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A Reduced Form Model of Cost Growth of Major Defense Acquisition Programs

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Research Question

- This paper provides a better answer than I gave at the time to a question I was asked after a presentation to last year's NPS Acquisition Research Symposium.*
- My presentation concerned a model that related cost growth on Major Defense Acquisition Programs (MDAPs) to a proxy for the intensity of competition for funding at Milestone (MS) B, changes in acquisition policy, and measures of program duration.
- The question asked was: Why had I not included as explanatory variables any program characteristics—for example, the degree of concurrency between Engineering and Manufacturing Development (EMD) and procurement?
- On reflection, I decided I had not thought through the issue completely. This paper presents my efforts to do so.

* David L. McNicol, "Further Evidence on Program Duration and Unit Cost Growth," in Vol. I of *Proceedings of the Fifteenth Annual Acquisition Research Symposium* (Monterey, CA: Naval Postgraduate School, April 30, 2018), 89–105.

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Overview of the Paper

There are five parts to the paper's argument:

1. The Program Characteristics Model (PCM)
2. The Funding Climate-Acquisition Policy Model (FC-APM)
3. Specification of an expanded model of cost growth
4. Demonstration that with the context of the more complete model, the FC-APM is, in a sense, the same PCM
5. Conclusions

The emphasis in the brief is placed on features of the acquisition process and decisions that get made, not the formalisms introduced.

1. The Program Characteristics Model

- The label “Program Characteristics Model” is just a handy name for a widely accepted presumption: that a major cause of cost growth in MDAPs is unrealistic elements in the MS B baseline; e.g., an unrealistic EMD schedule, immature critical technologies, etc.
- The application of this idea has mainly come in case studies.

$$Ch_{PAUC} = \frac{h(x_1, \ldots, x_n)}{C_{MSB}}$$

Ch_{PAUC} : Change in Program Acquisition Unit Cost (PAUC)
C_{MSB} : MS B baseline value of PAUC
$X_1, \ldots, X_n$: Deviations of program characteristics from realistic or nominal values
$h(\bullet)$: Function that relates deviations of program characteristics from realistic or nominal values to unit cost growth

IDA 2. The Funding Climate-Acquisition Policy Model

- The FC-APM was developed in a series of papers published over 2014–2018. Where the PCM is about proximate causes of cost growth, the FC-APM is situated upstream—it is closer to an analysis of root causes.
- The FC-APM starts with this question: Are there circumstances in which DoD is more likely to accept at MS B programs with significant unrealistic characteristics?
- The answer is: "Yes"—during bust budget climates; that is, during periods when the competition for funding for MDAPs is particularly intense. The "proof" of this conclusion is statistical.

$$\mathrm{Ch}_{\mathrm{PAUC}} = \frac{\mathrm{H}(\mathrm{W}, \mathrm{R})}{\mathrm{C}_{\mathrm{MSB}}}$$

W: Measure of the intensity of competition for acquisition funds
R: Vector of restrictions (that is, acquisition policies) that the PM believes must be observed

3. A More Comprehensive Model of Cost Growth

- The more comprehensive model adds to the PCM representations of two decisions. Both are made by the Program Manager (PM) or, more realistically, by the PM and his seniors.
- The context of the model is decisions made at the Service level during the year leading up to MS B.
- First, the PM must decide how low the cost of the program must be to gain funding in the prevailing funding climate. The cost that the PM decides is needed is denoted by C^*.

$$C^* = f(W, R)$$

- Second, the PM must decide what elements of the program to alter to get the cost down to the required level.

$$x_i^* = g_i(C^*, R),\ i = 1, \ldots, n\ .$$

4. Derivation of the Reduced Form Model

- A reduced form of a system of equations is the solution giving each of the endogenous variables in terms of the exogenous variables.
- The endogenous variables of the model are C*, the x_i^* , and Ch_{PAUC}.

1. $C^* = f(W, R)$
2. $x_i^* = g_i(C^*, R),\ i = 1, \ldots, n$
3. $Ch_{PAUC} = \dfrac{h(x*_1, \ldots, x*_n)}{C_{MSB}}$

- The reduced forms are found by substituting from top to bottom. The reduced form for Ch_{PAUC} is:

$$Ch_{PAUC} = \frac{h(x*_1, \ldots, x*_n)}{C_{MSB}} = \frac{H(W,R)}{C_{MSB}}$$

- The PCM and the FC-APM do not embody different theories of cost growth; the FC-APM is the reduced form of the PCM (given the model specified.)

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5. Conclusions

- The question that motivated this paper was: Why not include program characteristics as variables in the FC-APM?
- A technical answer is that doing so contradicts the specification of the comprehensive model behind the FC-APM.
- A better answer is that including program characteristics in an FC-APM would answer no question.
  - Studies that employ the PCM of cost growth are intended to provide good housekeeping guidance on how to structure MDAPs.
  - FC-APM is concerned with explaining why DoD does not always follow the dictates of policy and prudence in laying out major acquisition programs.
  - Including program characteristics in an FC-APM model would produce results that, regardless of the estimated test statistics, cannot be interpreted in terms of the questions either the PCM or the FC-APM is intended to address.

Backup

Estimated Coefficients for a Model that Includes the Boom Effect and Program Duration

$$PAUC_i = a_0 + a_1 Climate_i + a_2 DSARC_i + a_3 PCDSARC_i + a_4 DAB_i + + a_5 AR_i + a_6 T_{boom,i} + a_7 T_{bust,i} + e_i$$

	Coefficients	p-value
Intercept	73.1%***	< 0.001
Errors of Inception—Intensity of Competition for Funds		
Funding Climate	-28.7%***	0.009
Errors of Inception—Acquisition Policy		
DSARC	-56.7%***	< 0.001
PC DSARC	-50.3%***	0.001
DAB	-59.5%***	< 0.001
AR	-80.2%***	< 0.001
Errors of Execution and Program Changes		
T_{boom}	3.8%/yr**	0.021
T_{bust}	0.59%/yr	0.515

*** Statistically significant at less than the 1 percent level.

** Statistically significant at less than the 5 percent level.

R-Squared = 0.26, F = 7.02 (P < 0.001), N= 149. Estimated using OLS. Four programs that passed through two boom periods and the three mid-1980s MDAPs acquired using TPP-like contracts were omitted. Wald's test for the equality of the estimated coefficients of the categorical variables for acquisition policy periods with the Bonferroni correction yields F= 1.43, p = 0.0.946.