Understanding Risk and Return in Bidder's EPC Price Using CAPM Concept

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Abstract

Projects are currently characterized by their complexity, size and intensified multiparty involvement. It is therefore difficult to meet between company's and contractor's expectations in terms of project objectives. Using different types of contracts, contractors may have different view that is reflected from their price.

In EPC contract that uses a concept of lump sum contract, price submitted by contractor is a promise of each contractor to deliver the project. Contractor will then face risk in executing the project, while in the same time they will have its potential return.

This paper describes behaviour of contractors in submitting price as part of bidding process using CAPM concept. It mathematically proves that risk and return will be going to the same way, e.g. high risk may have high return. It concludes that the price heavily relies on contractor's experience and risk profile.

Keywords: Engineering Procurement Construction (EPC), Contract Price, Capital Asset Pricing Model (CAPM), Risk and Return

1. Introduction

We have known that there is a strong relationship between risk and return, e.g. high risk will normally have high return, and low risk will normally have low return. The question then, how can we mathematically prove such a relationship? Particularly in the EPC bidding process where bidders (contractors) have to come up with the price after getting project's scope of work, it is interesting to understand the bidder's behaviour in seeing the project's risk and translating it into the price as well as their potential return.

CAPM is a model from finance discipline that discusses about the capital market, company's value and company's cost of capital. In addition, it can be used to explore the optimum combination of an investment among portfolio of stocks and a risk-free asset. It has therefore become one of important finance models describing the relationship between risk and return. Hence, we will use CAPM theory to analyse the contractor's price in the EPC bidding process.

2. Contract and Bidding Process

a. Contract

A contract between company and contractor represents a mutually binding agreement including its terms and conditions which obligates contractor to provide something of value (e.g., specified products, services, or results) to company, and the company to compensate monetary or other valuable thing to the contractor

(PMI, 2013). It can be simple or complex reflecting the simplicity or complexity of the deliverables or required efforts.

There are two main types of contract, i.e. fixed price and cost reimbursable contract.

1) Fixed price contract
   It is also known as lump sum contract, setting a fixed total price for a defined product, service, or result to be provided (PMI, 2013). It requires that the company clearly define the scope of work and technical specifications prior to contracting the project to the contractors (O'Toole J and Jergeas G, 2010).

2) Cost reimbursable contract
   It sets payments (cost reimbursements) to the contractor for all legitimate actual costs incurred for completed work or service ordered by company, plus a fee for contractor's profit (PMI, 2013). It is often used on ill-defined fast tracked projects, where scope and specifications are developed over the duration of the project in addition to an expectation of rapid change (O'Toole J and Jergeas G, 2010).

Furthermore, there are many varieties of contract's type are derived from those two broad families. It may also include financial incentive and risk sharing clauses whenever the contractor exceeds, or falls below, defined objectives such as costs, schedule, or technical performance targets (PMI, 2013). Each of them has features depending on scope of works, uncertainty and degree of risk. The type of contract with its characteristics and suggested risk allocation is shown in figure below.

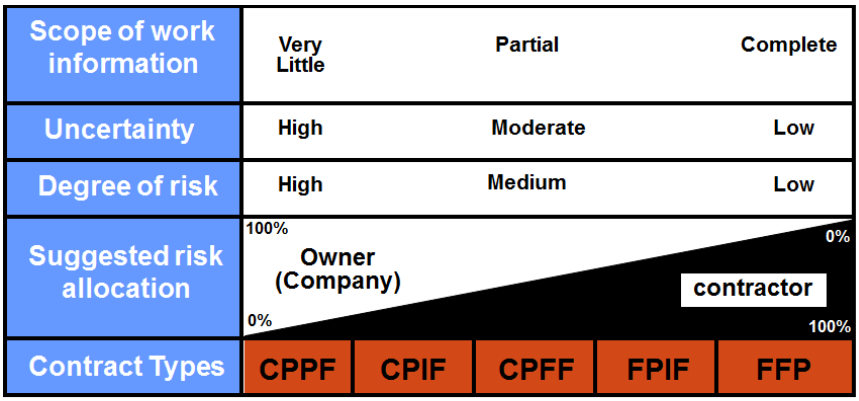

Figure 1: Type of Contracts and Its Characteristics

b. Bidding Process

Bidding process or tender can be simply said as a method to find a contractor to do the job (project). There are five main steps of tendering a project, which are:

1) Define specifications
   This is mainly company's responsibility in order to prepare bidding process, e.g. defining specification of works that will be tendered, developing contracting strategy and bidding procedure,

etc. In this stage, company also prepares cost estimate of works which subsequently become company's estimate (owner's estimate) to be benchmarked with price from contractor(s) or bidder(s).

2) Request (invite) for bids
   Company invites some qualified contractors to participate in the tender. The contractors then receive bidding documents from which they may come up with the deliverables' document and price.
3) Conduct bid submission
   Contractors who are interested in taking the project will submit their quotation. If there is no contractor (bidder) interested in, the process could be repeated (re-bid).
4) Review the bids
   Company will review documents submitted by bidder(s). The review includes administration, technical and commercial aspects.
5) Award the Contract
   If there are some bidders participate in the process, the winner is usually the one who is technically accepted and has lowest price. If the contractor's price exceeds company's estimate, bid may be repeated or company will keep accepting such high price. Finally, the winner has obligation to deliver the project.

Figure 2: Main Steps of Bidding Process

3. Capital Asset Pricing Model (CAPM)

a. Concept Overview

Capital Asset Pricing Model (CAPM) was developed in the early 1960s by William Sharpe (1964), Jack Treynor (1962), John Lintner (1965) and Jan Mossin (1966). It is based on the principle that not all risks would affect asset prices. In addition, it can be diversified away when held along with other investment in a portfolio to minimise risk or maximise return. Thus, CAPM gives us insights about relationship between risk and return (Perold, 2004).

CAPM states that the expected risk premium on each investment is proportional to its beta. Beta is defined as a ratio to see how an investment moves together to the capital market (market). For example, since the return on Treasury bills is fixed, it is unaffected by what happens to the market. In other words, Treasury bills have a beta of 0. It is therefore Treasury bills (government bond) and such a like called as a "risk-free" asset, since it is owned by the authority (government).

Portfolio is defined as a bundle set of stocks in the market. Using CAPM's concept, each investment should lie on the sloping security market line connecting Treasury bills and the market portfolio. From figure 3, the expected risk premium on an investment with a beta of .5 is half the expected risk premium on the market. Meanwhile, the expected risk premium on an investment with a beta of 2.0 is twice the expected risk premium on the market (Brealey−Meyers, 2003).

Therefore, we can write the formula as:
Expected risk premium on stock = beta x expected risk premium on market

$$E(R_i) - R_f = \beta * \{E(R_m) - R_f\} \quad (1)$$

By re-arranging equation 1 above, we can then find the famous CAPM formula as follows:

$$E(R_i) = R_i = R_f + \beta * \{E(R_m) - R_f\} \quad (2)$$

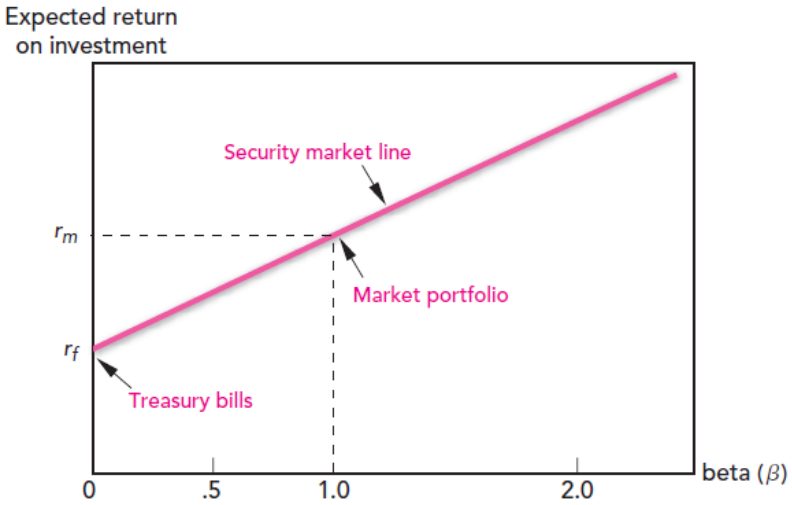

Figure 3: Expected Return and Beta (Brealey−Meyers, 2003)

b. Portfolio and Risk-Free Investment

CAPM is also used to calculate the expected return and the optimised portion of combining two investments, i.e. market portfolio which consists of a bundle of stocks and a risk-free asset. If we have an arbitrary risky portfolio with expected return R_p and a risk-free asset with return R_f, the expected return of combining those two investments (R_{xP}) will be (Berk JB and DeMarzo PM, 2007):

$$E(R_{xP}) = (1 - x) * R_f + x * E(R_p) \quad (3)$$

Where, x is fraction of putting the investment in the portfolio. We can then simply modify equation 3 to this equation:

$$E(R_{xP}) = R_f + x * \{E(R_p) - R_f\} \quad (4)$$

This gives us more descriptive interpretation stating that our expected return is equal to the risk-free rate and fraction of the portfolio based on the amount we invest in it. Graphically, it can be seen in the figure below in which portfolio (P) is a bundle of selected stocks.

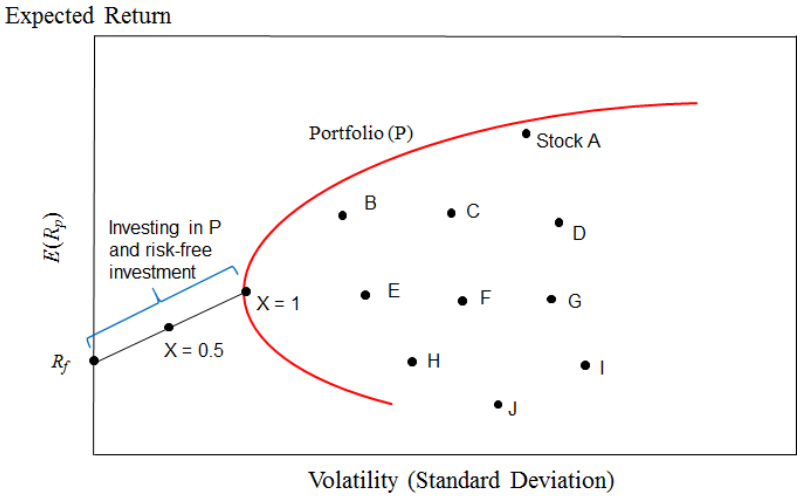

Figure 4: Combination of Portfolio and Risk-Free Investment

4. Analysis

To begin with, we use several terms in relation to contract and bidding price:

- BP = Bid Price, final price submitted from contractors (bidder) to company's bidding process
- BE = Base Estimate, base cost estimate of project made by contractor according to project's scope of works that consists of project direct and indirect costs.
- PC = Project Cost, base estimate added by project contingency and management reserve that is contractor's potential margin.
- *P* = probability (0 to 1), contractor's probability (confidence level) to deliver the project as per scope of works by utilising Project Cost (PC)

It is separated between BE and PC because contractors normally have their base estimate according to scope of works including indirect costs, e.g. technical allowance, home office cost, then it will be added up with other costs, i.e. project contingency and management reserve (potential margin). Thus, it can be structurally written:

PC = BE + Contingency + Reserve (5)

Project contingency is a cost element used to cover the uncertainty and variability associated with a cost estimate, and unforeseeable elements of cost within the defined project scope as well as covering inadequacies in complete project scope definition, estimating methods and data. Meanwhile, management reserve is an allowance for anticipated changes in scope, or to cover the costs for items that may be required but have not yet been specifically identified as being included in the current project scope (AACE International, 2013).

In addition, contingency and reserve is related to risks that contractor should deal with during executing the project. If they can be properly managed, a contractor will likely have more margin from unused amount of contingency and reserve that it has budgeted before. Conversely, they may screw up contractor's capital causing loss and even worse, going burst. As a result, risk and return is closely related.

Furthermore, adopting CAPM formula, it can then be derived a formula of contractor's bidding price as follows:

$$BP = (1 - p) * BE + p * PC \quad (6)$$

From above equation, Bid Price (BP) submitted by a contractor will depend on BE (Base Estimate), PC (Project Cost) and *p* (probability).

If PC = BE, where contractor decided to make BE as PC, then BP = BE = PC. In a case where PC ≠ BE, BE may not be much deviation between company's and contractor's estimate because the typical methods in estimating cost of a project. All project management institutions have rigorous guidelines and best practices how to do cost estimate. Then, the more significant different will be PC, because contractors will see project risks differently than company does. Therefore, it is very unlikely when PC = BE.

Moreover, probability also contributes significantly in determining bid price. Probability is basically explaining how a contractor views a project in relation to risks faced by such a contractor. For example, if project risks are considered high by a contractor because the project is very challenging and the contractor has less experience in handling similar projects, the probability to make Project Cost (PC) as contractor estimated final cost (actual after doing the project) becomes low.

Furthermore, by re-arranging equation 6, it will result in below equations:

$$BP = BE – p * BE + p * PC \quad (7)$$

$$BP = BE + p * (PC - BE) \quad (8)$$

As a result, it is clear that probability (*p*) is the most critical variable for a contractor in determining Bid Price (BP), in particular because there might be no much different in Base Estimate (BE) between company's and contractor's estimate. Company may also estimate contractor's contingency and margin to be added up in company's base estimate. What company can't do is to see contractor's view about the risks of such a project.

Further modification of equation 8 becomes equations as follows:

$$BP - BE = p * (PC - BE) \quad (9)$$

$$p = (BP - BE) / (PC - BE) \quad (10)$$

Finally from equation 10 we can mathematically find the relationship between risk and return. Project with high risk will have low probability (*p*) that is caused by high "PC – BE" (denominator). Consequently, it makes a higher PC which impacts on higher contingency and reserve as well as potential margin. Thus, it will result high risk-low probability and high potential return.

Interestingly, company sometimes only look at the difference between BP and BE that makes a tender failed, because company may also use typical estimation methods. Instead, PC that interacts with

probability and project risks seen by contractor is actually the more significant factor in determining the final bidding price.

5. Application

A contractor practically applies equation 6 in determining the final bid price that will be submitted to company for bidding an EPC project.

BP = (1 - p) * BE + *p* * PC

According to equation above, a contractor will likely win the bid if:

1) It has lower PC than other contractors, and (or)
2) It has *p* higher than other contractors

A contractor that has more experience handling similar projects and wants to win will have tendency to lower PC, because it has experience and know how to manage the project more efficiently. In other words, such a contractor faces lower project risks than other contractors. Hence, the probability to execute project based on PC will be high.

For instance, there is a bidding process that involves three contractors, i.e. contractor A, B and C. Contractor A views the project relatively easy to manage since it has experience on similar projects, and its probability (*p*) equals to 1. In this case, contractor A views low project's risk, so that it has high probability (*p* = 1) to succeed using the estimated PC. As a result, Bidding Price (BP) will equal to Project Cost (PC).

Using numerical data example, we assume variables from each contractor as follows:

Contractor A: BE = 100, PC = 115 (Contingency 10, Reserve 5), p = 1
Contractor B: BE = 100, PC = 120 (Contingency 15, Reserve 5), p = 0.9
Contractor C: BE = 100, PC = 125 (Contingency 20, Reserve 5), p = 0.8

By applying equation 6 to above data, we get contractor A winning the bid since it has the lowest bid price.

BP A = (1-1) 100 + (1) 115 = 115
BP B = (1-0.9) 100 + (0.9) 120 = 10 + 108 = 118
BP C = (1-0.8) 100 + (0.8) 125 = 20 + 100 = 120

In this example, contractor B and C may view higher risk due to some reasons, e.g. less experience or more risk-adverse profile. Consequently, they put more contingency that might be converted to margin if they can manage the risks resulting more unused contingency at the end of project. However, they are lost since their bid prices are higher than contractor A. Therefore, contractor A exposes low risk, high probability that leads to low potential return, while contractor B and C expose high risk, low probability that leads to high potential return.

6. Conclusion

Nowadays, it is more difficult to meet the project objectives and challenges between company and contractor in term of timely completion, costs, quality and revenue. Meanwhile, the process of awarding a contract based on lowest contractor's (bidder's) price is more practicable in many countries due to more limited project's return.

Contractor in submitting price for a bidding process has unique behaviour related to its risk profile. CAPM (Capital Asser Pricing Model) as one of important theories in finance can then be adopted to analyse risk and return of bidder's EPC (Engineering Procurement and Construction) project. Furthermore, it can be seen the link between risk and return when bidders determines the final price they want to bid.

All bidding price equations might not be in realty, but they are a mathematical approach to see and understand the contractor's behaviour when submitting the bid price. In addition, it demonstrates the relationship between risk and return that is going to the same way, e.g. low risk may have low return. It concludes that the price heavily rely on key factors, such as contractor's experience and risk profile.

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