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# Estimating the Estimate: Toward a Quick and Inexpensive Method for Weapons System Cost Estimation

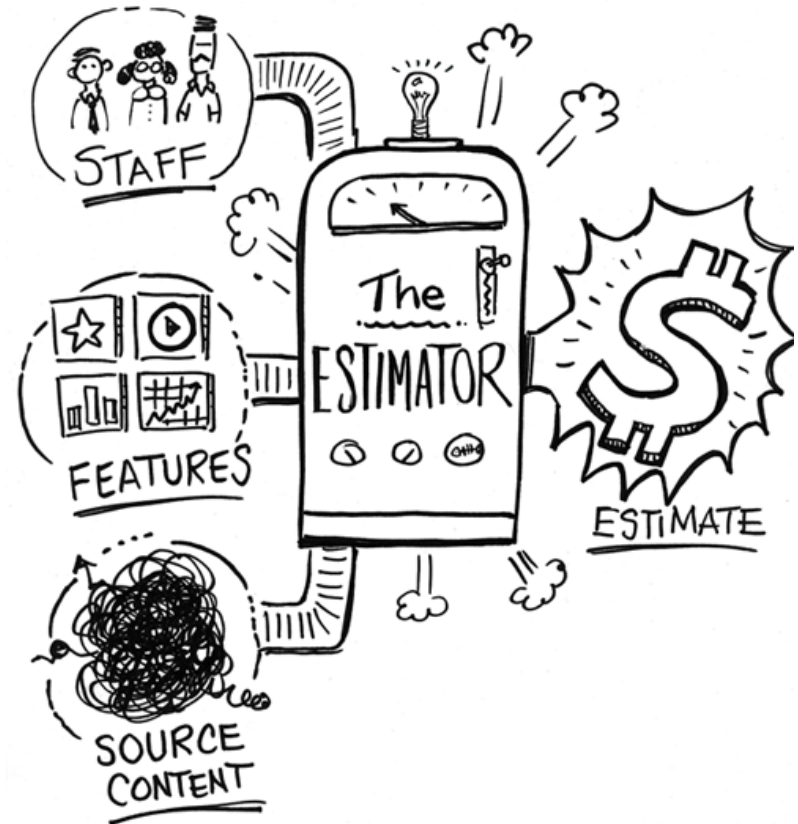
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# The Art & Science of Cost Estimation



"WELL, MAYBE UMPTEEN ZILLION WAS TOO GENERAL A COST ESTIMATE."



The Boss



*How soon can you get me a rough order of magnitude [ROM] on the cost?*

*I need at least a month...*

*Give me a ROM in one week if you really want any chance of funding this initiative*

Full bottoms up would take at least 3-4 months..

Project Engineer



# Research Question



*Can market pricing provide a reasonably accurate cost estimating methodology that is quick and less expensive to execute which provides actionable information to government program managers?*

# Cost Estimation



Formal, documented process. Review of the field identifies the broadly defined methods to estimate costs. (Boehm, 1984; Evans, Lanham, & Marsh, 2006; Jorgensen, 2005; Leung & Fan, 2002)

analogy;

top-down;

bottom-up;

Parkinson;

algorithmic models;

expert judgment;

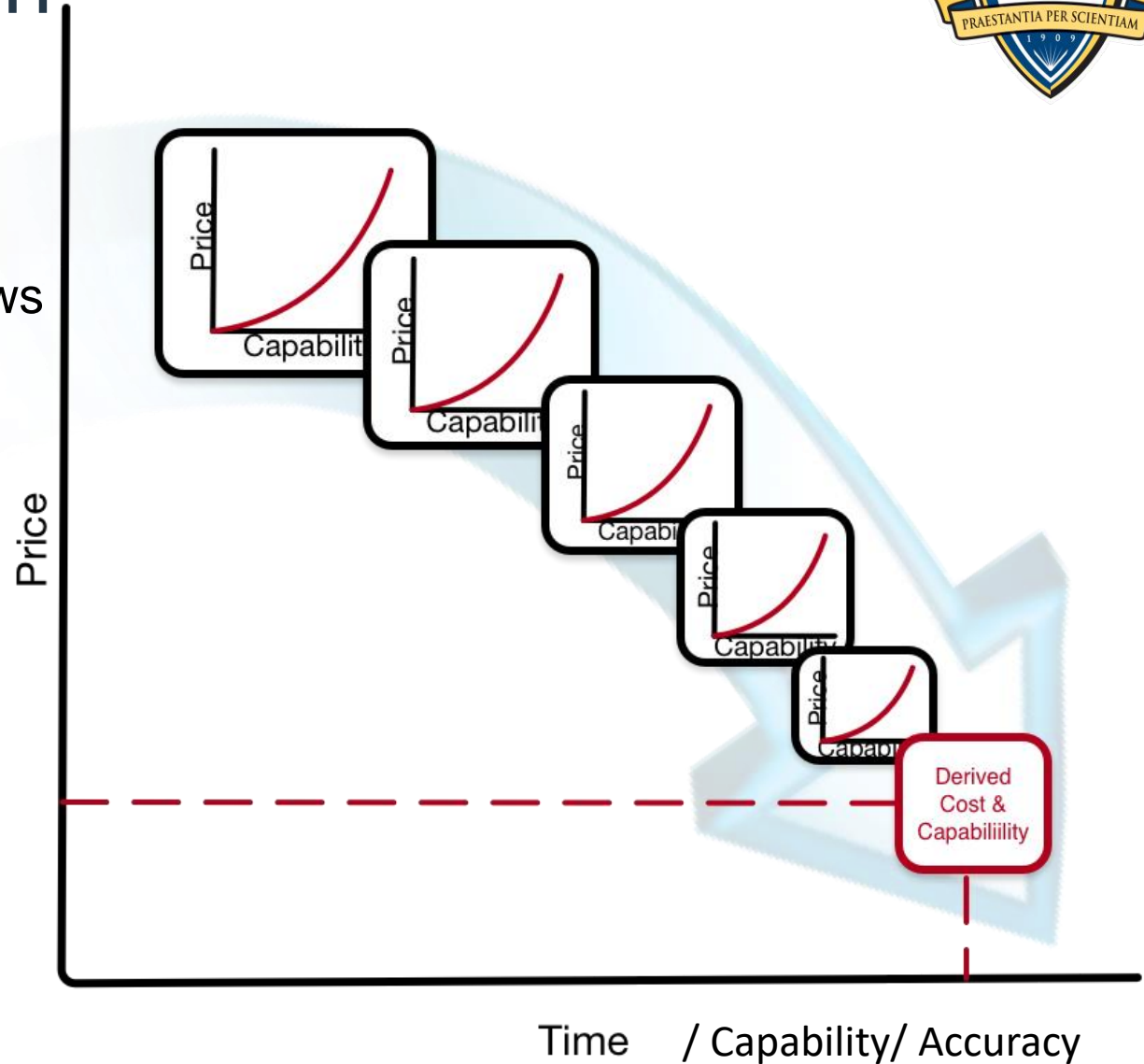
Price-to-Win (PTW)

# Price-to-Win



Iterative Process  
Requires Expert Judgment  
Improves as database grows

Is an estimate  
of the market



# Defense Company Price-to-Win Process



- **Understand the price-capability tradeoff**
- **Build and record market knowledge over time**
- **Determine the relevant pricing alternatives**
- **Determine the government's budget, funding profile, and acceptable price range**
- **Determine the government's should-cost estimate**
- **Estimate the range of solutions**
- **Determine your PTW**
- **Prepare, review, and implement a win strategy that integrates solution and PTW**
- **Consider not bidding if the primary focus of your sales team is on cutting the price**

# The Defense Marketplace



## Industry capability

- Labor Market (same talent pool)
- People

## Intellectual property

- IRAD Budget

## Efficiency/ Effective

- Process
- Manufacturing





# Microeconomic Theory & Applied Statistics



Equilibrium price is attained where supply equals demand.  
When supply exceeds demand prices will decrease.

## Hypotheses:

- Hypothesis 1 → In non-commodity markets the equilibrium price is actually the mean of a range of prices which are normally distributed about the equilibrium price.
  - The Defense market is a non-commodity market.
- Hypothesis 2 → The equilibrium price represents the balancing of costs, risks, and margin for the suppliers.
  - If one of these 3 elements is negatively skewed for a specific supplier they would exit the market.
  - If one of these 3 elements is positively skewed for a specific supplier, competition would respond and the price would adjust accordingly
- Hypothesis 3 → In the Defense market, which is a monopsony, supply exceeds demand and the price for the goods or services will be below the equilibrium price from Hypothesis 1

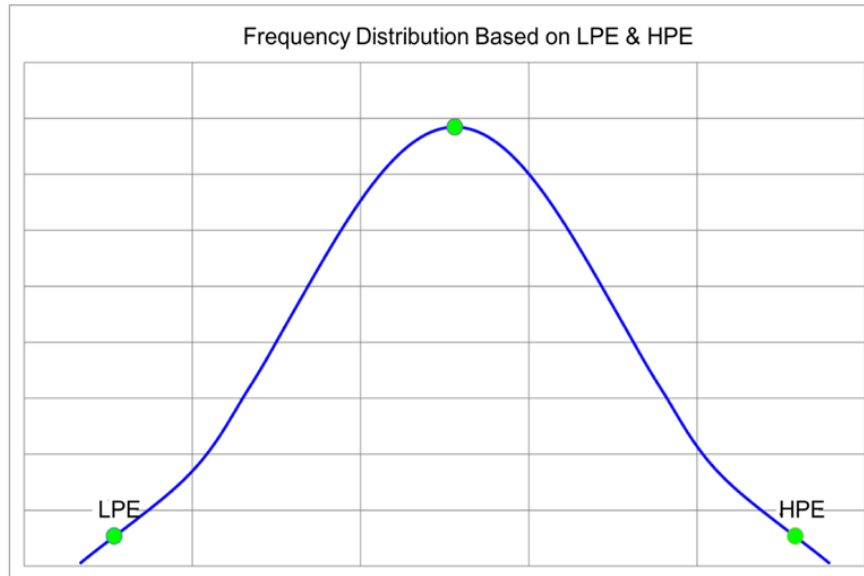
# Approximating the Equilibrium Price



Using Hypotheses 1 and 2 the range of prices can be approximated by developing two extreme estimates for a given statement of work (SOW).

- A low price estimate that will be extremely risky for a contractor to execute. **Low Price Estimate (LPE)**
- A high price estimate that has essentially no risk for a contractor to execute. **High Price Estimate (HPE)**

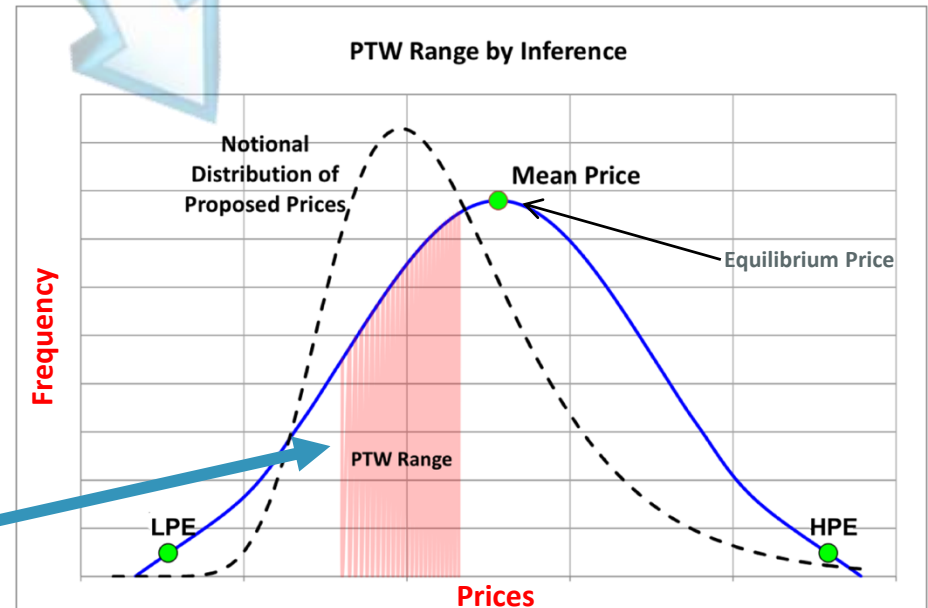
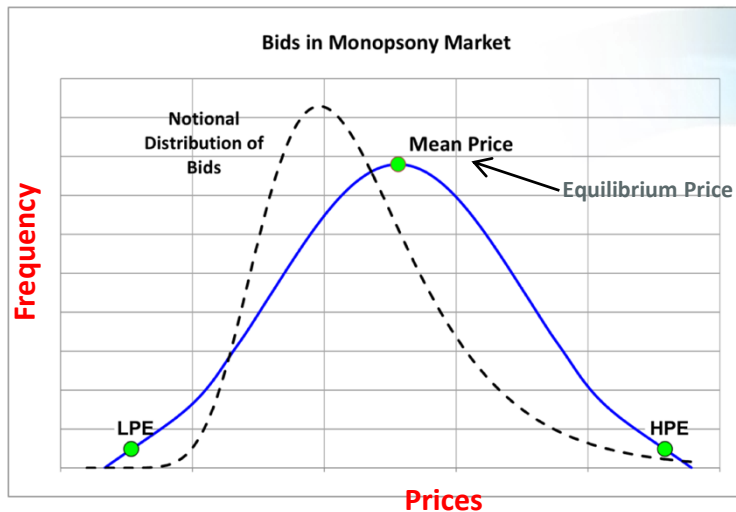
Compute the Mean of LPE and HPE → this represents the equilibrium price in balanced market where the price reflects an optimal balance between costs, risks, and margin.



# Adjusting for the Monopsony Market & Obtaining a PTW Range



Hypotheses 3 the winning price will be below the equilibrium price by bidders altering the balance of cost, risk, and margin to win the contract



Algorithm Based on Historical Winning Bids for like Capability

# Limitations to this Methodology



Access to/ detail of historical information

Confidence in the ability of the staff to create the LPE and HPE estimates

- Experts should have a reasonable understanding of the range of costs
- The PTW range is not static – as more information becomes available the analysis is quick and easy to update – it is fairly dynamic

Range will not predict game changing solutions.

# Does it Work?



Example project is a communications/ electronics retrofit solution for surface ships for the US Navy

Desired vehicle is FFP contract

Evaluation criteria is LPTA (Lowest Price Technically Acceptable).

Effort is for a build-to-print production contract for 89 systems for 3 different ship types.

Expert judgment estimate determined by RFI for the LPE and HPE is:

Ship	LPE (\$M)	HPE (\$M)
Ship Type A	\$7.0	9.5
Ship Type B	\$7.5	\$12.0
Ship Type C	\$2.5	\$5.0

# Does it Work 2



Using proprietary historical information, the following calculations represent a range of LPTA estimates for the Ship Type A work.

	LPTA Range Probabilities	
10%	\$7,330,402	
16%	\$7,373,314	
20%	\$7,396,158	
40%	\$7,484,087	
50%	\$7,521,955	
60%	\$7,559,822	
80%	\$7,647,751	
90%	\$7,713,507	

# Does it Work 3



Same process, but using best value approach,

	Best Value FFP Range Probabilities	
10%	\$7,844,924	
16%	\$7,894,477	
20%	\$7,920,857	
40%	\$8,022,393	
50%	\$8,066,121	
60%	\$8,109,849	
80%	\$8,211,386	
90%	\$8,287,318	

# Does it Work 4

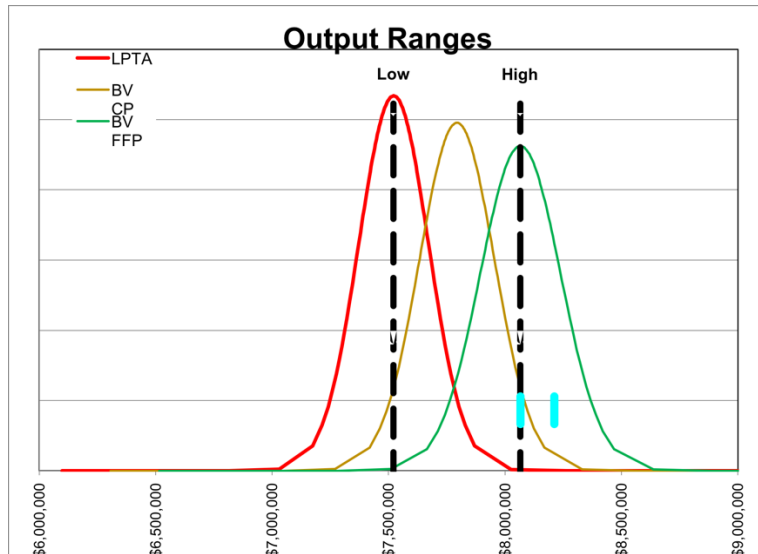


Figure 6. Plotted ranges

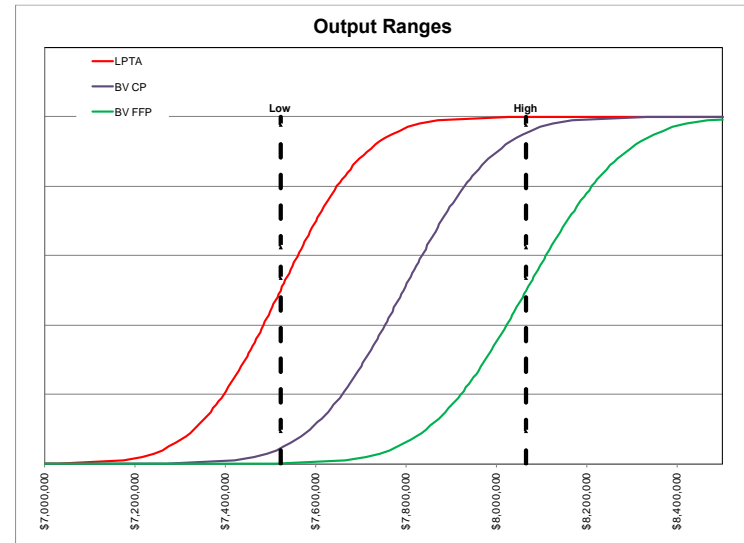


Figure 7. S-Curves for Example

In this example, the 90% probability value was within 2% of the actual winning bid.



# Does it Work 5



Applying the methodology to an example PTW analysis used in marketing literature by a PTW Consulting Company

## Steps

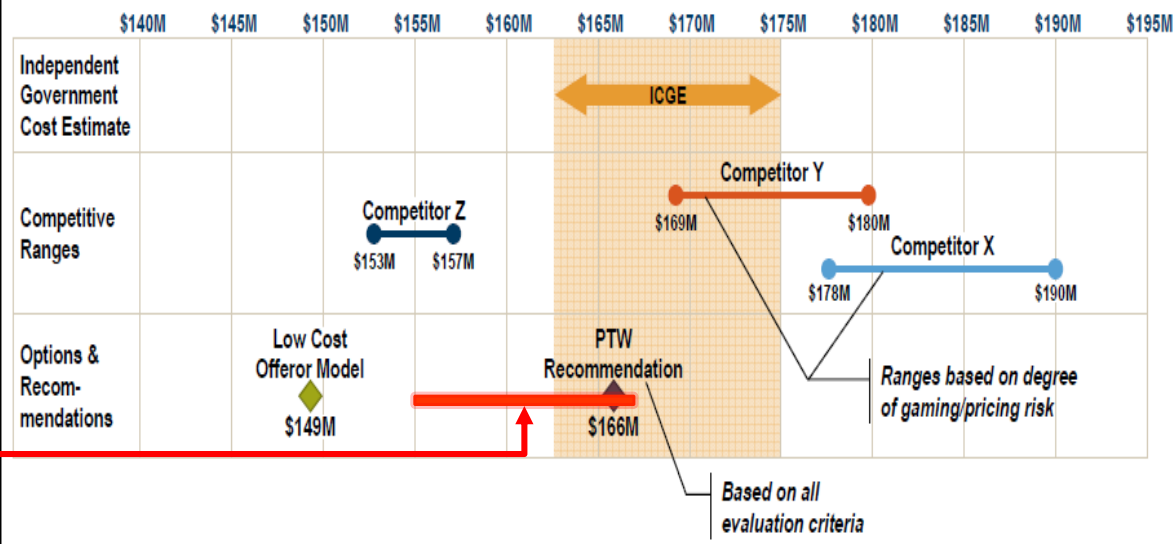
1. LPE is the "Low Cost Offeror Model" of \$149M
2. HPE is "Competitor X" high value of \$190M
3. Mean price is \$169.5M [  $(\$190M + \$149M) / 2$  ]
4. Algorithm Results

- Low end of PTW Range is \$157.3 M
- High end of PTW Range is \$166.4M

Portfolio of pricing related services provide customers with a range of value-added choices to match their needs and timelines

Option	What It Is / Is Not	Value
Comprehensive PTW Analysis	Complete, independent competitive assessment & PTW analysis • Provides the client with a pricing analysis of multiple competitors and a client-specific PTW recommendation in the context of price and non-price evaluation factors relative to the competitive landscape	<i>Defines recommended price-to-win for the opportunity in question</i>

Illustrative PTW Pricing Spectrum



**Winning bids are in the PTW Range**

# Summary



*Can market pricing provide a reasonably accurate cost estimating methodology that is quick and less expensive to execute which provides actionable information to government program managers?*

**We think it can**

**Requires more data, more opportunities**

**Align government insight to like-development projects**

- **Use data from actual procurements, winning bid, contractor history of pricing**

**Can serve as an inexpensive tool for Project/  
Program Office and Cost Estimators/ Engineers**