Contract Renegotiation and Option Contracts[¶]

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One of the most important reasons for writing contracts identified in both law and economics is the desire to protect relationship-specific investments (reliance expenditures) against the hazards inherent to exchange. However, such contracts are typically incomplete. At the time of contracting it is often impossible or prohibitively costly to specify the terms of future transactions for all possible states of the world. Thus, there may be contingencies in which the actions specified in the original contract would yield a very inefficient outcome and in which the parties want to renegotiate. Renegotiation is beneficial and necessary to achieve an *ex post* efficient outcome in every state of the world. But, it also undermines the protection of relationship-specific investments. Since these investments are sunk at the time of renegotiation, the division of the surplus does not reflect past investment efforts. Hence, the *ex ante* incentives to invest efficiently may be distorted.

Starting with the seminal paper by Grossman and Hart (1986) there is by now a large literature on incomplete contracts and relationship-specific investments. Most of this literature assumes that it is impossible to write any state-contingent contract prior to the investment decisions. The only contracts that can be written are contracts on the "governance structure" (Williamson, 1985) of the future relationship, e.g., on the allocation of ownership rights. The governance structure determines the relative bargaining power of each party at the renegotiation stage, which in turn affects the incentives for relationship-specific investments. The general conclusion from this literature is that the design of the governance structure matters, but that no governance structure can provide socially efficient investment incentives.

The assumption that no state-contingent contracts can be written at all is very strong. The question arises: Under what conditions can efficient investment incentives be given if only some but not all relevant contingencies can be contracted upon and if the contract may be renegotiated? This question has been addressed in various contractual environments in several papers, including Hart and Moore (1988), Aghion, Dewatripont and Rey (1994), Hermalin and Katz (1992), and MacLeod and Malcomson (1993). Nöldeke and Schmidt (1995) have shown that a particularly simple type of contracts, option contracts, that are often used in reality, can induce efficient investments and efficient trade in a wide variety of circumstances.

There is a closely related literature on legal remedies for breach of contract. If one party unilaterally breaches the terms of the original contract, what kind of damages should the courts award the other party? The breach remedy determines the default point of renegotiation and thus affects the *ex ante* incentives to invest. A number of papers, including Shavell (1980), Rogerson (1984), Spier and Whinston (1995), and Edlin and Reichelstein (1996) compare standard breach remedies, such as expectation damages, reliance damages, specific performance, and privately stipulated damages, in different economic environments.

It is interesting to note that option contracts and privately stipulated damages are essentially equivalent. Consider the relation between a seller and a buyer who can make relationship-specific investments now in order to increase their gains from trade in the future. An option contract gives one of the parties, say the seller, the right (but not the obligation) to deliver the good. The contract specifies two payments: The seller receives p_1 if he delivers the good and p_0 if he chooses not to trade (p_0 may of course be negative). Equivalently, under privately stipulated damages the contract specifies a price p_1 to be paid by the buyer if the contract is fulfilled and damages, $-p_0$, to be paid by the seller if he fails to deliver.

In this essay I will argue that an option contract or, equivalently, privately stipulated damages have two important properties. First, an option contract is a simple mechanism that induces one party to truthfully reveal an important piece of information about the realization of the state of the world. If the option is exercised then the state of the world must be such that exercising the option is more profitable than not exercising it. I will show below that if only one party has to make a relationship-specific investment and if the option price is chosen appropriately, then this is the only information needed to implement efficient trade and efficient investment.

Second, an option contract can be used to allocate bargaining power in the renegotiation game. In the last section I will argue that this additional effect can be used to achieve efficiency even if both parties have to invest and if it is impossible to specify completely all characteristics of the good to be traded in the future. These results suggest that in a wide variety of circumstances option contracts or privately stipulated damages are efficient and that there is no need for any further intervention by the courts - except to enforce the terms of the option contract.

Consider a buyer (B) and a seller (S) who may want to trade a good at some future date 3. Both parties are risk neutral. The buyer's valuation function for the good, denoted by v, depends on his relationship-specific investment, β, the cost of which is incurred at date 1. Assume that $v(\beta)$ is increasing and strictly concave and that the investment is measured by its cost. The seller's cost to produce the good, denoted by c, is a random variable the realization of which is determined after the buyer's investment has been made but before trade takes place, say at date 2. His cost may, for example, depend on his input prices which are uncertain *ex ante*. Assume that c is distributed according to the cumulative distribution function $F(c)$ with density $f(c)$ on $[\underline{c}, \overline{c}]$.

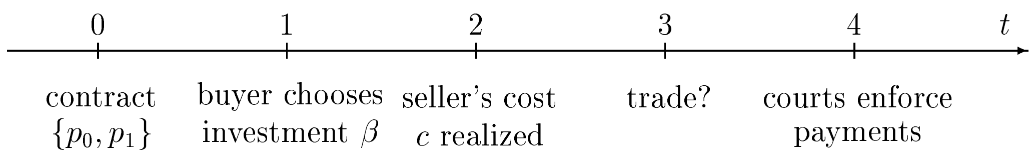

Figure 1: Time structure

At date 0 the buyer and the seller can write a contract. The contract cannot be made contingent on the buyer's investment nor on the realization of the seller's cost. I want to abstract away any asymmetries of information within the relationship. Therefore I assume that both of these variables are observable by the buyer and the seller but that they cannot be verified by an outsider, such as the courts. However, the contract may be contingent on the trade decisions of the two parties at date 3 and on any verifiable messages to be exchanged in the course of the relationship. However, I will restrict attention to a particularly simple class of contracts: options. An option contract specifies a pair of prices $\{p_0, p_1\}$ and gives one party, say the seller, the right to choose whether to trade and receive p_1, or not to trade and receive p_0. Note that this is a contingent contract, but a highly incomplete one. Finally, at date 4 disputes (if any) are settled by the courts and payoffs are realized. I assume that the courts can verify whether or not the seller delivered the good and that they enforce the respective payments.

What would be the (first best) efficient allocation that could be achieved in the absence of any contractual problems? Clearly, the buyer and the seller should trade at date 3 if and only if $v(\beta) \geq c$. Furthermore, the buyer should choose a level of investment which maximizes total social surplus S (given that there will be efficient trade)

$$S \;=\; \int_{\underline{c}}^{v(\beta)} [v(\beta) - c] f(c) dc - \beta \;. \tag{1}$$

A necessary condition for β^{FB} to be first best efficient is the first order condition

$$S'(\beta^{FB}) \;=\; v'(\beta^{FB}) F(v(\beta^{FB})) - 1 \;=\; 0 \;. \tag{2}$$

The interpretation is straightforward: The marginal social benefit of the investment is $v'(\beta)$ times the probability of (efficient) trade, which is equal to $F(v(\beta))$, while the marginal cost of the investment is 1. Let us assume that there is a unique optimal investment level and that $S'(\beta) > 0$ for all $\beta < \beta^{FB}$ and $S'(\beta) < 0$ for all $\beta > \beta^{FB}$.

Consider now an option contract, $\{p_0, p_1\}$. Given this contract the seller wants to trade if and only if $p_1 - c \geq p_0$. Note that the seller's trade decision may be inefficient. For example, if $v > c > p_1 - p_0$ trade would be efficient but the seller will refuse to trade. What about the buyer's incentives to invest? The buyer's payoff is $v(\beta) - p_1$ if the seller delivers the good, which happens with probability $F(p_1 - p_0)$. With probability $1 - F(p_1 - p_0)$ the seller refuses delivery and the buyer gets $-p_0$. Thus, his expected payoff as of date 1 is given by

$$U_B(\beta) \;=\; F(p_1 - p_0)\,[v(\beta) - p_1] - [1 - F(p_1 - p_0)]\,p_0 - \beta \tag{3}$$

Again, *a priori* there is no reason why the buyer should invest efficiently.

However, for the no renegotiation case Cooter and Eisenberg (1985) and others have shown that an appropriately chosen option contract can implement the first best efficient allocation. The idea is quite simple. Suppose that p_0 and p_1 are such that $p_1 - p_0 = v(\beta^{FB})$. Thus, if the buyer invests efficiently, the seller wants to trade if and only if $p_1 - p_0 = v(\beta^{FB}) \geq c$, i.e., if and only if it is efficient to do so. On the other hand, given the trade decision of the seller the buyer's privately optimal investment level β^* is uniquely characterized by

$$U_B'(\beta^*) \;=\; v'(\beta^*) F(p_1 - p_0) - 1 \;=\; v'(\beta^*) F(v(\beta^{FB})) - 1 \;=\; 0 \;. \tag{4}$$

Comparing (4) to (2) shows that $\beta^* = \beta^{FB}$. Note, that the buyer receives all the marginal benefits of his investment when there is trade. Hence, if the "option price" $p_1 - p_0$ is set at $v(\beta^{FB})$ the buyer gets the full marginal return of his investment in all states of the world where there is also a social return to it. Thus, the buyer is induced to invest efficiently.

This option contract has several interesting features: First, only the difference $p_1 - p_0$ matters for efficiency. Therefore, we have one degree of freedom in choosing p_0 which can be used to share the expected surplus *ex ante* between the two parties.

Second, an option contract is a very simple mechanism which induces the seller to truthfully reveal all relevant information about the realization of his cost. If the seller exercises his option his cost is below $v(\beta^{FB})$. Hence, the buyer can be given the full marginal return of his investment whenever there is a social return to it and no return in all other states. The courts do not have to speculate about the seller's cost or the buyer's level of investment. All relevant information is revealed by the seller's decision.

Third, if the seller does not deliver the buyer receives a net payment $p_1 - p_0 = v(\beta^{FB})$ which is equal to the *efficient* expectation damage, i.e., to the level of expectation damages evaluated at the socially efficient reliance level, β^{FB}. But, it is important to note that the breach remedy of (actual) expectation damages does not implement the first best. Suppose that the courts could evaluate the actual $v(\beta)$ (which requires that the courts can form an unbiased estimate of the level of investment) and that they force the seller to pay $v(\beta)$ to the buyer if he chooses not to deliver. Clearly, since the seller internalizes the utility loss of the buyer in the case of no delivery his breach decision will be efficient. However, under the breach remedy of (actual) expectation damages the buyer receives $v(\beta) - p_1$ in all states of the world, including those where there is no trade and therefore no social return to his investment. Hence, (actual) expectation damages induce the buyer to overinvest. Efficiency is induced only if the courts assess damages assuming that the buyer has chosen the efficient level of investment β^{FB}.

Finally it is important to note that the above arguments rely on two strong assumptions. First, I assumed that there is no renegotiation. With renegotiation the parties would always renegotiate to trade if and only if trade is efficient. Thus, the delivery decision of the seller does not reveal that $c \leq p_1 - p_0$ but rather that $c \leq v(\beta)$. Nevertheless, we will see in the next section that exactly the same option contract implements the efficient allocation, even though the argument is slightly more complicated. Second, I assumed that only the buyer has to make an investment. With two-sided relationship-specific investments the problem is considerably more complicated and will be dealt with in the last section.

Option Contracts and Renegotiation

Suppose the parties can renegotiate the contract between date 2 and date 3, i.e., after $v(\beta)$ and c are known but before trade takes place. If trade is efficient and the seller wants to exercise his option ($v(\beta) \geq c$ and $p_1 - p_0 \geq c$) there is nothing to renegotiate. The seller will trade voluntarily and any haggling about the price is essentially a zero-sum game. The same is true if trade is inefficient and the seller does not want to trade ($v(\beta) < c$ and $p_1 - p_0 < c$). Consider now the case where trade is efficient but the option price is too small to induce the seller to deliver the good ($v(\beta) \geq c$ and $p_1 - p_0 < c$). In this case the outcome would be inefficient and there is scope for renegotiation. I will not specify any particular renegotiation game in this section. Instead, I assume that the buyer (seller) receives $\alpha \in [0, 1]$ ($1 - \alpha$, respectively) of the surplus of renegotiation. Finally, there is the possibility that trade is inefficient but that the option price is so high that the seller wishes to trade ($v(\beta) < c$ and $p_1 - p_0 \geq c$). Again, there will be renegotiation to reach the efficient outcome (here of no trade) and the two parties will split the surplus in proportions α, $1 - \alpha$. Thus, with renegotiation trade is always efficient.

The question is whether it is possible to induce the buyer to invest efficiently. Spier and Whinston (1995, Proposition 1) have shown that the same option contract considered in the last section does the job. To see this let $p_1 - p_0 = v(\beta^{FB})$. We know from the last section that if the buyer chooses $\beta = \beta^{FB}$ then there is no need for renegotiation because the seller wants to trade if and only if it is efficient to do so. Furthermore, we know that at β^{FB} the private marginal return to the buyer's investment is equal to the social marginal return. Suppose now that the buyer chooses $\beta < \beta^{FB}$, so $p_1 - p_0 > v(\beta)$. For $c < v(\beta)$ and $c > p_1 - p_0$ the analysis is the same as in the last section: There is no need for renegotiation and the private and social marginal returns to the investment coincide. However, if $v(\beta) < c < p_1 - p_0$ there will be renegotiation in which case the buyer receives $v(\beta) - p_1 + \alpha(c - v(\beta))$. Thus, in this range the private marginal return to the buyer's investment, $(1 - \alpha)v'(\beta)$, exceeds the social marginal return which is equal to 0. On the other hand, if the buyer chooses $\beta > \beta^{FB}$ there will be renegotiation whenever $p_1 - p_0 < c < v(\beta)$ in which case the buyer receives $-p_0 + \alpha(v(\beta) - c)$. In this range the private marginal return to the investment, $\alpha v'(\beta)$, is smaller than the social marginal return of $v'(\beta)$. The utility of the buyer and the social surplus as functions of β are depicted in Figure 2. Note that we have that $U_B'(\beta) > S'(\beta)$ for $\beta < \beta^{FB}$, $U_B'(\beta) < S'(\beta)$ for $\beta > \beta^{FB}$, and $U_B'(\beta) = S'(\beta)$ for $\beta = \beta^{FB}$. Hence, the buyer will invest efficiently.

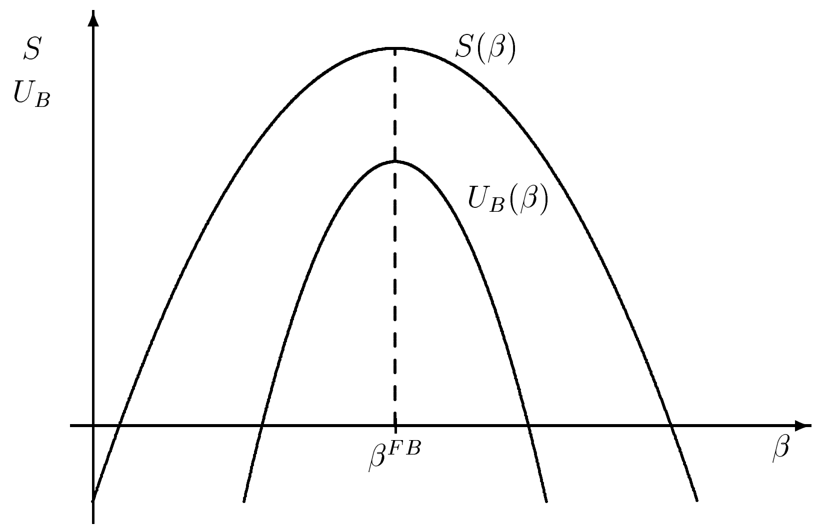

FIGURE 2: Private and social returns to the investment

The same comments as in the no renegotiation case apply in this section. There are two important differences, however. First, without renegotiation trade is efficient only on the equilibrium path. If the buyer does not invest efficiently, trade will also be inefficient. In contrast, if it is possible to renegotiate the option price, efficient trade will always obtain, no matter whether the buyer invests efficiently.

Second, even though the efficient contract is the same as the one discussed in the previous section, the result here cannot be viewed as following from the no-renegotiation result discussed above. It is essential to consider the payoffs that would arise off the equilibrium path, i.e. if the buyer chooses $\beta \neq \beta^{FB}$, and these payoffs are quite different with and without renegotiation.

Two-sided Investments and Unknown Specifications

Consider now the case where the seller also has to make a relationship-specific investment, σ, which reduces his production cost $c(\sigma)$. Again, if renegotiation is possible there will always be efficient trade. However, we now have to give both parties, the buyer and the seller, the right incentives to invest, which is considerably more complicated than in the one-sided investment case. The basic idea, proposed by Chung (1991), Aghion, Dewatripont and Rey (1994) and Nöldeke and Schmidt (1995), is to give all the bargaining power at the renegotiation stage to one party. At the margin, this party is the residual claimant of total social surplus and has the right incentives to invest. The other party can be induced to invest efficiently by choosing the default point of renegotiation appropriately. Nöldeke and Schmidt (1995) show that under certain conditions both features can be achieved with a simple option contract.

In order to explain the argument I have to be more explicit about the renegotiation game. Assume that there exists a time, date 3 in our model, at which trade has to take place. Thereafter, the gains from trade are irretrievably lost. Consider again an option contract which gives the seller the right to deliver and receive p_1 or not to deliver and get p_0. Suppose that after date 2 but before date 3 there is a finite number of points in time at which the buyer and the seller can exchange messages and propose new contracts. A new contract supersedes the original contract if and only if the new contract has been signed by both parties.

What will happen in this renegotiation game? Suppose that (given the old contract) the privately optimal decision of the seller is also socially optimal. In this case there is nothing to renegotiate: Efficient trade decisions will already result from the original contract, and each player can guarantee himself the corresponding payoff by not making a renegotiation offer and withholding any offer he might have received.

However, if the seller's privately optimal delivery decision is not efficient, there is scope for renegotiation. Note that renegotiation can only succeed if the buyer offers a new contract. To see this, suppose the buyer made no offer at the renegotiation stage. Then, no matter what new contract has been sent by the seller, the buyer can always induce the courts to enforce the old contract by rejecting any renegotiation offer he received. Therefore the seller will not take the efficient trading decision until he has a new contract in hand, offered and signed by the buyer, which guarantees him at least what he could get from sticking to the old contract and taking the inefficient action. Thus, the buyer must give in and adjust prices such that they are more favourable for the seller if he takes the efficient delivery decision. On the other hand, the buyer need not give in too much. It is him that makes the renegotiation offer, so he can suggest new prices which make the seller just indifferent whether or not to reverse his delivery decision.

The above argument shows that an option for the seller gives all the bargaining power in the renegotiation game to the buyer, in the sense that he will get all the surplus from renegotiation. This corresponds to the case $\alpha = 1$ of in the previous section. Hence, given the seller's level of investment, the buyer's returns coincide on the margin with the social returns to his investment and he will invest efficiently. Note, however, that this result requires that there is a final date at which trade has to take place. If trade can be postponed indefinitely, or if an inefficient trade decision can be reversed, then the buyer's share of the surplus from renegotiation may be smaller than 1.

The seller's incentives to invest depend on the default point of renegotiation which determines his utility. There are two possible default points: If the difference between p_1 and p_0 is higher than his production cost the seller will enforce trade when renegotiation is unsuccessful. If, however the difference between p_1 and p_0 is smaller than his production cost, then he will choose not to trade. Since the seller's production costs are a random variable, by varying $p_1 - p_0$ we can vary the probability of the two default points and thus vary his incentives to invest. Suppose we choose $p_1 - p_0 = 0$. In this case the seller always gets a payoff of 0 and has no incentive to invest. Suppose now that we choose $p_1 - p_0 > \overline{c}$. Now, with probability 1, the seller gets a payoff of $p_1 - c(\sigma) - \sigma$. Because the probability that trade is efficient is less than 1, such an option contract will provide the seller with an incentive to invest too much. Since we can induce underinvestment by choosing $p_1 - p_0$ sufficiently small and overinvestment by choosing $p_1 - p_0$ sufficiently large, the intermediate value theorem suggests that we can also achieve the efficient investment level by choosing $p_1 - p_0$ appropriately. Under a mild technical condition this is indeed the case, as shown by Nöldeke and Schmidt (1995, Proposition 2).

So far I have assumed that at date 3 the parties either want to trade exactly one unit of a given and well-specified good, or do not want to trade at all. But the argument given above can easily be extended to the case where the two parties do not know in advance the final specification, q, of the good to be traded, for example because the optimal specification, q^*, depends on a complex realization of the state of the world, θ. The specification may include the quantity of the good to be delivered and various aspects of its quality. In this case the parties could write a contract which gives the seller the option to deliver some fixed specification $\overline{q}$. Clearly, $\overline{q}$ will be inefficient in many (may be in all) states of the world. However, if renegotiation is possible, the parties will always renegotiate to the efficient $q^*(\theta)$. Furthermore, given the option contract the buyer is residual claimant on the total surplus at the margin, so he will invest efficiently. The question is whether the option to deliver $\overline{q}$ can induce the seller to invest efficiently, too. Suppose that the seller will overinvest if he has to deliver $\overline{q}$ with probability 1. Then, by choosing the option price $p_1 - p_0$ appropriately, the incentives to overinvest and to underinvest can be balanced so that the seller will just invest efficiently.

To conclude, this essay has shown that option contracts and privately stipulated damages are a simple but powerful instrument to implement efficient investment and trade decisions in a wide variety of circumstances.

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