) are perfect substitutes from the standpoint of contract performance, the buyer prefers to obtain a higher damage payment \( D_L \) rather than paying a higher price \( p \). Clearly, there is a limit in lowering \( p \) due to the non-negativity constraint and the seller’s participation requirement. □

Since the buyer determines \( p \) and \( D_L \) to maximise his expected payoff. Under asymmetric information, the principal cannot observe the agent’s effort. Thus the buyer’s pro-
gram is then to offer the seller a contract \((p, D_L)\) that will maximise his expected payoff subject to the incentive constraint (IC) and a participation constraint (IR) of the seller, so that the agent receives a nonnegative utility. We assume that the buyer has all the bargaining power in contracting; i.e., he makes a take-it-or-leave-it offer to the seller. The seller can accept or reject the contract. If the seller rejects, the outcome is \((q, p) = (0, 0)\). This is the seller’s reservation bundle. The seller’s reservation utility is therefore \(C = 0\) as there is no market alternative.

Thus we have the following optimisation problem –

\[
\max_{p, D_L, r^b, r^s} EP^b_L(p, D_L, r^b)
\]

s.t. (i) \(EP^a_L \geq 0\) \quad [IR]

(ii) \(\max_{r^s} EP^a_L\) \quad [IC]

Aside, the seller’s maximisation problem gives us the following the F.O.C. –

\[
f(.)[-C'(r^s) \cdot (p + D_L)] - f(.)[-C'(r^s) \cdot (p + D_L) + F(.)[-C'(r^s)] = 1
\]

\[
\Rightarrow \quad F[p + D_L - C(r^s)]C'(r^s) = -1
\]

Replacing this into the buyer’s maximisation problem, we rewrite the problem as follows –

\[
\max_{p, D_L, r^b, r^s} EP^b_L(p, D_L, r^b)
\]

s.t (i) \(EP^a_L \geq 0\) \quad [IR]

(ii) \(F(.)C'(r^s) = -1\) \quad [IC]

The buyer, by assumption, has entire bargaining power and thus extracts entire ex ante surplus; which entails that the participation constraint is binding in the light of Lemma 3.5.

We derive the following lemmata –
Lemma 3.6:

\[ p^* + D_L^* = V(r^{b*}) \]  
\[ D_L^* = F(V(r^{b*})).\{V(r^{b*}) - E(C|\hat{C} \leq V(r^{b*}))\} - r^{**} \]
\[ p^* = [1 - F(V(r^{bs})).V(r^{bs}) + F(V(r^{bs})).E(C|\hat{C} \leq V(r^{bs})) + r^{s*}] \]
\[ EP_L^b = D_L^* - r^{b*} \]
\[ EP_L^s = 0 \] .

Lemma 3.7: Both the seller (promisor) and the buyer (promisee) make efficient investment vis-a-vis the socially desired level of investments under liquidated damage remedy when one sided private information (pertinent to the promisor) is present.

Proof of Lemmata 6 & 7: We provide a joint proof of the lemmata as they are interlinked with each other.

Substituting IR into the objective function we get –

\[ F(.).V(r^b) - F(.).E[C'(r^s) + \theta | C(r^s) + \theta \leq p + D_L] - r^b - r^s \]

Now replacing IC into the previous expression, we get –

\[ \frac{1}{C'(r^s)}.V(r^b) - \frac{1}{C'(r^s)}.E[C'(r^s) + \theta | C(r^s) + \theta \leq p + D_L] - r^b - r^s \]

Maximising the above expression w.r. to \( r^b \) and \( r^s \) gives us the following –

\[ \frac{1}{C'(r^s)}.V'(r^b) = -1 \] or, \[ V'(r^{b*}) = -C'(r^{s*}) \]  
(3.21)

\[ \Rightarrow \] Marginal returns from reliance investments by the parties are equal.

And \[ f(.)[-C'(r^s)].V(r^b) - f(.)[-C'(r^s)].(p + D_L) - F(.)[-C'(r^s)] - 1 = 0 \]

\[ \Rightarrow f(.).C'(r^s).[V(r^b) - (p + D_L)] = 0, \] [since from (IC), \( F(.).C'(r^s) = -1 \)]
3.5 Party Designed Liquidated Damage:

\[ V(r^{bs}) = (p^* + D_L^*) \quad \text{[since } f(p + D_L) \neq 0] \]  
(3.22)

\( \Rightarrow \) The optimum total breach cost is equal to the optimum valuation of the buyer.

\[ r^{bs} = V^{-1}(p^* + D_L^*) \]

Putting \( p^* \) and \( D_L^* \) into the seller’s payoff function, we get the seller’s equilibrium payoff –

\[ EP_L^{p*} = F(p^* + D_L^*).[p^* - E(\tilde{C}|\tilde{C} \leq V(r^b))] + [1 - F(p^* + D_L^*)](D_L^* - r^b) - r^s \]

\[ = F(V(r^{bs})).[p^* - E(\tilde{C}|\tilde{C} \leq V(r^{bs}))] + [1 - F(V(r^{bs}))).(p^* - V(r^{bs})) - r^s], \]

\[ = p^* - F(V(r^{bs})).E(\tilde{C}|\tilde{C} \leq V(r^{bs})) - [1 - F(V(r^{bs})))V(r^{bs}) - r^s \]  
(3.23)

When we set \( EP_L^{p*} = 0, \) then

\[ p^* = [1 - F(V(r^b)).V(r^b) + F(V(r^b))).E(\tilde{C}|\tilde{C} \leq V(r^b)) + r^s \]

Thus,

\[ D_L^* = F(V(r^b).\{V(r^b) - E(\tilde{C}|\tilde{C} \leq V(r^b))\} - r^s \]

Therefore, the buyer’s equilibrium payoff:

\[ EP_L^{p*} = F(p^* + D_L^*).[V(r^b) - p^*] + [1 - F(p^* + D_L^*)]D_L^* - r^b \]

\[ = F(p^* + D_L^*).[p^* + D_L^* - p^*] + [1 - F(p^* + D_L^*)]D_L^* - r^b \]

\[ = D_L^* - r^b \]  
(3.24)

A Note: So long as the buyer’s valuation is observable, the breach cost \( T = v \) is the unique optimum. The corresponding contract price offered by the buyer is \( p \), which just satisfies the seller’s reservation price. Similarly, if the seller has all of the bargaining power, the seller will maximise profits subject to the buyer’s acceptance of terms (i.e., \( EP_L^b \geq 0 \)), which is identical to the buyer’s program above, and so we again find \( T = v \).
Note, however, that the price paid by the buyer to the seller under this scheme is \( p = v \), which extracts all of the buyer’s rent.

Finally, if a broker proposes a contract to the parties, the broker will maximise the expected gains from trade by choosing \( T \) to maximise the collective surplus \( EP^I_L(v, T, c) \). Again the solution is to set \( T = v \). The broker then chooses a price to allocate the gains from trade with \( p \) lying in the interval \([v, E(c)]\). It is not surprising that the optimal full-information contract specifies \( T = v \) for each contracting environment, since this condition guarantees that breach occurs if and only if it is efficient.

Liquidated damages are meant to fully compensate the promisee. At first sight, liquidated damages seem to be equivalent to the expectation measure. ‘Fully’ includes the expected profits (only in cases where the expected profits are compensated, the promisee is really indifferent with regard to performance or breach).

3.6 Concluding Note:

*Legal practice facing hidden information:*

In an asymmetric information environment the legal proceedings (both in Common Law and Civil Law countries) either take resort to objectifying damage measures or allow the victim of breach to opt for reliance damages. The present section examines such practice. The issue of verifiability arises in the two cases BS and SB where the uninformed party considers breaching such that expectation damages must be based on the informed party’s valuation or cost functions respectively. This function depends on the private information of that party and, hence, cannot be verified in front of courts.
In the setting of case BS 49, where the victim of breach holds some private information, objectifying expectation damages by the court would mean to fictitiously postulate an objective type $\theta^o \in \Theta$, based on which expectation damages amounting to

$$ D^o(r^b, q) = \max[V(r^b, \theta^o, q^o) - V(r^b, \theta^o, q), 0] $$

would be awarded to the buyer. Needless to say, the buyer’s private information may actually differ from the objective type.

Objectified expectation damages lead to an effective transfer schedule

$$ T(r^b, q) = T^o - D^o(r^b, q) $$

that does not depend on any message from the informed party. Such schedules must necessarily lead to an outcome that fails to be state-contingent. In fact, the seller would choose performance decision following

$$ q_S(r^b, r^s) \in \arg \max_{q \in Q} \{T(r^b, q) - C(r^s, q)\}, $$

independent of the actual state $\theta$, in fact it only depends on the choice of the amount of damage. Anticipating her own performance choice, the seller would choose her reliance level following

$$ r^*_S \in \arg \max_{r_S \in R} \{T(r^b, q_S(r^b, r^s)) - C(r^s, q_S(r^b, r^s)) - r^s\}. $$

Anticipating the seller’s performance choice, the buyer then makes reliance investments

$$ r^b_B \in \arg \max_{r^b \in R} \{E_\theta[V(r^b, \theta, q_S(r^b, r^s))] - T(r^b, q_S(r^b, r^s)) - r^b\}. $$

49 See, the appendix at the end of this chapter for more details on this case.
While it may still be feasible to generate efficient reliance incentives, the solution typically fails to be ex post efficient because performance choice is constant, no matter which move of nature has materialised.

Remarks: Some legal systems allow the promisee to opt for recovery of reliance expenditures instead of expectation damages. Allegedly, the option was introduced to accommodate the promisees that have difficulties to verify their true expectation damages in front of courts. We find that in case of bilateral-investments both the Reliance and the Restitution Remedies lead to inefficient outcomes (both in breach and in reliance) for fixed-price incomplete contracts. With no damage measure, in case the promisee undertakes reliance she would over-rely in specific assets, whereas the promisor would under-rely. When the remedy choice is reliance damage, the general result we find across the board is that it leads the promisee to over-rely and the promisor to rely less compared to their respective efficient reliance levels. Both of these remedies result in frequent breach by the promisor. To put it concretely, since reliance damages also lead to an effective transfer schedule $T(r^b, q)$ that does not depend on nature's move, ex post efficiency would not be restored. Finally, when expectation damage can be assessed by court properly and awarded, first, it ensures efficient performance; secondly it induces efficient reliance for the breaching promisor (if at all she invests) but leads the promisee to over rely. And this result holds good irrespective of the situation whether (selfish) investment is unilaterally or bilaterally undertaken.

To sum up, practical solutions of awarding damages under asymmetric information seem defective on two accounts. First, they fail to assess expectation damages correctly. If granted such damages, the promisee need not be equally well off as if the promisor had met
his obligation. Second, the outcome will be constant over states and, as such, will typically fail to be ex post efficient.

For a reliance setting with hidden information, the present analysis thus has categorically established that a trade-off exists between providing efficient incentives and assessing expectation damages correctly. Provisions that would allow assessing expectation damages correctly prevent efficient breach of contract whereas revelation mechanisms leading to the first best solution would fail to assess damages correctly.

Legal practice seems to be relying on two remedies. First, damages may be awarded that are of an objective type. This approach is shown to be defective as it neither assesses expectation damages correctly nor does it provide incentives for efficient breach. Second, the party suffering from breach and failing to verify her expectation damages in front of courts may opt for recovery of reliance damages instead. The outcome, again, cannot be state-contingent and, hence, ex post efficiency will not be achieved.

Since the revelation mechanisms were available that would generate the first best solution, at least for the present setting, justifying such legal practice from the economic perspective remains a challenging task for future research.
Here we deal with the case when the buyer holds the private information. We, therefore, given our assumptions in the subsection 3.4, denote the ex post trading surplus as:

\[ G_B(r^b, r^s, \theta, q) = V(r^b, \theta, q) - C(q, r^s). \]

The ex post socially best response performance choice is \( q^+(r^b, r^s, \theta) \in \arg \max_{q \in Q} G_B(r^b, r^s, \theta, q) \) that maximises social surplus at the performance stage (ex post) where reliance investment and the move of nature are given. Correspondingly, we define the ex ante social surplus –

\[ W_B(r^b, r^s, \theta, q^+) = V(r^b, \theta, q^+) - C(q^+, r^s) - r^b - r^s. \]

Thus efficient reliance investments are defined as follows –

\[ r^{b*} \in \arg \max_{r^b \in R} E_{\theta}[W_B(r^b, r^s, \theta, q^+(r^b, r^s, \theta))], \]

and

\[ r^{s*} \in \arg \max_{r^s \in R} E_{\theta}[W_B(r^b, r^s, \theta, q^+(r^b, r^s, \theta))] \]

that maximise the ex ante expected social surplus. Now folding back these efficient reliance choices into the socially best performance decision, we therefore define the efficient performance choice as: \( q^*(\theta) = q^+(r^{b*}, r^{s*}, \theta) \); i.e. this is the socially best response to efficient reliance investments. Then it must also hold that -

\[ r^{b*} \in \arg \max_{r^b \in R} E_{\theta}[W_B(r^b, r^s, \theta, q^*(\theta))], \]

and,

\[ r^{s*} \in \arg \max_{r^s \in R} E_{\theta}[W_B(r^b, r^s, \theta, q^*(\theta))]. \]

Given our assumptions, the earlier lemmata 3.1, 3.2 and 3.3 also hold here in similar fashion. Thus we now directly proceed with our analysis of breach and damage remedy when the buyer holds ex post private information.
(iii). Case BS

In case BS it is the buyer who obtains private information but the seller is the party who considers breaching the contract. The seller neglects her obligation by deciding \( q \neq q^o \) [obviously \( q < q^o \)], and thus according to expectation damage remedy of contract law she is liable to pay a sum of amount to the tune of

\[
D(r^b, \theta, q) = \max \{ [V(r^b, \theta, q^o) - V(r^b, \theta, q)], 0 \}
\]  

(3.25)
to the buyer. In case of breach, if the buyer receives such compensation then he would be at least as well off as if the seller had met her obligation. More precisely, he would be exactly as well off, if \( \{ V(r^b, \theta, q^o) - V(r^b, \theta, q) \} \geq 0 \); well in line with expectation damage remedy. On the other hand, in case \( \{ V(r^b, \theta, q^o) - V(r^b, \theta, q) \} < 0 \), he may even enjoy a windfall gain when the seller is neglecting her obligation. But, as \( \theta \) remains private information of the buyer, the courts would not be able to assess and award state-contingent damages \( D(r^b, \theta, q) \) correctly.

Now this case can be handled along the line of case SB in the previous subsection, so we suppress the analysis here.

(iv). Case BB

In case BB, it is the buyer who obtains private information and who contemplates breach too. Since it is the buyer who chooses to breach, the breach would be of the anticipatory type. After having obtained his private information, the buyer may announce that he is only going to accept delivery \( q \leq q^o \). Since, at the time of announcement, the seller has not yet started production (by assumption), therefore upon receiving announcement from
the buyer she should deliver \( q \) but claim compensation from the buyer to mitigate damages for her lost profits from the buyer’s announcement. In any case, the seller must grant a reduction of payments in the amount of her cost savings \([C(r^s, q^o) - C(r^s, q)]\), which can be easily monitored as there is no private information. Thus her final payoff after the adjustments amounts to

\[
T^o - [C(r^s, q^o) - C(r^s, q)] - C(r^s, q) - r^s = T^o - C(r^s, q^o) - r^s.
\]

Thus the seller in the face of anticipatory breach is as well off as the contract is honoured when compensated through expectation damage. The seller’s final payoff then strictly depends on the initial contractual quantity choice which is \( q^o \). Notice, in this case where the seller does not obtain private information, this price reduction can easily be administered by the courts. Thus in this case she would choose a level of investments according to

\[
r^s \in \arg \max_{r^s \in R} \{T^o - C(r^s, q^o) - r^s\}.
\]

hence she would have an incentive to rely (maybe higher than the socially best level) which corresponds to the quantity choice \( q^o \) and not to any state contingent quantity choice \( q \).

If the buyer announces anticipatory breach \( q \leq q^o \), upon receiving the benefit of reduction in payment to the tune of \([C(r^s, q^o) - C(r^s, q)]\), his net payoff amounts to

\[
\Phi(r^b, r^s, \theta, q) = V(r^b, \theta, q) - T^o - r^b + [C(r^s, q^o) - C(r^s, q)]
\]

\[
= [V(r^b, \theta, q) - C(r^s, q) - r^b - r^s] - [T^o - C(r^s, q^o) - r^s]
\]

\[
= W_B(r^b, r^s, \theta, q) + [C(r^s, q^o) + r^s - T^o]
\]

and is, up to the first term dependent on actual performance, equal to social surplus.
Hence, the buyer's performance choice in equilibrium solves

\[ q_B(r^b, r^s, \theta) \in \arg \max_{q \in Q} \Phi(r^b, r^s, \theta, q) = \arg \max_{q \in Q} W_B(r^b, r^s, \theta, q) \]

and coincides with the socially best response i.e. \( q^+(r^b, r^s, \theta) \). Anticipating such performance choice at the investment stage, the buyer would have the incentive for efficient reliance investments, as

\[ r^b_* \in \arg \max_{r^s_* \in R} E_{\theta} [\Phi(r^b, r^s_* \theta, q^+(r^b, r^s, \theta))] \]

\[ = \arg \max_{r^s_* \in R} E_{\theta} [W_B(r^b, r^s_* \theta, q^+(r^b, r^s, \theta))] \]

would hold, provided the seller invested efficiently (given an initial contractual quantity choice \( q^0 = q^{oo} \) according to Lemma 3). Otherwise, there would be over investment (resp. under-investment) if the seller over invests (resp. under-invest). In case the seller does not invest and the buyer is the only investing party, then the first best solution can be implemented by just requiring the producer to mitigate damages resulting from anticipatory breach and this solution is independent of any initial contractual quantity. This result even holds good in a binary quantity choice.

Such practice gives rise to a direct and efficient mechanism, which is incentive compatible and which works even if reliance investments are hidden action. Under this mechanism, the informed party buyer is directly asked to reveal his private information.

Proof of Proposition 3.5: Imagine that the true information is \( \theta \) but the buyer reports \( \theta' \in \Theta \) which may be false. The direct mechanism then imposes the performance choice \( \eta(\theta') = q^*(\theta') \) that would be the socially best response if the buyer had invested efficiently and reported truthfully. Moreover, the buyer is required to pay \( \tau(\theta') = C(r^s, q^*(\theta')) \) to
the seller. This direct mechanism is of the Clarke-Groves type. It provides the following incentives:

Suppose the buyer makes reliance investments \( r^b \) and plans to reveal information \( \theta' = t(r^b, \theta) \) if he later obtains private information \( \theta \). At the investment stage, his expected payoff under the direct mechanism amounts to

\[
E_\theta [V(r^b, \theta, q^*(\theta')) - C(r^s, q^*(\theta'))] - r^b \leq E_\theta [V(r^{b*}, \theta, q^*(\theta)) - C(r^s, q^*(\theta))] - r^{b*}
\]

and cannot be higher than if he had invested efficiently and revealed truthfully. In this sense, the above direct mechanism is incentive compatible, assigns the social surplus to the buyer and, as a consequence, provides efficient investment incentives to the buyer. To gain the consent of the seller, the buyer would have to make an up-front payment that, however, would not affect incentives. In fact, with up-front payment \( \{T^\sigma - C(r^s, q^0)\} \), the direct mechanism would lead to exactly the same solution as the producer must grant a price reduction for anticipatory breach in the amount of cost savings.

This direct mechanism may also serve as a basis for the efficient transfer schedule \( T^*(m, q) \), whose existence is claimed by Proposition 5. In fact, take as message space \( M = \Theta \). If the buyer has announced \( m = \theta' \in M = \Theta \) and the seller takes performance choice \( q \in Q \) then the net payment schedule:

\[
T^*(\theta', q) = T^\sigma + C(r^s, q) - [V(r^{b*}, \theta', q) - V(r^{b*}, \theta', q^*(\theta'))]^2
\]

provides efficient incentives. Indeed, since the seller is compensated for actual production costs, he has the incentive to minimise the square term by deciding \( q = q^*(\theta') \) at the
performance stage. The buyer's payoff then amounts to
\[
V(r^b, \theta, q^*(\theta')) - T^*(\theta', q) - r^b = V(r^b, \theta, q^*(\theta')) - T^o - C(r^s, q^*(\theta')) - r^b
\]
and, obviously, provides incentives to report truthfully and to invest efficiently. Proposition 5 is established.

The only difference with the direct mechanism arises from the fact that, under the efficient transfer schedule, the breach decision is inalienably assigned to the seller whereas, under the direct mechanism, it is exogenously imposed by the operator of the mechanism. In equilibrium, however, the efficient price schedule and the direct mechanism are leading to the same outcome.