

# QUANTITATIVE METHODOLOGY AS APPLIED TO MANAGEMENT ACCOUNTING: SURVEY AND SYNTHESIS

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## I. INTRODUCTION

Managerial (or cost) accounting has expanded in scope to cover many areas of quantitative methodology. They include linear programming, regression analysis, and statistical decision-making theory. This is illustrated by a variety of reports and publications dealing with the application of operations research to management accounting. For example, as early as 1964, a Committee of Measurement in the Institute of Management Sciences suggested:

The expected development and growth of management services will take place only if the accountants of the future possess more sophistication in mathematics than they typically have had in the past. Improved methods of analysis, now classified as 'operations research', must become the concern of the accountants.<sup>1</sup>

In line with this development, the National Association of Accountants has created the Institute of Management Accounting to administer the Certification in Management Accounting Program which fully recognizes the

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1. See "IMS Committee Comments for Common Body of Knowledge Study," *The Journal of Accountancy*, December 1964, pp. 79-83.

inclusion of quantitative methodology as part of its requirement. Furthermore, many CPA firms have added a quantitatively oriented Management Services Division to further integrate the area of quantitative methods into the accountant's function.

The purpose of this paper is threefold. The first is to outline the significant areas of quantitative methodology as applied to accounting. This includes a review of the material being covered in major textbooks. A comparison will be made of these texts in terms of their coverage of quantitative methods. Secondly, a brief survey will be made of recent applications that have appeared in accounting journals. In an attempt to integrate the coverage of quantitative analysis in texts and journals, a list of quantitative topics that may be pertinent to the education of the modern accountant will be provided. Finally, based on the survey, some recommendations will be in order.

## II. QUANTITATIVE AREAS IN MANAGEMENT ACCOUNTING

While a variety of techniques such as linear programming, regression analysis, inventory planning models, and capital budgeting decisions constitute a major portion of quantitative methodology in management accounting, its coverage and the level of its sophistication differs in the literature. One possible way to analyze this diverse treatment is to compare textbooks in terms of their coverage and treatment of specific areas of quantitative methodology.

For the sake of practicality, the comparison is limited to six texts<sup>2</sup> which

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2. These are the following: (1) Ira Bierman and T.R. Dyckman, *Managerial Cost Accounting*, New York: The Macmillan Co., 1971, (2) G.R. Cromningsfield and K.A. Gorman, *Cost Accounting: Principles and Managerial Applications*, Boston: Houghton Mifflin Co., 1974, (3) N. Dopuch, J.G. Birnberg and J. Demski, *Cost Accounting: Accounting Data for Management's Decisions*, New York: Harcourt Brace Javaovich, Inc., 1974, (4) Charles Horngren, *Cost Accounting: A Managerial Emphasis*, New Jersey: Prentice-Hall, Inc., 1972, (5) A. Matz and O.J. Curry, *Cost Accounting: Planning and Control*, Ohio: Soth-Western Publishing Co., 1972, and (6) Gordon Shillinglaw, *Cost Accounting: Analysis and Control*, Illinois: Richard D. Irwin, Inc., 1972.

have been widely adopted by accounting departments. This appears in Exhibit 1. However, the analysis is not intended to judge any of the texts listed. As a further indication of the divergent views, the number of questions on each topic appearing on recent CPA examinations<sup>3</sup> is provided.

As can be seen in the exhibit, the coverage and the level of sophistication vary with each text. For example, Matz and Curry do not mention such topics as learning curves and statistical cost variance analysis, while the other texts (except Shillinglaw) delve into them in detail. In terms of the level of sophistication, Dopuch and others is generally somewhat more advanced in treatment. For example, Dopuch and others prepares the appendix for treatment of sophisticated topics such as PERT/COST and sensitivity analysis. In the areas of multiple regression, capital rationing, and overhead allocation via matrix algebra, Bierman, Horngren, and Dopuch and others are fairly extensive. This all implies that the authors differ as to the nature and degree of quantitative analysis required of managerial accountants.

An interesting observation is that none of the texts mention either queuing (waiting line) theory or transportation cost minimization problems, although past CPA examinations have covered these areas. Apparently, there is a lack of consistency in the coverage of quantitative methods between texts and CPA examinations.

### III. A SURVEY OF RECENT APPLICATIONS

Many articles dealing with quantitative methodologies have merely been simplified representations of what have appeared in more sophisticated or technical journals. The application of quantitative analysis to accounting in the periodical literature is limited. However, a review of some publications dealing with its empirical applications is provided below.

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3. Based on Charles Horngren and A.J. Leer, *CPA Problems and Approaches to Solutions*, Fourth Edition, New Jersey: Prentice-Hall, Inc., 1974.

**Exhibit 1**  
**Cross-Reference Between Quantitative Chapters in Cost Accounting Texts**

Topics	Bierman, <i>et al</i>	Crowng- shield, <i>et al</i>	Dopuch, <i>et al</i>	Horngren	Matz, <i>et al</i>	Shilling- glaw,	Number of Multiple- Choice Questions in CPA Examinations	
Learning Curves and Cost Behavior	4	27	3	—	—	12	5	
Regression and Cost Estimation	Simple	3	12	3	24	17	3	5
	Multiple	3	—	3	24	—	3	—
PERT PERT/COST	12	—	12*	16	—	—	5	
	12	—	12*	16	—	—	—	
Statistical Cost Variance Analysis	2	24	12	25	—	—	—	
Inventory Planning and Control	EOQ	—	9, 25	7	15	12	28	5
	Qty. Disc- ount Model	—	—	—	15	—	13	—
	Stockout Case	7	9, 25	7	—	—	28	—
	Uncertain- ty	—	26	—	23	—	28	—
	ABC Plan	—	—	—	15	12	13	—
Linear Programming	Problem Setup and Graphical Method	—	21	4	27	28	28	25
	Simplex Method	—	22	4*	—	28	—	3
	Duality and Shado- w Prices	—	—	4*	—	28	—	1
	Sensitivity Analysis	—	—	4*	—	—	28	1
	Transport- ation Cost Problem	—	—	—	—	—	—	1
Decision Making under Uncertainty	—	23	—	23	—	2	3**	
Queuing theory	—	—	—	—	—	—	5	
Capital Budgeting	Selection Methods	13	20	5	13	26	26	2**
	Mutually Exclusive	13, 14	—	6	14	—	26	—
	Capital Rationing	14	—	6	14	—	26	—
Mathematical Fundamentals	Calculus and Relat- ed Subjects	—	—	—	—	—	—	10
	Overhead allocation by matrix algebra	—	—	14	12	9	—	7

\* Refers to appendices.

\*\* Regular problems.

## Linear Programming

There exists a number of papers regarding linear programming (LP). Many of them, which appear in accounting journals, are informative and address themselves to simple applications to artificial situations. Recently Bernard [2] and Samuels [17] have focused on the use of LP for determining and incorporating opportunity costs into a managerial accounting system. The problem of determining transfer prices facing a decentralized firm was investigated by a number of researchers (e.g. [5][7][15]), primarily with the aid of what is called the 'decomposition principle' in LP. Overhead allocation, which is crucial for product costing and income determination, was also examined within a linear programming framework by Kaplan and Thompson [11]. Unlike allocation via the traditional input-output technique, the basic scheme here was to charge products on the basis of their utilization of the scarce resources of the firm. Quite recently, Hartley [8] disputed the wide applicability of a decision rule concerning joint production which states that if additional revenue exceeds the additional costs, then the joint products should be further processed. He showed how LP can be utilized to develop a decision rule when there are bottleneck resources involved, and/or other complications.

## Integer Programming and Capital Budgeting

The importance of integer programming (IP) can not be overemphasized in connection with the problem of selecting projects that are interrelated for technical reasons and subject to budget constraints. Among others, the paper by Fogler [6] presents a good survey on the topic and proposes a multi-dimensional rank technique. However, Weingartner's work [19] provides the most comprehensive treatment on the subject.

### Goal Programming

Goal programming (GP) is a special case of LP. It differs from LP in that it can handle decision problems with multiple and conflicting goals. Problems amenable to this formulation are encountered in many economic and business areas. Since management's problems more often call for the solution of multiple goals rather than a single goal (i.e., profit maximization or cost minimization), the application of goal programming is expected to increase. Quite recently, Killough and Sanders [12] introduced GP to accounting by designing and solving a GP planning model for a hypothesized public accounting firm. The significant relationship between GP and classical breakeven analysis was first explored by Charnes and others [20].

### PERT/COST

The PERT/COST system is concerned with the problem of efficient allocation of limited resources in accomplishing work programs, and is based on the premise that activities on a network are subject to time/cost trade-offs. This system proved to be useful in managing large and complex programs of work; for example, space ventures, construction projects, budgeting process, etc. Two brief introductory articles ([1][16]) on the subject appear in the recent issues of *The Accounting Review*.

### Learning Curves and Regression Analysis

A number of informative articles on learning curves and regression analysis for cost estimation and control purposes are available. However, empirical applications in accounting journals are still limited. One paper using multiple regression merits a special note. Professor Brief [3] attempted to measure *goodwill* by developing a theoretical valuation model which was then compared to market transactions involving goodwill. The study related to seventy-four transactions involving the sale of liquor stores in New York State in 1958.

### Quadratic Programming

Quadratic programming (QP) deals with the problem of maximizing (or minimizing) a *quadratic* objective function subject to *linear* inequality constraints. It has been used widely in finding an optimum portfolio and solving planning problems in which quadratic utilities are assumed for the objective function. In the accounting sphere, Jensen [10] suggested the possibility of using QP to solve a problem dealing with the point of sale of joint products. In response to Jensen's article, Hartley [9] presented an illustrative problem with a quadratic objective function in the case of joint production.

### Simulation and Budgets

Simulation is experimentation with detailed models of real systems and processes for the purpose of finding optimal courses of action. It has distinct advantage over optimization models such as LP, IP, GP, and QP in that it can be used to solve problems involving mathematical equations which can not be solved by direct means. It is also useful in solving problems whose solution would be too costly or require too much time, and problems where experimental conditions simply can not be produced. Many authors such as Lerner [13], Mattessich [14], and Wagner and Pryor [18] attempted a simulated experiment of the budgeting process of a firm based on financial planning models. Today this method is in wider use, but principally by the larger companies.

### Markov Chains and Other Quantitative Models

An application of Markov chain models to accounting appeared in Management Science more than a decade ago. Cyert and others [4] estimated the allowance for doubtful accounts, which represents the estimated amount of receivable balances that will ultimately prove uncollectable, by utilizing Markov chain theory.

Publications on such topics as probabilistic inventory models and queuing

theory have yet to appear in accounting journals. However, these methods are intensively discussed in operations research texts. Further, empirical applications of these methods appear in quantitative analysis journals. Nevertheless, their treatment in accounting journals is greatly needed in order to facilitate their empirical applications to accounting fields.

#### IV. SUMMARY AND RECOMMENDATIONS

The primary purpose of this paper was to outline the major developments of quantitative methodology and its application to specific areas of accounting. Exhibit 2 integrates in a tabular form what has been discussed in this paper. It does not provide, by any means, a complete list of quantitative applications made available to date. It is only a framework of quantitative methods pertinent to the education of the modern accountant. It is hoped that this list may prove to be instructive to fill the void that exists in accounting curricula.

The results of the survey reveal that no one text covers all of the pertinent quantitative methods and all have neglected discussing some areas which have been covered on past CPA examinations. In other words, the authors differ as to the nature and degree of quantitative analysis required of management accountants. Furthermore, there is a lack of consistency in the coverage of quantitative methods between texts and CPA examinations.

It is recommended that accounting professors involved in this area come up with a consensus as to an appropriate course outline that will cover the major areas of quantitative applications to accounting. It is further recommended that the American Institute of CPAs should establish a 'Committee on the Application of Quantitative techniques to Accounting.' The purpose of this committee will be to recommend those areas of quantitative analysis that would be most useful to managerial and public accountants in the per-



formance of their functions. The committee should consist of theoreticians who possess an understanding of what sophisticated quantitative techniques would be most useful in solving accounting problems. This group is comprised of academicians in the accounting and operations research disciplines. The committee should also consist of practitioners and managerial accountants who are aware of the accounting problems that must be solved by using sophisticated quantitative methods. However, this group is not sure of which techniques would be most appropriate in specific applications.

The committee should interact with similar committees of other professional organizations such as the American Accounting Association. It is through these types of committees that a suitable accounting curricula can be developed and a lack of consistency between texts and CPA examinations can disappear.

## EXHIBIT 2

### Summary of Quantitative topics

Project Evaluation and Control	Inventory Planning and Control
Selection Methods	Economic Order Size
Interrelated Projects	Production Run Model
Capital Rationing Problems	Quantity Discounts
Use of Integer Programming	Uncertainty Case
PERT and PERT/COST	
Linear Programming-Optimization	Cost-Volume-Profit Analysis
Graphical Methods	Break-Even Analysis
Simplex Methods	Use of Goal Programming
Duality and Opportunity Costing	Special Topics
Sensitivity Analysis	Markov Chain Models and Bad Accounts
Decomposition and Transfer Pricing	Quadratic Programming and Joint Production
Cost Estimation and Control	Queuing Theory and Cost Models
Naive Models	Simulation and Budgets
Simple Regression	
Multiple Regression	
Learning Curves	
Statistical Variance Analysis	

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