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Budget Estimating Relationships for Depot-Level Reparables in the Air Force Flying Hour Program

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One of the key cost and budget O&S categories is flying DLRs. These are the reparable spare parts that directly support the USAF Flying Hour Program. In fiscal year 2002 (FY02), they constituted about $3.5 billion of total O&S costs of about $24.3 billion, or slightly greater than 14 percent of the total. It can be argued, however, that it is a particularly important 14 percent. Because of the direct connection between flying hours and military readiness, fulfilling the Flying Hour Program is one of the priority objectives of the Air Force. As a result, the funds budgeted for this program, within a MAJCOM, are fenced and cannot be moved to other Air Force budget activities without Chief of Staff approval. And, if the budgeted funds are not adequate to support this program, and additional funding is not authorized by Congress, funds needed to support the program may be moved from certain O&M activities by the MAJCOM. As the scale of these other activities is reduced, their contribution to military readiness would decline.

The O&M-obligated funds finance the “net sales” of the spare parts by the Materiel Support Division (MSD) of Air Force Materiel Command (AFMC) to the commands and their parts-demanding organizations. While other terms have been used, throughout this analysis, we use the term “net sales” to describe the dollar value of the flying DLR transactions. Because the associated obligations are sanctioned by budget authorizations, the models that explain net sales are called budget estimating relationships, or BERs.
Objective of the Study

The purpose of this research is to support the Air Force Cost Analysis Improvement Group (AFCAIG) flying DLRs budgeting process by explaining why net sales of these DLRs to the commands are at their historic levels. The AFCAIG analyzes command inputs on numerous aircraft Mission Design Series (MDS), submits budget recommendations to the Air Force corporate structure, and develops command-specific cost per flying hour (CPFH) factors. To both explain the historical data and provide the AFCAIG with a tool to better understand the commands’ budgetary submissions, we develop several explanatory BERs to understand why flying DLRs are at their particular levels.

We explain the historical flying DLRs by estimating models that relate net sales to the contemporaneous values of aircraft characteristics, operational tempo (OPTEMPO), and time-related variables. The aircraft characteristics are aircraft mission type and flyaway cost; the OPTEMPO variables are flying hours, average sortie duration (ASD), and landings per sortie, which capture the macro usage dimensions of mission profiles; and the time-related variables are fiscal year categorical variables and aircraft MDS age. We also extend the analysis to account for the serial correlation that occurs across fiscal years.

Explanatory Variables in the BER

If we focus our attention on flying DLR transactions during a particular period, and successfully explain how these budgets change when specified variables change, the causal structure of flying DLR budget determination is identified. To achieve this objective, we develop BER response schedules using data for explanatory variables that are contemporaneous with flying DLR net sales.\(^1\) Such response schedules

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\(^1\) Causality and the role played by response schedules are discussed in Freedman (2005). Simon (1990) discusses causality in terms of specified mechanism by “how widely we draw the boundaries of the system to be examined.” The boundaries of this analysis exclude inter-temporal phenomenon. We are also isolating the transactional relationship between the base maintenance organization and base supply from other elements of the supply chain and repair cycle.
permit one to estimate how DLR budgets respond to changes in the explanatory variables. As a result, for an aircraft MDS, if a change in flying hours is instituted, or there is a change in the retirement profile that affects the average age of the remaining aircraft, the model can estimate the effect of such a policy intervention.

**Intertemporal Prediction**

It is likely that net sales of flying DLRs are also influenced by factors occurring in prior periods. While it is quite difficult to develop an explanatory model that characterized the full nature of intertemporal effects, we can capture the broad forces associated with intertemporal association by exploiting the serial correlation that exists among the residuals of subsequent periods. We do this and find that the results of the contemporaneous causality model are robust. This second model is particularly useful for predicting net sales.

**Statistical Methods Employed**

Because of the limited data for each of the aircraft MDS, we employ longitudinal regression statistical methods and explain flying DLR budgets by analyzing all of the aircraft MDS-command data simultaneously. We must emphasize that there are significant correlations among the explanatory variables, but that the multiple-regression estimation techniques employed are designed to take these into account. Whenever we speak of an explanatory variable having a positive or negative effect on net sales, we always mean that the values of the other explanatory variables in the model are formally held constant. Our shorthand for this is “other things equal.”
Empirical Findings

The first model hypothesized includes fiscal year categorical variables, and we find that these are not statistically significant and are deleted from the analysis (see p. 42).

In the revised model, which excludes the fiscal year variables, all aircraft mission types show significantly lower net sales than fighters, “other things equal.” We also show a significant relationship between flyaway cost and net sales. A 1 percent increase in flyaway cost increases net sales by about 0.81 percent (see p. 44).

In this aircraft system model, a 1-percent increase in flying hours increases net sales by about 1.04 percent. The flying hours effect is so close to a proportional relationship between flying hours and net sales that it supports the working assumption of the CPFH AFCAIG budgeting process that there is a proportional relationship between net sales and flying hours (see p. 44). Under this assumption, changes in flying hours result in like-proportional changes in net sales.

During peacetime training activities, there have traditionally been very high correlations among flying hours, sorties, and landings, which are three different measures of OPTEMPO. As a result, in this peacetime training environment, it is very difficult to separate the different effects of these three variables on net sales. However, during contingencies, mission profiles change. ASD increases (see p. 31) and landings per sortie decrease (see p. 32). Because of the significant amount of contingency flying in FY02 and FY03, there is now sufficient independent variation in ASD and landings per sortie to incorporate these variables in BERs. We find that ASD has a negative, statistically significant effect on net sales, while landings per sortie have a significant positive effect.

Aircraft Aging

For the past several years, there has been a strong interest in the aging effects. When the traditional ordinary least squares (OLS) estimation technique is used, we show that a one-year increase in MDS age increases
net sales by about 2.7 percent (see p. 45). However, we emphasize that the measured aging effect must be given a broader interpretation than the simple effect of material degradation. It can also embody the effect of aircraft modifications, and may be affected by technical progress that occurs over time, as new aircraft MDS enter the inventory.

**Observations on BERs**

Our discussion of the explanatory models notes many of the complications associated with constructing such models. Yet in some settings—say, during the acquisition process—the values of contemporaneous variables provide the primary input to estimating cost. In such analyses, aircraft type, OPTEMPO, and aircraft age variables are very natural variables to consider. To aid in the validation of budget estimates developed by the MAJCOMs, and to understand the moving forces determining net sales, these models may play a useful role. Also, to predict the value of flying DLRs, the model that accounts for the correlation among the residuals has attractive properties.

The appendix includes several amplifications and extensions. We address the issue of outliers, and investigate a first-difference model to better isolate the pure effects of aging and eliminate any possible “non-stationarity” from the data.