FORECASTING IN FMS

By

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In the financial management of Foreign Military Sales (FMS) cases and programs, one of the most critical responsibilities of the financial manager is to develop, monitor, and modify the existing FMS case payment schedules. This responsibility requires, in part, that the financial manager forecast the future. Fortunately, the manager has numerous analytical tools at his disposal; however, he is faced with the dilemma of choosing the methods that best suit his needs.

The intent of this article is to examine some of the analytical alternatives and to guide the reader toward a possible solution. The reader is presented with a short overview of payment schedules and is then acquainted with a partial list of analytical tools. Next, the article scrutinizes three tools which seem to offer promise, and settles on one, regression analysis, as a possible candidate for consideration. This tool is then tested for relevance on actual FMS cases. Finally, the reader is encouraged to initiate further study in this area.

The payment schedule that accompanies the DD Form 1513 (Letter of Offer and Acceptance) is a consolidated formal presentation to the FMS customer of the estimates of cash requirements for the FMS case, and is displayed on a quarterly basis. This payment schedule provides specific calendar dates for each required payment and the specific amounts due on these dates. It is the financial guide which the customer country can use for its internal FMS budgeting process.

The initial payment schedule is prepared based on the best estimate of future cash needs at that time. Unfortunately, actual costs are likely to vary from those initial estimates, and these estimates may need modification as better and more timely data become available. The major criterion is that

payment schedules must accurately reflect project/case funding requirements. The FMS financial manager must ensure that the US collects sufficient funds in advance from the client country, and he must also attempt to minimize unnecessary collections.[1]

Since incurred costs determine payments, the financial manager must, give attention to developing improved cost projections.[2] In some cases, however, incurred cost projections have been little more than a reactive, quarter-by-quarter estimation. This is unfortunate since the forecasting techniques available to other financial managers in other fields can be applied by the FMS financial manager in order to improve his incurred costs projections. Since the forecasting of incurred costs is such an important area, it is imperative that the manager give serious consideration to those forecasting methods/techniques which are available to him.

The financial manager faces the problem of choosing a reliable method of forecasting incurred costs which is neither too costly nor too complex. The most appropriate forecasting technique is not necessarily the most sophisticated or the most accurate, but rather the method that meets the needs of the financial manager for reliability at a reasonable cost and convenience. There is no single best forecasting technique, since decision needs vary considerably in scope and importance. There are, however, numerous well-developed forecasting methods, some more applicable than others in given situations.

Forecasting techniques can be categorized into two basic types or models. In the first and most common, the time series model, the variable to be predicted is historically analyzed over a period of time, and the discernable pattern(s) is modeled and estimated. A time series model assumes that the time-sequenced pattern that has occurred in the past will continue into the future. The model can be developed solely from the historical pattern of the predicted variable. A few examples of a time series model are: single moving average, linear moving average, Spencer's moving average, Henderson's moving average, simple exponential smoothing, linear exponential smoothing, Winter's exponential smoothing, classical decomposition, Census II, Foran, adaptive filtering, Box-Jenkins, and life cycle curves.

The second type of forecasting technique used is the causal model. In this technique, other variables related to the entity to be predicted are delineated and their productive relationship is modeled and used to forecast. For example, incurred costs might be related to commitments, expenditures, percentage of work complete, obligations, etc. Incurred costs would then be considered a function of these independent variables and the functional relationship would be estimated. Thus, using expected future values of the independent variables, one can predict the dependent variable. The advantage of such models is that they allow incorporation of changes in management policies or shifts in the environment. The disadvantages of the causal models are that they are more difficult to develop and that they require much more historical data (i.e., data on various variables and not simply on the item to be predicted). A few examples of this type of model are: simple regression, multiple regression, econometric models, and input-output models.

For incurred cost forecasting, two time series methods (exponential smoothing and the Box-Jenkins approach), and one causal model (regression analysis) were examined. For the reasons described below, these three methods seem to warrant further consideration as possible forecasting tools. For more information on alternative forecasting methodologies, the interested reader can refer to one of the many texts dealing exclusively with forecasting.[3]

In principal, exponential smoothing, which is a low-cost technique, is analogous to a moving average in that it attempts to smooth out the randomness from the historical data. The procedure, however, is different. In exponential smoothing, the observations are weighted, with more weight being given to the more recent observations. In other words, to forecast using exponential smoothing, only the most recent observation and the most recent forecast need to be known. Because of the reduced data requirements compared to using the moving average method, most forecasters prefer exponential smoothing to moving averages.

An improvement over exponential smoothing is the Box-Jenkins approach. Although it is similar to exponential smoothing, it can also handle data with seasonal and cyclical components. The Box-Jenkins approach is the most

comprehensive time-series analysis technique that has yet been developed. All techniques in this group can be considered, in one way or another, a special case of the Box-Jenkins approach. Basically, the forecaster fits a time-series with a mathematical model. This model is optimal in the sense that it has smaller errors or variability than any other model fitted to the data. The type of model must be specified, and its parameters are then computed. Although the Box-Jenkins approach is apparently the most accurate statistical technique available, it is also one of the most costly and time-consuming computational procedures.

Functionally, a regression model relates factors that are to be predicted (i.e., incurred costs) to elements of the system which explain some of their variation, such as economic or internal variables. Regression analysis is the computational technique that estimates the coefficients of the regression model, commonly using the least-square technique. Primarily, relationships are statistically analyzed, although any relationship should be selected for testing on a rational ground.

The basic regression model is linear in form, although there are several nonlinear functions whose parameters can be estimated with basic regression analysis. If a basic linear model is used, the data should fall along a straight line in a plot of y_i against x_i. In practice, however, the relationship between y_i and x_i is often not linear. When these situations occur, it is frequently possible to transform the nonlinear relationships into linear functional expressions so that linear regression analysis can be conducted on the transformed values of x and y. In other cases, it may be possible to use the ordinary procedures on a nonlinear relationship.

Efforts directed toward choosing the best possible functional relationship should result in a regression equation that provides the best fit to the sample data; this specification of the form of the equation should also provide the most accurate predictions. When possible, it is good practice to plot the raw data before deciding the form of the relationship to be used. The pattern emerging from the points in the plot should indicate which functional form will best conform to the actual data.

Although the expense associated with applying the regression modeling technique is not significant, the overall time that the analyst requires for developing a regression model depends on his ability to identify relationships. This may take several weeks and is a function of the availability of data and the ability of others to help identify the meaningful variables.

Since regression analysis seemed to hold the most promise for forecasting incurred costs, actual cases from a major FMS program were tested. The following chart provides a profile of the cases involved:

No. of Cases	Types of Cases	Avg. Case Value ($ millions)	Avg. No. Pymt. Qts. to Date	Avg. No. Pymt. Qts. Remaining	Avg. No. Modifs./ Amdmts.
5	Materials	174	12	7	5
5	Weapons	215	12	6	6
3	Training	90	13	4	3
2	Services	412	10	0	5
1	Facilities	3,762	35	4	9

For testing purposes certain parameters and assumptions were made. Incurred costs were used as the variable to be forecast and are referred to as the dependent variables. Incurred costs for the next period were to be based on an independent variable from the present period, hence they were lagged by one quarter. In all tests, with the exception of multiple regression, incurred costs were separately regressed against obligations and against time. For multiple regression, both obligations and time were used as the independent variables. In addition, all variables were net of administrative and accessorial surcharges. The types of regression analysis used and their explanations are presented below:

Simple linear regression - the most common type of regression. The objective is to locate the best-fitting straight line between one

independent and one dependent variable; represented by the equation: $y = b_o + b_1 X$.

Least square fit (geometric) - a nonlinear relationship. A curve line whose change in slope is a constant; represented by the equation: $y = ax^b$.

Least square fit (exponential) - a nonlinear relationship. A curve line whose change in slope is changing (i.e., increasing or decreasing); represented by the equation: $y = ae^{bx}$.

Polynomial regression - a curvilinear relationship. Polynomial functions of a degree higher than 2 have graphs which can turn up and down several times; represented by equation:
$Y = b_o + b_1X + b_2X^2 X \ldots + b_nX^n$.

Multiple linear regression - similar to simple linear regression, except that it uses two or more independent variables; represented by the equation $Y = b_o + b_1X_1 + b_2X_2 + \ldots + b_{n-1}X_{n-1}$.

The chart presented below displays those types of regression analyses which provide the best fit for the tested FMS cases. This best fit was ascertained by examining the correlation coefficients (r) and the coefficients of determination (r^2) generated by the analysis. Due to space limitations, only the r^2s are presented, though there were other measurements generated (T test, F test, Durbin Watson test, etc.).

This chart presents two things. First, each case requires the application of different regression analysis techniques, since each has its own unique curve. Secondly, the coefficients of determination (r^2) is significant. It is unfortunate that the tests were not consistent (i.e., all materials cases are simple regression, etc.), but the results do provide encouragement to further study this area.

Case	Simple Reg. Oblig./Time		Least Sq(G) Oblig./Time		Least Sq(E) Oblig./Time		Poly. Reg Oblig./Time		Multiple Reg Oblig. + Time
Weapons								.976	
Weapons	.883								
Weapons							.941		
Weapons								.901	
Weapons								.869	
Materials								.812	
Materials					.649				
Materials								.775	
Materials						.904			
Materials					.998				
Services									.749
Services								.869	
Training								.929	
Training							.977		
Training									.714
Facilities									.869

r^2 is measured between 0 and +1; the closer to 1, the stronger the relationship between the independent and dependent variables. For example, it a case has a r^2 value of 0./5, this means that 25 percent of the variation in incurred costs would be due to the influences of other variables beside those chosen.

The intention of this article was not to pursue an in-depth technical analysis, but was intended to suggest that there are many forecasting techniques available to the FMS financial manager, each having its own strengths and weaknesses. The data requirements, costs, basic principles and assumptions, accuracies, and overall effectiveness differ for each technique for various conditions. Additional research must be conducted in this area to determine which technique is the most applicable for forecasting incurred costs. Each of the above techniques must be evaluated to determine how they benefit the FMS financial manager.

At present, seat-of-the-pants, reactive managerial styles are already on the wane, and increased emphasis is being placed on "scientific" analysis and planning. Practical experience is still invaluable, but it must be used with greater discipline. Analysis is now more rigorous, and computers allow for more convenient and thorough analysis of the alternatives. The financial manager must research and determine which of the available forecasting tools will ensure proper financial management of his FMS cases.

ENDNOTES:

1. Established DOD policies concerning the development and maintenance of FMS case payment schedules are prescribed in DSAA Security Assistance Management Manual, DOD 5105.38-M, 1 April 1984; Foreign Military Sales Billing and Reimbursement Procedures, DODINST. 2140-3, 6 September 1979; and other guidance documents.

2. DODINST. 2140.3, 6 September 1979.

3 For example, Steven Wheelwright and Spyios Makridakis, Forecasting Methods for Management (New York: Wiley, 1973).

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