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

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Abstract

This paper considers a problem posed implicitly by comparing a basic assumption typically used in quantitative analyses of cost growth of major defense acquisition programs (MDAPs) with that used in David L. McNicol, *Acquisition Policy, Cost Growth, and Cancellations of Major Defense Acquisition Programs*, IDA Report R-8396, September 2018 (hereafter *Acquisition Policy*). An analysis in the traditional mold mainly uses program characteristics (such as the maturity of key technologies) to explain cost growth. *Acquisition Policy* instead uses a categorical variable for funding climate, categorical variables marking major changes in acquisition policy, and measures of program duration. At first glance, these two approaches seem to adopt radically different theories of the causes of cost growth in MDAPs. In fact, they do not. The paper demonstrates this by deriving the model of *Acquisition Policy* from a more complete model in which the traditional model is a structural equation. In terms of the more complete model, that of *Acquisition Policy* is the reduced form representation of the traditional model.

Introduction

I wrote this paper to answer a question I was asked after a presentation I made to the 15th Annual Naval Postgraduate School (NPS) Acquisition Research Symposium (McNicol, 2018b). My presentation concerned a model that related cost growth on major defense acquisition programs (MDAPs) to changes in acquisition policy, funding climate (which is a proxy for the intensity of competition among MDAPs for funding at Milestone [MS] B), and measures of program duration. The question asked was: Why did you not include as explanatory variables any program characteristics—for example, the degree of concurrency between Engineering and Manufacturing Development (EMD) and procurement? I had anticipated this question and had an answer, but it was clear to me as I gave it that my answer was inadequate. On reflection, I concluded that I had not fully thought through the issue. This paper is the remedy offered.

The following section identifies relevant previous studies, and states in a general form a model in which program characteristics are used to explain cost growth. The Funding Climate-Policy Model section briefly sketches the model of McNicol (2018b). The next section, A More Complete Model and the Reduced Form Relationship, uses a more complete high-level model of cost growth on MDAPs to show that the Program Funding Climate-Policy Model is drawn from an underlying theory consistent with analyses that employ program characteristics to explain cost growth. The final section states my revised and, I hope much improved, answer to the question that led to this paper.

The Program Characteristics Model of Cost Growth

During the 1960s and 1970s, several papers produced by the RAND Corporation considered whether the changes in acquisition policy and process made by Robert McNamara in the early 1960s, and further changes introduced by David Packard in July 1969, had improved MDAP outcomes, particularly with regard to cost growth (Dews et al., 1979; Perry, 1975; Perry et al., 1971; Perry et al., 1969). Perry et al. (1971) contained a section on the causes of cost growth; it attributed cost growth to three factors—technical uncertainty, scope change, and cost estimating error (see also Srull, 1998, Chapter 1).[1] These papers did not suggest that program characteristics were causes of cost growth.

It is unclear when or why thinking shifted, but the idea that cost growth of MDAPs can to a large extent be explained by program characteristics seems to have entered the literature through two studies that appeared in the early 1990s—Tyson et al. (1992) and Drezner et al. (1993). Tyson et al. (1992) is cast as an evaluation of the effects on cost growth and schedule slips of six policy changes, each of which is embodied in a program characteristic. Drezner et al. (1993) states that they are using program characteristics (and also changes in DoD-level funding) to explain cost growth. Each of these studies took the program characteristics they considered as a given. In contrast, Tyson, Harmon, and Utech (1994) attempted to derive from the analysis the set of characteristics that are most important for cost growth. Lorell, Payne, and Mehta (2017) provided a clear and compelling study with a broadly similar intent.

The following are representative examples of the program characteristics linked to cost growth by studies that have appeared since the mid-1990s:

- Realism of the MS B EMD schedule
- The maturity of the technologies employed
- Whether the program involved a full-scale prototype prior to MS B
- The degree of concurrency between development and production
- The appropriateness of the contract type used
- Whether program requirements are technically feasible and remain stable
- Funding stability
- Whether the MS B cost estimate is realistic
- Test assets in the program
- The amount of computer code that will be reused (i.e., taken from a legacy system)
- The overhead rate

Until fairly recently, no two studies adopted (or derived) the same set of program characteristics as the main causes of cost growth. Since 2010, however, root cause analyses sponsored by the Office of Program Assessment and Root Cause Analyses

[1] Perry and his colleagues thought that cost estimating errors were by a considerable margin the least important of the three sources of cost growth they identified. In 1970, David Packard, then Deputy Secretary of Defense, identified unrealistically optimistic MS B cost estimates as the main source of cost growth.

(PARCA) have gone a considerable distance towards establishing a taxonomy of the proximate causes of cost growth. Examples of root cause analyses sponsored by PARCA are Blickstein et al. (2011), Blickstein et al. (2012), and Diehl, Gould, and Lo (2012).

Generally accepted conclusions have been reached on only a few topics. For example, there is a consensus that Total Package Procurement (TPP) and Fixed Price Development contracts are associated with high cost growth. There also seems to be a consensus that average cost growth of MDAPs has not increased or decreased across the past half century. More generally, there is widespread, although not unanimous, agreement that unrealistic assumptions embedded in MS B baselines are the largest source of cost growth. On many topics, however, the cost growth literature leaves considerable room for debate.

The term *Program Characteristics Model* is used here as a label for the idea that program characteristics are a major source of cost growth.[2] A general representation of this idea is the following:

$$\mathrm{Ch}_{\mathrm{PAUC}} = \frac{\mathrm{h}(\mathrm{x}_1, \ldots, \mathrm{x}_\mathrm{n})}{\mathrm{C}_{\mathrm{MSB}}}.$$

The dependent variable ($\mathrm{Ch}_{\mathrm{PAUC}}$) is the percentage change in Program Acquisition Unit Cost (PAUC), which is defined in the following section. $\mathrm{C}_{\mathrm{MSB}}$ is the MS B estimate of acquisition cost. The numerator [$\mathrm{h}(\mathrm{x}_1,\ldots,\mathrm{x}_\mathrm{n})$] is the actual cost the model projects based on program characteristics $X = (x_1,\ldots,x_n)$.

In practice, studies of the extent to which program characteristics influenced cost growth require large amounts of often difficult to acquire data. They inevitably are imperfect because of gaps in the data and analytical issues. These problems are not important in the context of this paper, however.[3] What we need is simply the representation of the idea that program characteristics drive a significant part of cost growth.

The Funding Climate-Policy Model

The model adopted by McNicol (2018b) is drawn from McNicol (2018a) (hereafter referred to as *Acquisition Policy*), which accepts the premise of the Program Characteristics Model: the proximate causes of a large portion of cost in MDAPs lie in unrealistic assumptions embedded in the MS B baseline. Viewed from this standpoint, the model in *Acquisition Policy* is placed one step upstream from previous cost growth studies. It

[2] Not all studies that fall under the heading "cost growth" were concerned with the links between program characteristics and cost growth. Some were concerned with the more modest problem of describing the main features of cost growth. Is cost growth markedly higher in one of the Services? Has cost growth increased over time? Others examined whether changes in acquisition policy and process led to improvements in MDAP outcomes over time, e.g., lower cost growth.
[3] It is worth noting that estimating a Program Characteristics Model statistically is effectively impossible because of the huge data requirements. Drezner et al. (1993) seems to be the only example of an attempt to do so. That study, however, used only six program characteristics and a measure of budget growth, and did not report the estimated equation. McNicol (2004) might be regarded as another example; however, it uses a hybrid of the Program Characteristics Model and what the study calls the Speeding Model of cost growth, plus several other variables inspired by cost analysis considerations.

examines root cause (i.e., causes of causes), where the Program Characteristics Model is concerned with the proximate causes of cost growth.

For convenience, I will refer to the model developed in *Acquisition Policy* as the Funding Climate-Policy Model. This model is a version of the Speeding Model of cost growth introduced in McNicol (2004). The Speeding Model posits that all "drivers"—program managers (PMs) and the components who "own" the MDAPs—have some propensity to speed, that is, to adopt unrealistic assumptions about the performance of the system or unrealistic assumptions that reduce its apparent cost and/or EMD schedule. The other side of the Speeding Model is external constraints on speeding—speed limits backed up by the police, fines, and the courts. In the context of major system acquisition, that primarily means acquisition policy and Office of the Secretary of Defense (OSD)–level oversight.

From this line of thought, the Funding Climate-Policy Model distills two sets of variables to characterize cost growth due to Errors of Inception: funding climate (the surrogate for the intensity of competition for acquisition funds at MS B), and changes in acquisition policy. The model takes an ad hoc approach to the other two main sources of cost growth—Errors of Execution and Program Changes.

The equation estimated is

$$Ch_{PAUCi} = a_0 + a_1Climate_i + a_2DSARC_i + a_3PCDSARC_i + a_4DAB_i + a_5AR_i + a_6T_{boomi} + a_7T_{busti} + e_i.$$

PAUC is acquisition cost (the sum of EMD and procurement cost) divided by the number of fully configured units acquired. PAUC growth is computed by comparing the MS B baseline value of PAUC—which can be thought of as a goal or a prediction—to the actual PAUC reported in the final Selected Acquisition Report (SAR) for the program. Both the MS B baseline and the final value[4] of PAUC are stated in program base year dollars. The actual value is restated on the basis of the MS B baseline quantity by moving up or down the cost progress curve as appropriate. The ratio of the MS B baseline value of PAUC to the quantity-adjusted actual value is an estimate of what PAUC growth would have been had the MS B baseline quantity been acquired.

Table 4 defines the categorical variables used in the study. The first of the acquisition policy bins (McNamara-Clifford) does not appear explicitly in the model because it is used as the reference category. *Acquisition Policy* identifies the factors used to establish the break points between bust and boom climates and the acquisition policy bins.

[4] For a program that is still underway, the most recent estimate (as reported in the SAR) of the final value was used.

Table 4. Categorical Variables of the Funding Climate-Policy Model

Variable	Short Name	Period (Fiscal Years)
Climate	bust climates	1965–1982, 1987–2002
	boom climates	1983–1987, 2003–2008
McNamara-Clifford	McNamara-Clifford	1965–1969
Defense System Acquisition Review Council	DSARC	1970–1982
Post-Carlucci DSARC	PC DSARC	1983–1989
Defense Acquisition Board	DAB	1990–1993, 2001–2009
Acquisition Reform	AR	1994–2000

Finally, T_{boomi} and T_{busti} are the numbers of years the i^{th} program spent in boom and bust years, respectively. These provide a rough and ready way to capture PAUC growth due to Errors of Execution and Program Changes, which the model cannot distinguish. The term e_i is a random variable that is assumed to have a constant mean and variance.

Table presents the estimated parameter values and their associated p-values.[5] It is difficult to find anything to complain about in these results. Each of the estimated coefficients has the expected sign, and the estimated magnitudes are reasonable. All the coefficients from the Speeding Model are statistically significant at the 1% level or less, which is the most striking feature of the results. The estimated coefficient of T_{boom} is significant at about the 2% level. The estimated coefficient for T_{bust} is insignificant, which is consistent with prior expectations. About 26% of the variation in PAUC growth over the sample is accounted for by the model, which, for panel data without any lagged variables, is remarkably high. Of course, results like this never "prove" a model to be valid but, as in this case, they may fail to reject it.

[5] The p-value in this instance provides a test of the statistical significance of the estimated coefficients of the regression equation. The null hypothesis is that the true value of the coefficient is zero. The p-value then is the probability of obtaining the estimate from a sample if its true value is zero. For example, the estimated coefficient of T_{boom} is 3.8%/yr. and the associate p-value is 0.021. This means that the odds of observing a coefficient for T_{boom} as large as 3.8%/yr. are about 2 in 100. Consequently, we reject the null hypothesis that the true value of the coefficient is zero. The border for statistical significance is generally set at 5% or sometimes 10%. Thus, an estimate coefficient with a p-value of 0.05 or less would be said to be "statistically significantly different from zero at the 5% level."

Table 5. Estimated Coefficients and p-Values for a Model That Includes the Effects of Post-MS B Funding Climate and Duration †

	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% level

** Statistically significant at less than the 5% 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.

† Adapted from Table 16, page 38, of *Acquisition Policy*

A More Complete Model and the Reduced Form Relationship

The Program Characteristics Model and the Funding Climate-Policy Model were developed to answer different questions, so their differences may be tolerable. Still, it is awkward to have two models that address related questions, have the same dependent variable (cost growth of MDAPs), and different explanatory variables, a situation that cries out for an explanation. This section extracts one from a more complete high-level model of cost growth on MDAPs. A couple of pages are required to sketch the model. After that is done, the argument can be completed very quickly.

The first relationship in the model describes the results of the PM's judgment of what the cost for the program must be for it to be funded. (The PM's superiors may be involved, but that fact is not important for the purposes of this exercise.) Note that the context is a specific program coming up for MS B review in a particular Program Objective Memorandum (POM) cycle. No assumption about how the PM makes their judgment is required, but it is worth noting that the problem is intrinsically one of constrained optimization. The PM wants the highest cost that will provide a solid chance that the program will be funded. The cost that the PM decides is needed is denoted by C^*. The variable marking the intensity of competition is denoted by W, and the restrictions (that is, acquisition policies) that the PM believes must be observed are denoted by R. We assume that

$$C^* = f(W, R)\ , \qquad (1)$$

and assume further that C* decreases as competition for funds (W) becomes more intense. The question of how to measure W is set aside here.

The next part of the model represents the choice of program characteristics to be changed as necessary to get apparent cost down to C*. Recall that the relevant program characteristics are denoted by X = (x_1,…,x_n). By departing from realistic values for any of the program characteristics, the PM creates some risk for the program. The problem is to select values for the program characteristics that reduce cost to C* at minimum risk, but this may not be a hard problem. Suppose that the PM, with the assistance of the program office staff, can assign the x_is to risk bands—say low, medium, and high. The assignments would be made in terms of the perceived risks to the program of departing from the realistic or best practice value of the characteristic. The reduction in the apparent cost of the program also is associated with each of the x_is. The least risk solution is then found by reading down the list until the cost estimate for the program cost reaches C*.

This approach assumes that the risk of setting one program feature at an unrealistic level is not affected by the choices made for other program features. For example, the assumption would be that the risk entailed by procuring an unrealistically small quantity of initial spares is not affected by assuming an unrealistically early start for operational testing. In fact, these two elements of risk are intertwined.[6] Consequently, most would model this decision as a problem of picking the values of program characteristics X to minimize some measure of program risk M given C, and subject to the interactions of program risks and restriction R imposed on the program office. The solution to this problem is a relationship (known as an “efficient frontier”) between the risk measure M and the cost achieved, C. Each point on the curve of this relationship is associated with a particular set of program characteristics that achieves the cost C at minimum risk, given R and the interdependencies of program risks. In this simple model,[7] the bundle of program characteristics accepted is that which gives C*. This solution can be written:

$$x_i^* = g_i(C^*, R),\ i = 1,\dots, n\ , \qquad (2)$$

where x_i^* is the value of the ith program characteristic given by the solution to the optimization problem.

Many will balk at the apparent implication that PMs and their staffs literally solve the optimization problem sketched above. Especially during the early years of a program, the volume of work that a program office must do and the rapid pace of events are such that spending the time required to optimize any one decision probably would be, well, not optimal for a program office. Consequently, on many decisions that must be made, PMs and program offices live in the land of “good enough.” Of course, PMs and program office staffs are professional and knowledgeable and work at solving problems, so the solutions they develop generally are sound. The essential assumption, however, is not that the decisions made are near-optimal. Rather, in the context of the model, the essential assumption is that the PM’s decisions on program characteristics respond to changes in external events—

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[6] The simple approach may still be viable if the interdependencies are few enough and simple enough.
[7] The first of many refinements of the model would replace Equation (1) with a relationship that characterizes the PM’s willingness to trade off two categories of risks: (a) risk that the program will not be funded because it is perceived as being unaffordable; and (b) latent risks to the program created by adoption of unrealistic values for some program characteristics.

especially the intensity of competition for funds and restrictions that they must observe—in the same way as the optimal solution. The statistical analysis does not "see" departures from optimality. What it sees are the responses to changes in relevant external conditions—funding climate and acquisition policies—and the model is rejected if these responses depart significantly from what it predicts.

The final relationship in the model is just the Program Characteristics Model of cost growth:

$$C_f - C_{MSB} = h(x_1,\ldots,x_n)\ . \tag{3}$$

C_f is what the acquisition cost of the program finally turned out to be (adjusted to the MS B quantity and stated in program base-year dollars), excluding cost growth due to Errors of Execution and Program Changes. C_{MSB} is the acquisition cost projected at MS B (which always tacitly assumes no Errors of Execution or Program Changes). Note also that the x_is are consistent with the MS B baseline and the CARD (which ideally are consistent with one another).

The remainder of the argument is just a matter of substituting Equation (1) into Equation (2) and the result into Equation (3). The first of these steps yields:

$$x_i^* = g_i(f(W,R), R) \equiv G_i(W,R), \quad i = 1,\ldots, n\ . \tag{4}$$

Note that $G_i(W,R)$ is simply a renaming adopted to cut down on notational clutter. Substitution of Equation (4) into the Program Characteristics Model, Equation (3), gives:

$$C_f - C_{MSB} = h(G_1(W,R), \ldots , G_n(W, R)) \equiv H(W,R)\ . \tag{5a}$$

Now divide by the MS B PAUC and use the original form of the Program Characteristics Model (Equation (3)):

$$\frac{C_f - C_{MSB}}{C_{MSB}} = Ch_{PAUC} = \frac{h(x_1,\ldots,x_n)}{C_{MSB}} = \frac{H(W,R)}{C_{MSB}}\ . \tag{5b}$$

It is obvious in Equation (5b) that the Funding Climate-Policy Model is simply the reduced form of the Program Characteristics Model.

An elaboration of the model sketched here—for example, incorporation of uncertainty—is unlikely to change the result just stated. What could change it is incorporation into the model of an additional feature of the acquisition process. Thinking along these lines, the first place to look would be the OSD-level acquisition review process. The policy variable R was defined as the set of acquisition policies that the PM believes must be observed. That is, the model tacitly assumes that the PM knows with certainty which policy restrictions require compliance. A PM, of course, never knows for sure how rigorously the applicable policies will be enforced.

A surface read of this observation is that it points to an elaboration of the model. The real point, however, is that the Funding Climate-Policy Model largely is irrelevant unless there is significant porosity in the OSD-level oversight process. Within the logic of the model, more intense competition for funds is an incentive for PMs to propose programs that have unrealistically optimistic and unreasonably risky characteristics. But to the extent that OSD-level reviews lead to the rejection of unrealistic elements in proposed programs, the programs that emerge from the review are realistic and are risky only within the bounds of existing policy. All of the x_i^* of Equation (4) are then determined by policy restrictions (R), and funding climate has no effect. For funding climate to have an effect, it must be that a PM can, at some risk, violate some of the rules some of the time or that there are major gaps in the rules.

Conclusion

To repeat, the question that motivated this paper was: Why did I not include program characteristics as variables in the Funding Climate-Policy Model? One answer is that doing so would contradict the specifications of both models. A better answer is that including program characteristics in a Funding Climate-Policy model would answer no question. The studies that employ the Program Characteristics Model of cost growth are intended to provide good housekeeping guidance on how to structure MDAPs. The Funding Climate-Policy Model is concerned with explaining why the DoD does not always follow the dictates of policy and prudence in laying out major acquisition programs. Including program characteristics in a Funding Climate-Policy model would produce results that, regardless of the estimated test statistics, cannot be interpreted in terms of the question either model is intended to address.

Some might respond that it is reasonable to test the Funding Climate-Policy Model against alternatives. There is of course nothing wrong with doing that. It is not accomplished, however, by simply including one or more program characteristics in a Funding Climate-Policy Model. It would be necessary to formulate carefully the two models to be compared, and design a good way to distinguish them. Certainly the most direct—and probably the best—way to test the model sketched here is to estimate Equation (4) for several program characteristics over an interval of time long enough to include both bust and boom funding climates and some significant changes in acquisition policies.

References

Blickstein, I., Boito, M., Drezner, J., Dryden, J., Horn, K., Kallimani, J. G., … Wong, C. (2011). *Root cause analyses of Nunn-McCurdy breaches*, Vol. 1 (MG-1171/1-OSD). Retrieved from https://www.rand.org/pubs/monographs/MG1171z1.html

Blickstein, I., Drezner, J., Libicki, M. C., McInnis, B., McKernan, M., Nemfakos, C., … Wong, C. (2012). *Root cause analyses of Nunn-McCurdy breaches,* Vol. 2 (MG-1171/2-OSD). Retrieved from https://www.rand.org/pubs/monographs/MG1171z2.html

Dews, E., Smith, G. K., Barbour, A., Harris, E., & Hesse, M. (1979). *Acquisition policy effectiveness: Department of Defense experience in the 1970s* (R-2516-DR&E). Retrieved from https://www.rand.org/pubs/reports/R2516.html

Diehl, R., Gould, B., & Lo, T-N. (2012). *Root causes of Nunn-McCurdy breaches—A survey of PARCA root causes analyses, 2010–2011* (IDA Paper P-4911). Alexandria, VA: Institute for Defense Analyses.

Drezner, J. A., Jarvaise, J. M., Hess, R. W., Norton D. M., & Hough, P. G. (1993). *An analysis of weapon system cost growth* (MR-291-AF). Retrieved from https://www.rand.org/pubs/monograph_reports/MR291.html

Lorell, M. A., Payne, L. A., & Mehta, K. R. (2017). *Program characteristics that contribute to cost growth: A comparison of Air Force major defense acquisition programs* (RR 1761). doi:10.7249/RR1761

McNicol, D. L. (2018a). *Acquisition policy, cost growth, and cancellations of major defense acquisition programs* (IDA Report R-8396). Alexandria, VA: Institute for Defense Analyses.

McNicol, D. L. (2004). *Cost growth in major weapon procurement programs*. Alexandria, VA: Institute for Defense Analyses.

McNicol, D. L. (2018b). Further evidence on program duration and unit cost growth. *Proceedings of the 15th Annual Acquisition Research Symposium* (Vol. I; SYM-AM-18-032; pp. 89–105). Retrieved from https://calhoun.nps.edu/handle/10945/58481

Perry, R. (1975). *Reforms in system acquisition* (P-5482). Retrieved from https://www.rand.org/pubs/papers/P5482.html

Perry, R. L., DiSalvo, D., Hall, G. R., Harman, A. J., Levenson, G. S., Smith, G. K., & Stucker, J. P. (1969). *Systems acquisition experience* (RM-6072-PR). Retrieved from https://www.rand.org/pubs/research_memoranda/RM6072.html

Perry, R., Smith, G. K., Harman, A. J., & Henrichsen, S. (1971). *System acquisition strategies* (R-733-PR/ARPA). Retrieved from https://www.rand.org/pubs/reports/R0733.html

Srull, D. (Ed.). (1998). *The Cost Analysis Improvement Group: A history*. McLean, VA: LMI.

Tyson, K. W., Harmon, B. R., & Utech, D. M. (1994). *Understanding cost and schedule growth in acquisition programs* (IDA Paper P-2967). Alexandria, VA: Institute for Defense Analyses.

Tyson, K. W., Om, N. I., Gogerty, D. C., & Nelson, J. R. (1992). *The effects of management initiatives on the costs and schedules of defense acquisition programs*, *Vol. I: Main report* (IDA Paper P-2722). Alexandria, VA: Institute for Defense Analyses.

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