The Option to Change One Construction Contract for Another

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Abstract

The aim of this article is to propose a solution to the principal-agent problem arising in construction contracts. The inability to write complete and enforceable contracts gives the contractor the opportunity to earn by cheating. The ultimate method to deal with this problem is to design a contractual mechanism that would stop a self-interested contractor from taking benefit resulting from any post contractual opportunism. According to this method, the contractor must simultaneously enter into a cost-reimbursement contract and buy a call option for the work to be performed. This combination acts as if the owner enters into a cost-reimbursement contract and a fixed price contract with an exclusive right of choosing which contract to apply when the actual cost is known. The owner's advantage lies in the power of preventing the contractor from behaving inefficiently. The contractor's advantage lies in the possibility to demonstrate good faith and to make a credible promise without relying on reputation typically enjoyed by the already established contractors.

Key words: moral hazard, construction contracts, real options.

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Introduction

Over the last decade, the real option approach is expanded to include an evaluation of all kinds of investments in various economic activities (Dixit and Pyndick, 1994; Trigeorgis, 1996; Amram and Kulatilaka, 1999). The enormous progress in this area brought the real option theory to maturity. It is now becoming a common practice in numerous companies and it is progressively introduced in professional literature and academic programs (Copeland and Antikarov, 2001).

This article explores a new field for an application of real options. It proposes a solution to the principal-agent problem arising in the construction contracts. Agency relationship refers to circumstances where an individual (the agent), acts on behalf of another (the principal), in order to pursue the latter's interests. Moral hazard problems may arise when the agent is tempted to take self-interested actions for the detriment of the principal's goals.

The first section outlines the problem of moral hazard in construction contracts. The second recommends an option-like mechanism for resolving the moral hazard problem. The third and last section demonstrates pricing mechanism for this option.

Moral Hazard in Construction Contracts

Construction contracts are usually classified into two main categories: fixed price contracts and cost-reimbursement contracts, also known as cost plus contracts (Federal Acquisition Institute, 1999; Canadian Construction Documents Committee, 1998). The two categories differ in a sense that a different party becomes the bearer of the risk. In fixed price contracts, the contractor is required to deliver the specified product or service for a predetermined amount regardless of the actual cost. Hence, the scope of work and all requirements are fully and accurately defined prior to contracting.

In contrast, under cost plus contracts, the owner assumes the actual cost, and pays a fixed or percentage fee to the contractor over and above the actual cost of work performed. The fixed fee is based upon a rough estimate of the value of work required to fulfil the contract. The percentage fee is calculated by multiplying an agreed upon percentage times the actual cost of the work performed. Usually, cost-reimbursement contracts are used when it is difficult to define precise scope of work to determine a fixed price.

The selection of the contract type has a significant impact on the contractor's behaviour and contract monitoring. A cost-reimbursement contracts with a percentage fee is the most difficult to administer because the contractor earns a higher profit when he increases costs and takes longer to complete the work. This is the reason why some companies and government agencies do not allow cost-reimbursement contracts with percentage fees. If the contractor is paid a fixed fee, he has no incentive to either increase or decrease the costs.

Consequently, both cost-reimbursement contracts with either fixed or percentage fees require an extensive involvement by the owner in controlling the costs. Detailed costs monitoring

system and owner's approval of contractor activities, such as personnel increases, overtime, and major material purchases, are required.

On the other hand, owner's involvement in controlling costs is not necessary in the fixed price contracts since the actual cost transfers to the contractor. Furthermore, fixed price contracts can be used in a competitive bidding process to obtain the lowest price for a specified product or the required scope of work. These advantages can result in significant cost savings in comparison to the cost-reimbursement contracts.

Since the cost of performing the work determines the contractor's profit, he has an incentive to perform explicitly according to specifications defined in the contract. Any change or additional work means less profit. Knowingly, some contractors offer too low a price in order to win the contract and afterwards they take advantage of a favourable position allowing them to inflate their price for carrying out the inevitable changes. The situations in which the scope of work does not change are extremely rare. Consequently, many fixed price contracts can result in a higher cost than the one that would be incurred with cost-reimbursement contracts.

In addition, fixed price contracts can result in quality problems even though they meet contract requirements. For increasing their profit, the contractors are tempted to cut the cost by employing strict minimum number of people, hiring less skilled employees, and cutting on inspection and quality control activities.

As a rule, monitoring and providing incentives are two main ways of controlling moral hazard in construction contracts. Monitoring is intended to prevent the contractor from behaving inappropriately through a direct supervision and an adequate system of rewards and punishments. Sometimes contractor's desire to maintain good working relationship and reputation is enough. In other circumstances, the efficacy of monitoring may depend on establishing verifiable evidence that is costly or sometimes impossible to obtain (Holmström, 1979). Generally, even if the owner knows that the contract has been breached, this fact cannot be confirmed by a third party, such as court or arbitrator, who would have the enforcement powers. Moreover, some commitment problems might make it costly to carry out the punishment.

Nevertheless, it may be still possible to observe outcomes and to provide incentives for a good behaviour through rewarding desirable results. These incentives can be incorporated into the cost-reimbursement contracts or the fixed price contracts. An incentive contract functions with a linear payment structure, where the contractor earns a fixed fee plus some additional gain depending upon his performance. The most commonly used performance incentives are based on cost, schedule and quality. The types and amounts of incentives are specified in the contract and are established on the basis of performance (Graham, 2003). A set of valuable incentives encourages the contractor to achieve a superior performance. However, two important problems arise.

The first problem concerns the bearing of risk. A higher intensity of incentives creates more uncertainty in contractor's income, requiring a compensatory risk premium that translates in a greater fixed fee. The issue of designing efficient contracts, that balance the costs of risk bearing against the incentive gains, is widely discussed in the literature (Cummins, 1977; Weitzman, 1980; Lafont and Tirole, 1986; McAffee and McMillan, 1987). The results show that the intensity of incentives depends on the contractor's risk aversion and his ability to achieve the performance.

The second problem concerns the performance measurement. If an incentive contract has only one performance objective, the contractor will strive to achieve that goal but may perform poorly in other important areas. Inevitably, this may lead the owner to reward the wrong behaviour all the while he is thinking that he is acknowledging the good behaviour (Kerr, 1975). Also, providing incentives in a more balanced set of objectives can only mitigate, but not completely eliminate the problem. This is the case because the contractor takes many more actions than any performance measurement system is able to capture (Baker, 1992; Feltham and Xie, 1994; Datar et al. 2001). In real world, it is impossible to write a completely enforceable contract (Milgrom and Roberts 1992).

Option Like Self-Enforcing Mechanism

Another way of dealing with the moral hazard is to design a contractual mechanism that stops a self-interested contractor from taking advantage from the post contractual opportunistic rent. Being aware of this mechanism, the contractor will not be willing to behave in an opportunistic way. In order to illustrate this situation, let us suppose that two selfish individuals want to share a cake. The best way to incite the one who is going to cut it to be equitable is to give to the other person an exclusive right to take the piece of his choice, once the first one has cut the cake. In the same way, a self-interested contractor will be discouraged from behaving inefficiently if the owner has the right to pay him once the project is complete, using either the predetermined fixed price or the actual cost plus agreed fee. In other words, the contractor has the option to switch from one contract to another (Boukendour and Bah, 2001).

For instance let us consider a craftsman who enters into a fixed price contract for painting a house. Wanting to increase his profit, he may be tempted to work hastily and to spare the paint at the expense of the service quality. The contract may contain some preventive provisions but it cannot prevent all future circumstances. The craftsman is able to find a way to cut in corners. However, if the owner has the right to change the fixed price contract for a cost-reimbursement contract, the craftsman cannot benefit from providing a low quality service. In contrast, under a cost-reimbursement contract, the craftsman may be tempted to work slowly and not care about the quantity of used paint. If the owner has the right to change the cost-reimbursement contract for a fixed price contract, the craftsman will assume the consequences. The craftsman, knowing how his pay is calculated, will typically behave suitably.

In order to obtain such a choice, the owner must simultaneously enter into a cost-reimbursement contract and buy a call option upon the work to be performed by the terms of the contract. In other words, the underlying asset of the option is nothing else but the debt owed to the contractor. Practically, under the cost-reimbursement contract, the contractor reassigns the actual cost of work performed plus the agreed upon fee into the owner's account. Once the project is completed, the owner will call the option only if the amount due exceeds the exercise price. When the option is called, the debt is automatically deleted.

From another point of view, entering into the cost-reimbursement contract and writing the call option upon the work to be performed are collectively as selling the same asset to two different individuals. When it is delivered to one, it cannot be delivered to the other. When the owner exercises the option, the contractor abides to the decision and delivers work for a fixed

price. Consequently, the contractor has no power to make the cost-reimbursable contract enforceable. However, if the option is not exercised, automatically the cost-reimbursement contract comes into effect. It is the owner who decides which contract is valid and the contractor must abide to the owner's decision.

Therefore, the option provides the owner with a significant advantage over the contractor in all circumstances. If the inputs prices increase, the owner can exercise the option, and consequently the contractor bears the cost increases despite his good behaviour. Unfortunately, if the inputs prices drop, the contractor will not benefit because the owner will certainly abandon the option and the cost-reimbursement contract will apply. Therefore, the owner is obliged to give the contractor fair compensation, since the price fluctuations are beyond the contractor's control. Still, the owner owes nothing to the contractor for the just behaviour. Indeed, from an ethical point of view, paying someone for not cheating cannot be thought of as fair remuneration but as a bribe.

The main advantage of the option is to discourage the contractor from behaving opportunistically at the owner's expense. On the other side, it provides the contractor with a significant opportunity to demonstrate his good faith and to make a credible promise without referring to any previous experience. This seems fair, especially for new comers and outsiders, who would be disadvantaged by the traditional selection system based on reputation.

How to Price the Option

Let K be the exercise price of the option; S_T, the actual cost at the expiration date T; and F, the agreed upon fee. Both amounts K and F are contractually determined, but S_T is unknown at the starting date of the contract. We also assume that the actual cost remains uncertain until the work is fully completed. Otherwise, if the contractor knows the actual cost before completing the work, he can relax his effort to the owner's expense when input prices are going down. The owner can protect himself by introducing in the contract a provision requiring a constant effort from the contractor.

Assuming the input prices being log normally distributed, the call option can be estimated using Black and Scholes formula:

$$(1)\quad C = S_0 N(d_1) - Ke^{-rT} N(d_2)$$

Where :

$$d_1 = \frac{\ln(S_0/K) + (r + \sigma^2/2)T}{\sigma\sqrt{T}}$$

$$d_2 = \frac{\ln(S_0/K) + (r - \sigma^2/2)T}{\sigma\sqrt{T}} = d_1 - \sigma\sqrt{T}$$

N(d): cumulative probability for a standardized normal distribution
r: risk free interest rate
σ: daily standard deviation
S_0: current spot price

To determine S_0, let us consider the exercise price K as the future price of the asset. According to the cost and carry model, the spot price must be such that $S_0=Ke^{-rT}$. Since the asset does not yet exist physically, there is no cost of storage and thus the cost of carrying consists only of the risk free interest rate.

By substituting Ke^{-rT} for S_0 in (1), we get:

(2) $C = Ke^{-rT}\left[N(d_1) - N(d_2)\right]$

With: $d_1 = \frac{\sigma}{2}\sqrt{T}$ and $d_2 = -\frac{\sigma}{2}\sqrt{T}$

Besides, let us suppose that the premium C will be paid at the expiration date of the contract, the equation (2) becomes:

(3) $C = K\left[N(d_1) - N(d_2)\right]$

Finally, the value of the option depends only on two parameters, the input prices volatility and the exercise price K.

The standard approach to estimating the volatility computes the daily standard deviation of the logarithms of daily returns on the basis of historical data (Hull, 2002). However, there is a great difference between financial options and real options due to the uncertainty. In financial options, there is no major obstacle to gather historical data necessary to estimate the volatility because the underlying asset and the option itself are both traded on the market and their prices are observable. The real options are more complex because they often have multiple sources of uncertainty. For instance, any project has a multiple input prices consisting of different kinds of materials, equipments and labour. The consolidation of all these multiple sources of uncertainty in one single estimate of volatility is necessary to apply the option pricing model.

Monte Carlo simulation method can be used, but this process requires defining many parameters and to establishing many hypotheses. For the sake of simplicity, a *synthetic price index,* that already consolidates many different prices, can be used as a proxy. Further, a French national construction index BT01, published monthly in the "Journal Officiel," is used. This index takes into account all the construction trades, and it is used for indexing construction contracts and pricing sales on drawings.

Since the option is payable at the expiration date of the contract, its price can be calculated on the basis of the actual volatility occurring within the contract duration instead of using historical volatility. In fact, the price index is published with two or three months of delay. Still, this problem can be resolved by considering a number of the most recent indexes that correspond to the contract duration. For example, a contract starting in January, 2003 and finishing in March, 2004 would use the series of the indexes from October, 2003 till January, 2004. For this period we get a monthly standard deviation of 0.889%, which translates into $0.889\%\sqrt{15} = 3.45\%$ for the whole contract duration.

Assume for example a fixed price of \$200 000, the value of the option according to equation (3) is $\$200000\left[N(\frac{3.45\%}{2}) - N(-\frac{3.45\%}{2})\right] = \$2752.57$. Table 1 below displays the value of the option as a function of various volatilities and time durations for a hypothetic contract with a fixed price of \$1000. The results show that the value of the option increases as a function of

the volatility of input prices and the time duration of the contract. It is more sensitive to the former than to the latter.

Table 1. The value of an option for K= $1000

Volatility		Contract duration in months						
Month	Year	6	9	12	15	18	21	24
0,50%	1,73%	4,89	5,98	6,91	7,73	8,46	9,14	9,77
1,00%	3,46%	9,77	11,97	13,82	15,45	16,92	18,28	19,54
1,50%	5,20%	14,66	17,95	20,73	23,17	25,38	27,42	29,31
2,00%	6,93%	19,54	23,93	27,63	30,89	33,84	36,55	39,07
2,50%	8,66%	24,43	29,91	34,54	38,61	42,29	45,68	48,83
3,00%	10,39%	29,31	35,89	41,44	46,33	50,74	54,80	58,58

Conclusion

The success of construction projects depends particularly on the contract efficacy. A huge difficulty to write complete and enforceable contracts in real world makes this success problematic, especially when the contractors attempt to take individual advantages at the owner's expense. Monitoring and providing incentives can only alleviate but not eliminate the problem completely.

A new self-control mechanism intended to force the contractor to behave in congruency with the owner's interests was discussed in this article. The mechanism is based on a blend of a cost-reimbursement contract and a call option upon the work to be performed by the terms of the contract. The system acts as if the owner enters into a cost-reimbursement contract and a fixed price contract with the exclusive right of choosing applicable contract upon the project completion when the actual cost of work performed is known. As such, the contractor is in a position of bearing the consequences of possible bad behavior. Also, the contractor may seize a significant opportunity for demonstrating his good faith and for making a credible promise without backup of his reputation. This seems a fair practice, more so than the traditional system based on reputation, which generally favors the established contractors.

However, the contractor's behavior only partially determines the actual cost since the input prices fluctuations are beyond his control. Due to this reason, he deserves a fair compensation that is estimated using the option pricing model.

Finally, the proposed mechanism is based more on a threat of bearing the consequences of his bad behavior rather than on direct supervision or incentives. Thus, this method seems less costly, more effective and ethical rather than the traditional systems.

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