Measuring and Managing Uncertainty: The Case of Competitive Bidding

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Nearly all significant business decisions are made under conditions of uncertainty. No accounting or performance management technique can remove the uncertainty, but it is at least possible to carry out some analysis (often involving some form of the expected value principle) so as to facilitate a rational choice by the decision-maker.

Consider the case where a construction firm is trying to win business in a "competitive bidding" situation. In particular, a potential customer invites the construction firm to submit a "sealed bid" stating a fixed price at which the construction firm would be willing to construct a building[1]. The nature of the arrangement is that:

- The customer will almost certainly ask a number of construction firms to submit bids;
- No individual construction firm has any guarantee that its bid will be accepted;
- The construction firm which is awarded the contract is obliged to complete the work at the price specified.

Therefore, in deciding what price to bid, each construction firm must somehow manage two uncertainties. The first relates to the price-sensitivity of the customer – e.g., the higher the price which a construction firm bids, the greater the likelihood that the price will be undercut by a rival construction firm. The second concerns the cost to the construction firm of carrying out the work: The construction firm can make an estimate at the time of bidding, but (since no cost prediction system is perfect) the actual cost of performing the work may turn out to be very different if and when the customer accepts the bid. Therefore, the profitability of the construction firm's bidding strategy depends on effective management of the joint probabilities associated with these two factors. Fortunately, the expected value rule can be used for this purpose, as is shown in the example below.

Example: Buildex Ltd. and Constructex Ltd.

Buildex Ltd. and **Constructex Ltd.** are two rival construction firms. They regularly bid against each other for sealed bid contracts to construct major buildings. For purposes of the illustration, it can be assumed that:

- Buildex Ltd. and Constructex Ltd. are the only bidders in the market.

[1] Of course, the "competitive bidding" business model is not limited to the construction sector. Many other firms (such as subcontractors in either manufacturing or service sectors) have to find their customers in the same way.

- Before setting a bid price, each firm predicts the costs which it would incur in fulfilling the specific contract and then adds a 24% markup to its estimate of cost in arriving at its bid price.

- Both firms perform work of equal quality and therefore the "winning bidder" (i.e., the firm which is awarded the contract) will be whichever firm quotes the lowest bid price. Since both firms apply the same profit markup (24%) the firm which makes the lower estimate of cost will also set the lower bid price.

- Inevitably, the cost prediction process is subject to a degree of error. In particular, for any individual firm, the relationship between **the firm's estimate of costs** and **the actual costs of fulfilling contracts** has the following pattern:

	Probability
Costs underestimated by 20%	0.25
Costs estimated correctly	0.5
Costs overestimated by 20%	0.25
Total	**1.0**

Scenario 1: Cost estimate made by winning bidder = **80%** of true cost:

What is the probability that the contract will be awarded to a firm which underestimates cost by 20%, i.e., the winning bidder is a firm whose estimate of cost equals (100 – 20 = **80%**) of the true cost? There are three cases where this could happen:

Description	**Probability**
Both firms underestimate cost by 20%	(0.25) * (0.25)
Buildex underestimates cost by 20% and Constructex either estimates costs correctly or overestimates cost by 20%	(0.25) * (0.5 + 0.25)
Constructex underestimates cost by 20% and Buildex either estimates costs correctly or overestimates cost by 20%	(0.25) * (0.5 + 0.25)

In summary, the probability of Scenario 1
= (0.25)(0.25) + (0.25)(0.75) + (0.25)(0.75) = **0.4375**.

Scenario 2: Cost estimate made by winning bidder = **100%** of true cost:

What is the probability that the contract will be awarded to a firm which **estimates costs correctly**, i.e., the winning bidder is a firm whose estimate of cost equals **100%** of the true cost? Again, there are three cases where this could happen:

Description	**Probability**
Both firms estimate cost correctly	(0.5) * (0.5) = 0.25
Buildex estimates costs correctly and Constructex overestimates cost by 20%	(0.5) * (0.25) = 0.125
Constructex estimates costs correctly and Buildex overestimates cost by 20%	(0.5) * (0.25) = 0.125

In summary, the probability of Scenario 2
= 0.25 + 0.125 + 0.125 = **0.50**.

Scenario 3: Cost estimate made by winning bidder = **120%** of true cost:

What is the probability that the contract will be awarded to a firm which overestimates cost by 20%, i.e., the winning bidder is a firm whose estimate of cost equals (100 + 20 = **120%**) of the true cost? There is only one case in which this could happen:

Description	Probability
Both Buildex and Constructex overestimate cost by 20%	(0.25) * (0.25) = 0.0625

So the probability of Scenario 3 is just **0.0625**.

Implications of Scenarios 1, 2, and 3:

Taking into account all three scenarios above, it's clear that on average, the winning bidder will be a firm which has estimated cost at the following level:

(0.4375 * 80%) + (0.5 * 100%) + (0.0625 * 120%) = **92.5%** of the actual level of cost[2].

What profit markup will the winning bidder actually achieve? Each bidder set its bid price at (100% + 24% = **124%**) of the estimated cost of carrying out the contract, but we now know that (on average) the winning bidder will be a firm whose cost estimate is only 92.5% of the true cost ("TC") of carrying out the work under the contract. In summary:

- Price received by the winning bidder = 124% * 92.5% = **114.7% of TC**.
- Costs incurred by the winning bidder = **TC**, since the winning bidder is obliged to complete the contract in full even if costs are higher than expected.
- So the profit markup actually achieved by the winning bidder is only **14.7%** of the true cost, and not the **24%** which each bidder added to its cost estimates.

This pattern arises because (on average) firms tend to "win" in situations where they have underestimated cost and have therefore set very low prices. By contrast, firms only very rarely "win" in situations where they have overestimated cost, because in those situations their prices tend to be pitched significantly higher than those of competitors.

More complex examples

What if the relatively simple example in this case were to be modified? For example, what if the example were a larger one, with three or more bidders? In such situations, the technique illustrated here could still be used. The number of scenarios would grow

[2] To put this another way: On average the winning bidder will be a firm which underestimates cost by 100% - 92.5% = **7.5%**.

rapidly with each extra bidder, so a spreadsheet model would be needed to implement the analysis in practice if there were three or more bidders. Intuitively, one might expect that an increase in the number of bidders would decrease the profit markup which the winning bidder would achieve. This intuition is correct. The greater the number of bidders, the greater the probability that at least one bidder will underestimate cost.

Another type of complexity which could be modelled in a spreadsheet analysis of the problem would be differences between the individual bidders. In the Buildex and Constructex example, both firms were identical in terms of the accuracy of their costing systems and in the percentage markup applied in arriving at bid prices, and a spreadsheet modelling of the problem would facilitate relaxing of these two assumptions.

Managing and reducing risk

The analysis illustrated here provides a useful means of managing the joint uncertainties associated with cost estimation and customer price-sensitivity. Could this be extended to finding ways of reducing risk?

In principle, firms such as Buildex and Constructex could decline to offer seal builds to potential customers, and could insist instead that contracts specify that customers will reimburse costs in full along with a specified markup. However this would simply transfer the risks from the bidders to the customer. It is not likely that the customer would accept this risk transfer, especially in a situation there are a number of firms competing for the customer's business.

A more realistic approach may be for bidders to increase somewhat their markup percentages. We saw above that, when Buildex and Constructex add markups of **24%** when setting bid prices, the actual outcome is likely to be that (on average) firms achieve markups of only **14.7%** on bids which they win. Suppose that both firms regard 14.7% as inadequate but would be satisfied with 20%? What is the profit markup which, if added to estimated cost by both bidders, would result in the winner achieving an actual profit of **20%** of the actual cost of fulfilling the contract?

- Required: Winner's Bid Price = 120% of "True Cost" (TC) of performing the work.
- Previously shown: For the winning bidder, "Estimated Cost" (EC) is likely to be only 92.5% of TC. Hence, TC = EC / 0.925.
- Hence: Bid Price = 120% * TC

  = 120% * (EC / 0.925)

  = **1.297** * EC.

In summary if both bidders set their bid prices by estimating cost and adding a 29.7% markup, then the actual outcome will (on average) be that each firm earns profit markups equal to 20% on the bids where it is successful.

Of course it is unlikely that firms could formally collude in setting their markups without falling foul of the law. However, firms which achieve customers through seal bids know that their profit markups must be high enough to allow for the fact that the actual markup achieved will (on average) be consistently lower than the markups which they allow when setting their prices for bidding purposes.