Defense Acquisition in Transition

6TH ANNUAL ACQUISITION RESEARCH SYMPOSIUM

Performance Incentives and Award Fees: Information and Decision-Making

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Overview

- **Historical background**
- **Classical cost-effectiveness model and extensions**
  - 1960s: Uncertainty at time of Award, but contractor trades cost and performance after cost uncertainty is resolved
    - Policy prescription remains in effect
  - 1970s: Contractor cost uncertainty remains at time of cost-performance trade-offs
    - Optimal cost/risk sharing ratio determined
  - 1980s: Contractor's "effort/cost-reducing actions" unobservable by government
    - Contractor maximizes economic profit
  - 1985: Optimal competitive contract with cost-sharing
  - 1990s: Award Fee proposal
    - Government can observe cost-reduction actions and implicit cost to contractor at completion of milestones or contract
- **Questions addressed**
  - What is optimal incentive contract for each informational and decision-making structure, and what are the government's informational requirements
  - What are new challenges?

Brief Historical Background

- **Wright Brothers Multiple Incentive Contract**
  - Target Price = $25K; Target Speed = 40mph
  - Contract gains/loses $2.5K for every mph over/under target
  - Actual speed = 42 mph; Received reward of $5K
- **1962: *Incentive Contracting Guide***
  - "Perhaps no other DoD procurement policy offers greater potential rewards than the expanded use of performance incentives in development contracts."
- **1968: DoD Program Office for Evaluating and Structuring Multiple Incentive Contracts (POESMIC) Established**
  - Review all multiple incentive contracts with a value over $5M. Evaluated 150 contracts within two and half years
- **1969: DoD/NASA Incentive Contract Guide**
  - Emphasizes communication of government objectives and performance incentives guiding contractor toward these objectives
- **1975 – Present: Academic Contributions**
  - Extensive academic research on effect of asymmetrical information and competition on optimal incentive contracts
- **2005: GAO Report**
  - Criticized excessive Award and Incentive Fees
  - Significant use of SAR Program data

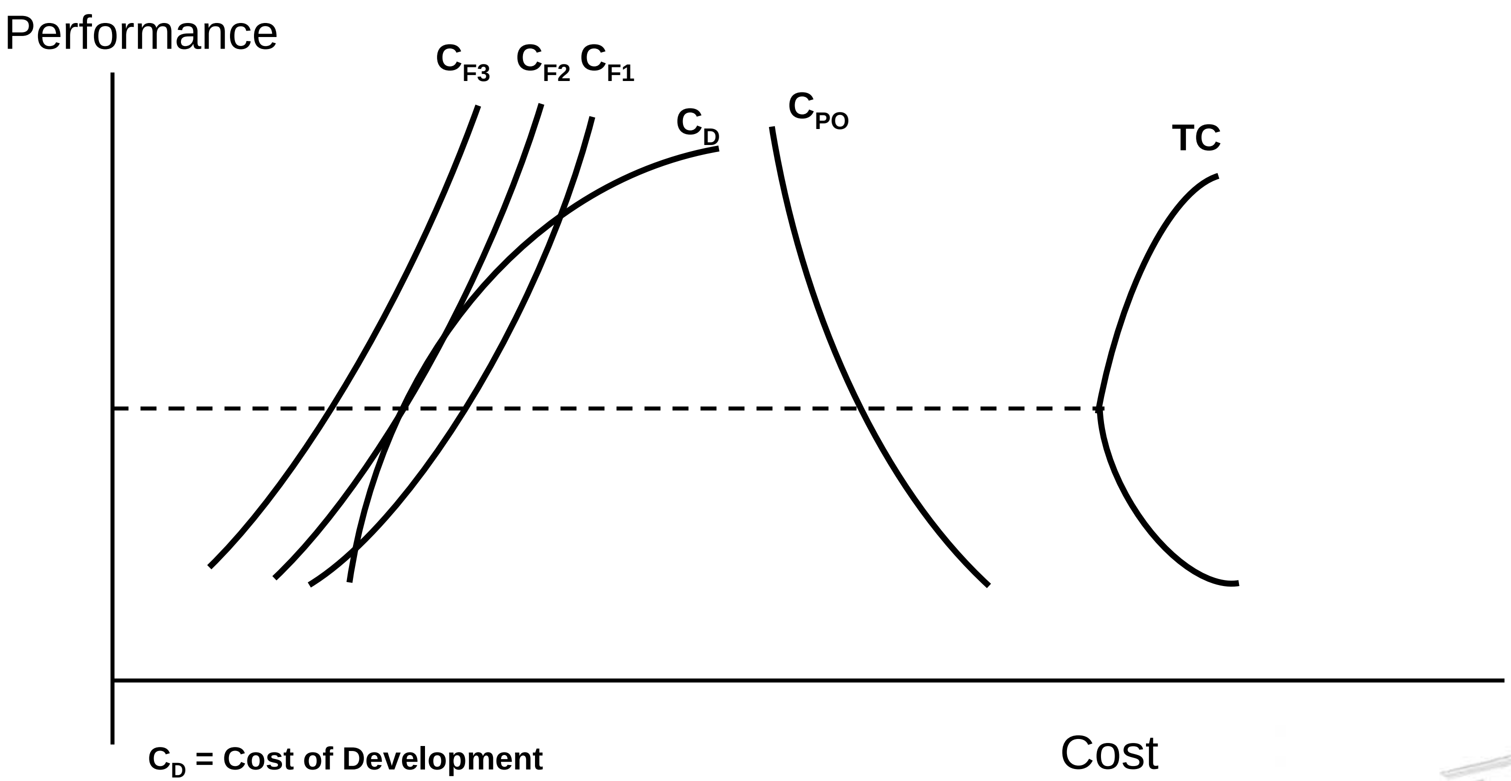
1969: *DoD/NASA Incentive Contracting Guide*

- Performance Incentives achieve two important objectives:

  "first, it communicates, the Government's objectives to the contractor; second, of greater significance, it establishes the contractor's profit in direct relationship to the value of combined performance in all areas"

- Guide implemented Air Force Academy research and material taught in Harbridge House contracting courses in mid-1960s
  - Methodology independently developed
- Policy still in effect today, but under review

Model 1: DoD Cost-Effectiveness Model 1960s



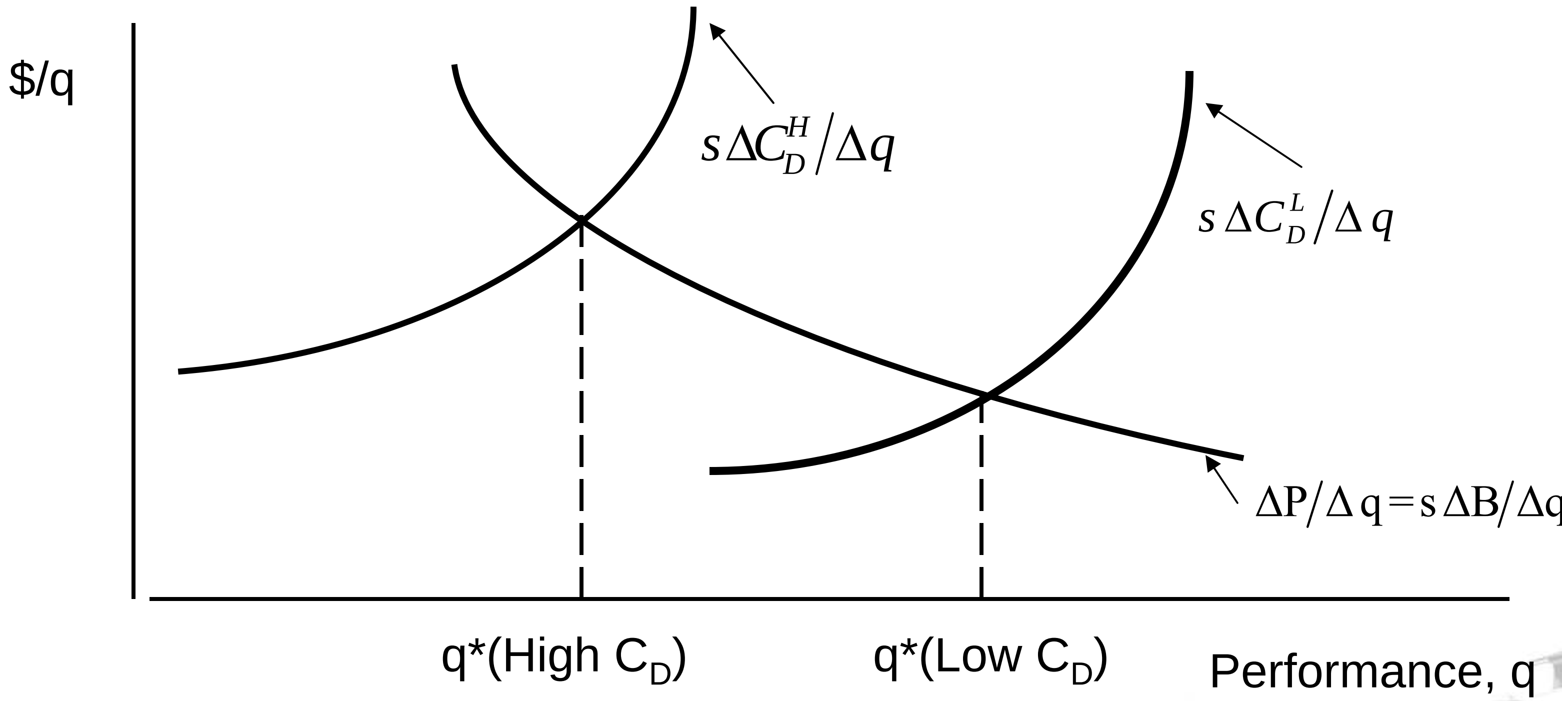
C_D = Cost of Development

C_{PO}= Cost of Procurement and Operations

TC = Total Cost

C_F = Constant Fee (C_{F1} > C_{F2} > C_{F3}; Mirror Image of C_{PO})

Model 1 (cont.) Structuring Performance Incentive Function, P(q) Using Marginal Willingness to Pay, $\Delta B/\Delta q$



In 1970s, it was shown that contractor's share of costs, s, the risk sharing parameter, is constant if certain utility functions apply to both the government and contractor. The cost-sharing ratio does not depend on the degree of cost uncertainty at time of contract award.

Aspects of Cost-Effective Model with Contractor Facing Known Trade-offs

- Assumes contractor maximizes accounting profit
- At time of contract award, t_1, (accounting) cost function facing government and contractor is uncertain.
- Resolution of uncertainty applies to contractor, but not to government, at t_2, time of cost versus trade-off decision-making
- Changes in contractor's cost share, s, target profit, π_T, or target Cost, C_T, do not affect the performance level selected or the final cost outcome
- Cost overruns may be in the interests of government

Model 2: Cost Uncertainty at t_2, Time of Contractor's Trade-off Decisions

- Both government and contractor must know utility functions at t_1
- If government and contractor utility functions support an optimal constant cost-sharing ratio (exponential, quadratic, logarithmic)
  - Sharing ratio achieves optimal expected risk sharing from vantage point of t_2
  - Contractor selects the performance level that government would select at t_2, if government were to have same knowledge of expected trade-offs

Model 3: Contractor Maximizes Economic Profit by Accounting for Implicit Cost of Effort

- Economic Profit, π, equals Accounting Profit, π_A, less implicit cost of “effort,” h(e)
  - $\pi = \pi_A - h(e)$
  - Government cannot observe e
- With discrete outcomes, and all around diminishing returns, one obtains the following first order condition with respect to π_A :

$$U^{G'}\left(B(q_i)-C_i-\pi_{i_i}^{A}\right)=U^{C'}\left(\pi_{i_i}^{A}(C_i,q_i)\right)\left(\lambda+\mu\left(\left(\Delta P_i(e)/\Delta e\right)/P_i(e)\right)\right)$$

where i = ith$_{th}$ outcome, C_i, q_i, i = 1,...,n

P_i = probability ith outcome is achieved with effort level, e

λ= shadow price of constractor's reservation utility

- μ=shadow price of contractor's incentive compatibility constraint

Model 4: Government Can Observe Contractor's "Effort" and Implicit Costs

- Build on Model 1, in which contractor trade-off decisions are made at t_2 under conditions of certainty
- Government Program Office and DCMA has substantial information about contractor's effort at both milestones and completion of contract, and can infer implicit cost function, h
- Applicable to CPAF/IF contract with performance incentives

Incentive Structure for Model 4 When Target Performance is q_T

- Assume linear sharing is optimal
  - Both government and contract have exponential, quadratic, or logarithmic utility function
- For ease in displaying solution, assume that cost-reducing increases in "effort" do not affect relationship between performance and cost
- Then, when P, B, and A represent, respectively the Performance Incentive Function, Benefits to Government and Award Fee, the following CPAF/IF multiple incentive contract structure applies:

$$P(q-q_T) = sB(q-q_T)$$

$$A = (1-s)h$$

Information Requirements of Alternative Incentive Contracts

Information Required	Model 1 (1960s) Relative Govt. Benefits	Model 2 (1970s) Cost-Uncertainty at t_2	Model 3 (1980s) Unobservable Effort	Model 4 (1990s) Observable Effort
Govt. Benefit Function	X	X	X	X
Utility Functions of Govt. and Cont.		X	X	
Cost Function and Uncertainty at t_2		X		
Probabilityof Ci and qi Outcome wrt Effort			X	
Ex Post Accounting Cost, C_A; and q	X	X	X	X
Linear Sharing, Cont. Share of Costs = s	*	Exponential, Quadratic Logarithmic Utility		*
Disutility of Effort Function, h(e)				X (at Milestones)

* Optimal sharing ratio can be obtained using utility functions for government and contractor, thereby, achieving optimal risk sharing. However, this is not required to achieve optimal performance or contract cost

William Rogerson on Information Requirements of Complex Incentive Contracts (e.g., Unobservable Effort)

The nature of the optimal contract varies tremendously depending on the precise functional forms of the utility functions and the distribution function …[summarizing the asymmetric cost uncertainty]. For normative purposes the problem this creates is that the precise nature of the optimal contract is highly dependent on features of the contracting environment that government may be unsure about. For positive purposes, the problem is that the theory does not generate testable predictions …. [T]he major value …has been to help clarify the underlying incentive issues rather than to explain specific contracting phenomenon.

Implications of Analysis

- Models 1 and 4 require substantially less information
  - Model 1
    - Requires knowing only relative dollar value of government benefits from additional performance and final contract accounting cost
  - Model 4
    - Also requires plausible assumption that government can observe effort and its disutility at completion of contract, or at relevant milestones
    - Can reduce distortions resulting from objective performance measures failing to fully reflect government's valuation of contract "performance"

F/A-18E/F CPAF/IF Multiple Incentive Contract During Engineering Development

- Includes cost and performance incentives and award fee provision
  - Contractor shares a portion of development cost
  - Fee based on both objectively and subjectively determined performance
    - Fifty percent based on technical performance, of which 70 percent based on measurable performance and 30 percent based on subjective government assessment of technical performance
    - Remaining 50 percent based on subjective government assessment of contractor management and logistics
    - Schedule incentive in which certain funds are withheld until first flight is achieved included

Defense Procurement and Acquisition Policy Memo, 24 April 2007

The following shall apply to all award fee provisions:

Award fee may be earned in accordance with the following:

Rating	Award Fee Pool Earned
Unsatisfactory	0%
Satisfactory	No Greater Than 50%
Good	50%-75%
Excellent	75%-90%
Outstanding	90%-100%

Definitions of Ratings

Unsatisfactory	Contractor has failed to meet the basic (minimum essential) requirements of the contract.
Satisfactory	Contractor has met the basic (minimum essential) requirements of the contract.
Good	Contractor has met the basic (minimum essential) requirements of the contract, and has met at least 50% of the award fee criteria established in the award fee plan.
Excellent	Contractor has met the basic (minimum essential) requirements of the contract, and has met at least 75% of the award fee criteria established in the award fee plan.

New and Continuing Challenges

- Dealing with contract changes remains a challenge
- Specification Policy and Performance Incentives
  - Detail design specifications
    - Limited room for trading-off cost for performance
  - Performance specifications
    - Specification of Threshold and Objective Performance enhances trade-off possibilities
  - Navy's recently implemented System Design Specifications
    - Specifications lie between Detail Design and Performance
    - Hierarchical structure with uncertain role of Threshold and Objective Performance at top of hierarchy
    - Lower-level supporting specifications may be amenable to Award Fees
- Recent Pentagon memoranda indicate policy swing from subjective to objective performance incentives
  - Research required to understand relationship between use of performance incentives and new System Design Specification policy during engineering development