COMPUTER APPLICATION AND COST ACCOUNTING

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I. INTRODUCTION

Contemporary cost (or managerial) accounting courses cover a wide range of subjects taken from different disciplines in business administration. It includes PERT, linear programming, simple regression, and capital rationing. More sophisticated decision making techniques such as PERT/COST, multiple regression, and goal programming are treated (or at least mentioned) in graduate seminar courses.

While these topics are also treated in operations research and/or statistics courses, students are usually given limited exposure to empirical applications with the emphasis placed upon computational methods and theory. This deficiency is more true for cost accounting courses. Practical applications of decision making models are greatly needed to fill the gap between theory and practice.

The computer can be a valuable teaching aid for the instructor and student for this purpose. The use of "canned" computer programs would

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make it possible for the instructor to cover applied work in the decision-making process, and help students prepare for more empirical work. The student will gain experience in the area of computer assisted data analysis without requiring a formal computer programming knowledge.

This paper discusses some of the computer packages available for use in cost accounting courses. Examples of problems that can be solved by these programs will be presented. Finally, a list of the program packages that have been developed with respect to quantitative methodologies as applied to cost accounting will be provided in the Appendix.

II. QUANTITATIVE METHODS AS APPLIED TO COST ACCOUNTING AND THEIR COMPUTER PROGRAMS

Quantitative methodologies as applied to cost accounting can broadly be classified into two categories: (1) regression analysis, and (2) optimization models involving linear programming, zero-one programming, goal programming, PERT/COST, etc. Regression analysis is basically concerned with estimating parameters in a postulated relationship between a dependent variable and explanatory variables. It has been proved to be quite useful in estimating cost behavior and sales. On the other hand, optimization models deal with the problem of finding a solution that maximizes profit or minimizes cost without violating the constraints available. They are essentially used in the areas of planning and scheduling. For example, linear programming has been widely applied to the problem of determining opportunity costs and transfer prices that serve as valuable tools for optimal resource allocation. The importance of zero-one programming can not be overemphasized in connection with the problem of selecting projects that are interrelated and subject to budget limitations.

This section will outline some of the program packages developed for the above purposes. The package is viewed primarily as an instrument of data analysis for applying previously developed algorithms rather than new ones. On this basis, it is used for summarization, estimation (in the case of regression), optimal solution (in the case of optimization models), and additional information useful for decision making. In selecting the package the sophistication of the users as well as the hardware available have important implications. It will be of little value if it is beyond the scope of the course and the students. Thus, the software packages should be chosen on the basis of these considerations. In what follows, some of the widely used program packages will be described for each of the subject categories but no attempt will be made to rank them or compare their technical performance features.

Estimation:

The canned programs for estimation are usually divided into general purpose packages and specific use programs. There are two widely used packages: Regression Analysis Program for Economists (RAPE) and Time Series Processor (TSP). These programs utilize the method of ordinary least squares (OLSQ) and suffice to estimate general purpose problems. They all have the arithmetic data transformations—substraction, addition, division, multiplication, log, and forward and backward lag transformation—built in and thereby require no formal programming knowledge. They all print out a Durbin-Watson statistic (which is crucial in the analysis of time series data), t-test and residual analysis. They also include advanced estimation methods such as two-stage least squares (TLSQ), instrumental variables and distributed lag analysis. Regresion programs are also found in statistical packages such as Biomedical Compter Program (BMD), IBM Scientific Subroutine Packages (SSP), Statistical Package for Social Sciences (SPSS), and DATATEXT. However, these programs have limited capability for data transformation. Furthermore, they do not present some of the important statistics—for example, a Durbin-Watson statistic. Specific use programs, involving Almon distributed lags, Bayesian estimation, spectral analysis, etc. are not discussed in this paper, since they are found useful for some of economic problems but not for cost accounting problems.

Optimization:

A variety of optimization techniques, collectively classified as operations research or management science, have been developed to provide management with a tool for planning and decision making. Linear programming is probably the most widely applied technique. Computer manufacturers have developed program packages in this area. These packages are available for use on almost every type of computer. However, these programs are not without shortcomings. Many of them lack flexibility in feeding input data since they assume all constraints have been converted to equalities. More importantly, they do not provide valuable information such as cost range that is critical for post-optimality analysis.

With this in mind, many colleges have written their own codes and make them available for use at their computer conters. Examples include ALPHAC and SIMPLEX whose features are briefly described in the Appendix. Furthermore, quite recently, IBM has developed a very powerful linear programming routine, referred to as MPS/360. This was written for the IBM 360/370 computer systems. Not only does it generate all of the information needed for decision making but it can solve many nonlinear programming problems.

Program packages for techniques other than linear programming are usually hard to come by. A list of some of the packages developed to date is provided in the Appendix. Prospective users will have to refer to the list for the origin and special features of these packages.

III. PROBLEM APPLICATION

In an effort to facilitate an understanding of computer applications in cost accounting, two examples of problems that can be solved by the program packages are presented below. The first one shows how some of the estimation problems can be effectively handled by the use of the OLSQ regression packages. The second one involves the use of an optimization technique to solve a complicated capital budgeting problem.

Estimation:

An OLSQ regression package is quite a versatile tool and may be used with nonlinear functional forms, dummy variables, heteroscedasticity and the presence of serial correlation in the error terms.(1) A few cases are in order.

Relations which are nonlinear in the variables but linear in parameters can be transformed and estimated with the aid of any one of the OLSQ packages described in the previous section. Such relations as

$$y=a+bx+cx^2$$

can be converted to linear equations through a logarithmic transformation.

Another interesting problem is the case where the error term is not constant but heteroscedastic. In this case, the original equation.

$$y_i=a+bx_i+u_i$$

is transformed as

$$y_i/x_i=a(1/x_i)+b+u_i/x_i$$

and then estimated by applying an OLSQ program. This problem usually prevails in cross section data and will be corrected by this transformation.

One final problem concerns the case where the error terms are serially correlated. This problem arises with respect to time series data. The Durbin-Watson statistic will detect the presence or absence of serial correlation. In this case, the model.

$$y_t=a+bx_t+u_t$$

must be transformed as

$$y_t-\rho y_{t-1}=a(1-\rho)+b(x_t-\rho x_{t-1})+v_t$$

(1) For an additional discussion, refer to Benston [2].

where ρ is obtained by estimating $u_t=\rho u_{t-1}+w_t$.
This is in the form of $y_t^*=A+Bx_t^*+v_t$, and can be estimated again by using an OLSQ package. If programs are used which have the data transformations built in, the students are not required to have any formal programming knowledge. Other programs would require the students to write the programs to perform the transformations and then invoke the OLSQ subroutine.

Optimization:

The following problem(2) involves the use of an optimization technique to solve a complicated capital budgeting problem.

A company is considering ten investments. The measure of value is the net present value of each project. For technological reasons, two projects, GP and SP, are mutually exclusive. This is a special condition: project F can not be selected without project E; however, E can be selected without F. Assume that $5,000,000 is the total capital budget for the coming year. The following table shows the relevant information.

(in thousand dollars)

projects	NPV	capital required	projects	NPV	capital required
C	400	600	E	112	800
GP	400	1,000	B	134	1,200
SP	900	3,000	H	27.5	550
D	128	400	G	4.5	450
F	150	1,000	I	0	1,000

This can be set up as a zero-one programming problem which involves the selection of the set of capital budgeting projects that will maximize total net present value without violating the constraints available.

In mathematical form, the problem is:

$$\text{Max NPV} = 400C+400GP+900SP+128D+150F+112E+134B+27.5H+4.5G$$

(2) This problem has been adapted from Horngren [5, pp. 510-2].

subject to

$$600C+1000GP+3000SP+400D+1000F+800E+1200B+550H+450G+1000I \leqq 5000$$
$$GP+SP \leqq 1$$
$$F-E \leqq 0$$
$$C,\ GP,\ SP,\ D,\ F,\ ,I = 0 \text{ or } 1$$

where, say, C=1 implies project C to be taken and C=0 implies project C to be rejected.

The zero-one programming code discussed in the Appendix will provide the following optimal solution: C=1, GP=0, SP=1, D=1, F=0, E=1, B=0, H=0, and G=0. The optimal portfolio, therefore, includes C, SP, D, and E, and calls for capital expenditures of $4,800,000. The total contribution to the firm's net present value is $1,540,000.

IV. SUMMARY AND CONCLUSION

The use of canned computer programs in cost accounting courses will help students in the empirical application of cost accounting theory. Some of the available program packages which may be used in such courses were discussed. Specific examples of problems were detailed. A glossary of the programs appears in the Appendix. This glossary contains a description of the program's origin and special features.

It is hoped that this will encourage more applied cost accounting courses, especially for students who wish to use quantitative models as a tool for empirical applications. Instructors might benefit from this work for their own research.

APPENDIX

Regression Programs

1. RAPE-Regression Analysis Program for Economists

RAPE was developed by William J. Radchel of Harvard University. It is a general purpose regression program designed for use in econometric research. It includes many linear estimation methods: OLSQ, TLSQ, limited information and instrumental variables. The package also contains two non-linear estimation subroutines. Any transformations not built into the program may be incorporated in a user-written subroutine. The normal input routine will load data on cards in free or fixed format or from a magnetic tape or disk in fixed format or binary.

2. TSP-Time Series Processor

TSP was prepared by Robert E. Hall of MIT. The program does the following:

a) data transformations

b) OLSQ, TLSQ and instrumental variables

c) distributed lag analysis

d) extrapolation and plots

e) punching and printing of all original and created variables

All input to the program is in free or fixed format.

3. Statistical Packages Containing Regression Subroutines

There are five widely used statistical packages: Biomedical Computer Program (BMD), IBM Scientific Subroutine Package (SSP), Statistical Package for Social Science (SPSS), Univac Statistical Package (STATPAC), and DATATEXT. BMD, SSP, SPSS and DATATEXT are available on most IBM 360 systems, while STATPAC is the basic software pack on UNIVAC systems. Each provide multiple regression subroutines for general users.

However, the output generated by these programs are not detailed enough for specific purposes. For example, none of them presents a Durbin-Watson statistic, which is quite crucial in the analysis of time series.

Linear Programming Packages

1. MPS/360-Mathematical Programming System

MPS/360 was developed for the IBM 360 system. It is composed of procedures dealing with linear and separable programming. It handles problems that involve nonlinear as well as linear objective functions. Printouts include:

1) Input matrix

2) Objective function at each iteration

3) Output matrix

4) Cost range for sensitivity analysis

2. ALPHAC

ALPHAC is Linear Programming ststem written for the University of California, Berkeley CDC 6400. It provides about the same information as MPS/360.

3. SIMPLEX

SIMPLEX is a linear programming code written for the New York Institute of Technology by Professor Fraiman. It uses the two-phase method. Like MPS/360 and ALPHAC, the program will add slack, surplus and artificial variables to the constraints as needed. It provides the following output: the initial and final simplex tableau, the intermediate basic solution and optimal primal and dual solution.

4. LPGOGO

LPGOGO is a maximizing code. It uses the two-phase method. It assumes that all constraints have been converted to equalities. The program is no doubt much less sophisticated than the ones described above in terms of flexibility in feeding input matrix and output gererated. It prints out the following: input data, optimal solution and cost range. For the complete source deck, refer to Appendix B of Daellenbach, Hans G. and Earl J. Bell, *User's Guide to Linear Programming,* Prentice-Hall, Inc., New Jersey, 1970.

Capital Budgeting Packages

1. **DRATE**

DRATE finds a time-adjusted rate of return (or more often called internal rate of return) for a series of cash flows. The discounted cash flows are also computed. For further information see pp.117-119 of the *IBM 1130 Scientific Subroutine Package-Programs Manual* (*H20-0252*).

2. **Zero-One Programming Routine**

It solves the linear programming problem whose decision vaiables can have the value of either 0 or 1. It has numerous applications in advertising media selection and manpower assignment problems as well as capital budgeting. For a complete source deck, refer to Appendix A of Plane, Donald R. and Gary A. Kochenberger, *Operations Research for Managerial Decisions,* Richard D. Irwin, Inc., Homewood, Illinois, 1972.

PERT and PERT/COST Routine

PERT and/or PERT/COST problems can be handled by any linear programming routine described earlier. However, it would be necessary that any given problem should be appropriately constructed as a linear programming problem. For a special purpose deck, the computer code "Critial Path Programming Method" is available. This was written by Calvin Keeler of the University of California, Berkeley. The user has three output options:

a) Generate all possible characteristic project schedules;

b) Generate normal schedule only;

c) Generate normal and crash schedules.

Time and cost for normal and crash activity must be given in integer.

Goal Programming Code

The routine developed by Professor Sang Lee of Virginia State University solves goal programming problems. Goal programming is a special case of linear programming. It differs from linear programming in that it can handle decision problems with multiple and conflicting goals. It has been widely applied to a variety of management and economic planning problems. The code will provide the following print-out: Input data, the final simplex solution, slack analysis, variable analysis and the analysis of the objective. For the complete goal programming computer deck, see the appendix to Chapter 6 of Lee, Sang M.,*Goal Programming for Decision Analysis*, Auerback Publishers, Inc., Philadelphia, 1972.

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