This is to certify that the

thesis entitled

A MULTIPLE FORECASTING SYSTEM FOR THE
TELECOMMUNICATION INDUSTRY

presented by

Charles W. Holmes

has been accepted towards fulfillment
of the requirements for

M.A. degree in Telecommunication

Robert E. Yadon

Major professor

Robert E. Yadon

Date July 22, 1983

A MULTIPLE FORECASTING SYSTEM FOR THE TELECOMMUNICATION INDUSTRY

By

Charles W. Holmes

A THESIS

Submitted to
Michigan State University
in partial fulfillment of the requirements
for the degree of

MASTER OF ARTS

Department of Telecommunication

1983

Accepted by the faculty of the Department of Telecommunication, College of Communication Arts and Sciences, Michigan State University, in partial fulfillment of the requirements for the Masters of Arts degree.

Robert B. Yadon

Director of Thesis

ABSTRACT

A MULTIPLE FORECASTING SYSTEM FOR THE
TELECOMMUNICATION INDUSTRY

By

Charles W. Holmes

The purpose of this study is to develop a computerized multiple forecasting system for use in the telecommunication industry. This quantitative tool is designed for both managers and potential investors who must prepare realistic projections of business activity.

Several different methods of time-series analysis are used in the program, each having strengths and weaknesses in handling various data sets. Any data set introduced into the system will follow a pattern or trend. The individual forecasting routines attempt to match the pattern and project it into the future. The forecasting method which comes closest in matching the pattern will provide the most accurate forecasts.

The system evaluates itself with built-in measures of accuracy for each method including variance, standard error and the number of residuals exceeding two standard deviations. The system then provides a method analysis using the mean square error for each routine in order to identify the method which provides the best set of forecasts.

ACKNOWLEDGEMENTS

This thesis would not have been completed without the encouragement and guidance of Dr. Robert E. Yadon. I would like to thank him for his support and most of all for his patience. I must also thank Linda Yadon for her hospitality and inspiring good nature. Without her graciousness, this task would certainly have been unbearable.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER I

INTRODUCTION AND STATEMENT OF PURPOSE

Introduction

Broadcast station acquisition involves many steps; the most critical entails the process of investment analysis. Because first time investors are generally inexperienced in the businesses of broadcasting, lack of specific skills and knowledge pertinent to the industry can severely compound their investment risk.[1] These potential station owners suffer the most from the absence of a comprehensive industry tool for evaluating purchase criteria.

Without proper financial insights, the neophyte buyer is at the mercy of the seller who has at least three years broadcast experience. In addition, the seller receives a differential advantage from media brokers who get a commission based on the selling price.[2]

Successful buying, therefore, lies in the preparation of a sound financial plan. Ideally, the plan will serve two purposes. First, future benefits of the purchase can be determined; investors need to assess both risk and earning potential when contemplating an acquisition. Second, financial forecasts are part of the prospectus used to obtain external capital. A thoughtfully prepared, concise proposal often makes the difference between securing a loan or being rejected.[3]

While broadcasting has become a lucrative venture that doesn't always require a great deal of starting capital, it is nevertheless, a volatile and high-risk business.[4] The complexity associated with broadcast acqusition is emphasized by the National Association of Broadcasters, who maintain that a broadcast station "is far from a traditional franchise type business."[5] Yet, the trade in radio stations, the usual outlet for the first time investor, is steadily increasing.

In 1979, 546 commercial stations changed hands for an average station price of $614,000. In 1975, only 363 stations were sold for an average price of $361,063.[6] Although small station investors have relied on banks and seller financing as a way of obtaining external capital, the increase in station trade combined with the increase in station price has strained the availability of traditional equity sources.

Financing options for broadcasters are further limited because of two other supply factors.

1. Accelerating inflationary factors, coupled with heightened uncertainty with respect to long-term funds markets have reduced availability of fixed rate seller-note financing.

2. Accelerating cost of funds coupled with record loan losses have substantially reduced regional bank availability of fixed rate term loan packages.[7]

The odds of obtaining suitable financing are greatly increased by having a complete, realistic, and professional presentation. Two major factors are considered by a lender in determining the degree of risk involved with a loan. First, a potential lender evaluates the borrower's ability to generate cash flow for repayment of principal and interest. Second, the potential lender appraises its own ability to recover principal in the event of default. Lenders, therefore, are primarily interested in operational results, both historical and projected, especially cash flow, after debt service.[8]

Thorough financial planning entails the anticipation of as many of the lender's objections as possible and resolving them in the proposal before they are raised.[9] The astute investor will spend considerable time supporting the projections with realistic assumptions. These accurate forecasts are essential; a borrower has nothing to gain by being overly conservative. At the same time, a borrower, by being too optimistic, will endanger loan opportunities.[10]

Statement of Purpose

This study attempts to develop and construct a forecasting tool for broadcast investors who, on their own, may not be able to prepare realistic projections of business activity.

Radio and television sales, for example, are influenced by supply and demand factors which will cause revenues to fluctuate by seasonal or cyclical trends.[11] These trends occur, not only because of limited inventory and seasonal demand, but also because of audience levels which are rarely constant throughout the year. For example, in Buffalo, New York the prime time TV viewing levels peak in February and drop to their lowest level in July.[12]

Since the determining factor in station profitability is management,[13] forecasting becomes a necessary tool because of the increased operational costs and the fact that the profit margin can be very susceptible to "variations in an increasing sales pattern."[14]

Table 1. Buffalo Viewership Trends

	Households Using Television (HUT) July 1982	November 1982	February 1983	May 1983
Monday-Friday 8-11 p.m.	43%	62%	66%	58%

SOURCE: Nielsen Station Index, "Buffalo, New York," Viewers in Profile, (Northbrook, IL, A.C. Nielsen Company, May 1983), p. 4.

Forecasting models must be able to provide management with realistic projections in the fact of uncertainty. This is especially important, and becomes complicated, because of the various trends associated with the financial elements in broadcasting.

Therefore, determining a station's financial value and its earnings ability forces an investor to rethink the basic soundness of an acquisition while supplying valuable financial material for potential lenders. Both prospective owners and financiers need a complete financial package used to make the requisite determination that a project has merit.

As an ancillary use, students studying the art of broadcast acquisition will have the opportunity to apply acquisition theories normally covered in formal "lecture" type instruction. Although this thesis will be geared to professionals, the student proficient in elementary managerial finance will find the concepts and principles easy to understand and follow.

The tool developed as part of this study, is a computer-based financial planning forecasting model. The program will strive to describe the dynamic behavior of a broadcast station in terms of its future financial health. It can then be used to test financial hypotheses about the property in question.

The power of simulation forecasting lies in its ability to predict the behavior of a system without disturbing normal operations. Through the use of forecasting, the prospective station owner is able to prepare projections of property performance. The validity of such an analysis is, of course, directly related to the accuracy of the forecasting model.

Scope of the Study

Although the basic financial principles used apply to all areas of the telecommunication industry, this study will focus on, and use as examples, only broadcast station properties. There are several reasons for this: first, the greatest number of transactions occur with radio.[15]

Second, the Federal Communication Commission's attempt to add more radio stations to the spectrum, combined with the push for low-power television, will create a greater supply of affordable broadcast outlets.

There are also some inherent limitations associated with this study. Due to the complex nature of broadcast acquisition, the model cannot be all inclusive. A station's financial forecast does not give an accurate indication of a market's (or station's) complete potential. Investors must also prepare a comprehensive market analysis. In some situations the market analysis should be prepared before the station financial analysis.[16]

A potential investor must consider market variables such as: total advertising dollars, total retail sales, consumer spendable dollars, media competition and industrial stability. The inability of the proposed study to accommodate a subjective station analysis is another limitation of this study. The prospective owner must decide if a format needs changing or if personnel should be replaced. Affiliation and other contracts have to be evaluated along with the physical station property. Major replacement costs may be incurred causing a disruption in the financial plan.

Although no program can take the place of thorough acquisition planning, this simulation model will alleviate some of the financial uncertainties. It will help investors answer questions about a station's earning potential and give them help in determining the proper structure for financing.

Reviewing a station's present standing is only part of the investment analysis. Prudent investors need to develop long-range financial plans and goals. Many troubles associated with financing and profitability reflect poor and/or inappropriate preparation. The blame, however, cannot lie solely with the investor inexperienced in station acquisition. Without a tool for broadcast investment analysis, they may not be able to avoid the financial pitfalls encountered when buying a station.[17]

CHAPTER I--NOTES

[1] Ward L. Quaal and James A. Brown, Broadcast Management, 2nd ed. (New York: Hastings House Publishers, 1976), p. 281.

[2] Stephen J. Sansweet, "How to Buy Your Own Radio Station," The Green Pages (1978), pp. 54-55.

[3] National Association of Broadcasters, Purchasing a Broadcast Station: A Buyer's Guide (Washington: National Association of Broadcasters, 1978), p. 12.

[4] Kay D. Ingle, "Radio Entrepreneurs Fill the Airways," Venture (1979), pp. 62-63.

[5] National Association of Broadcasters, Purchasing a Broadcast Station: A Buyer's Guide, (May 1978), p. 2.

[6] Barry J. Dickstein, "'True' Station Value is Key Ingredient in Broadcast Financing," Broadcast Financial Journal 10 (March 1981), p. 16.

[7] Ibid.

[8] National Association of Broadcasters, Purchasing a Broadcast Station: A Buyer's Guide, (May 1978), p. 12.

[9] Lee Hague, "Acquisition Financing: An Overview Update," Broadcast Financial Journal, 8 (March 1979), p. 21.

10 Ibid.

11 Robert E. Yadon, "Application of Forecasting Techniques to the Telecommunication Industry," (Department of Telecommunication, College of Communication Arts and Sciences, Michigan State University, East Lansing, MI, 1980), p. 7.

12 Nielsen Station Index, "Buffalo, New York," Viewers in Profile, (Northbrook, IL, A.C. Nielsen Company, May 1983), p. 4.

13 Ward L. Quaal and James A. Brown, Broadcast Management, p. 293.

14 Ibid., p. 304.

15 C. David Ungruhe, "A Comparative Analysis of the Communications Media," Valuation Reporter (First Quarter, 1979).

16 National Association of Broadcasters, Purchasing a Broadcast Station: A Buyer's Guide, p. 36.

17 Harold Poole, "What's Your Station Worth?" Broadcast Financial Journal, 8 (March 1979), pp. 10-12.

CHAPTER II

REVIEW OF LITERATURE

The massive amount of work done in corporate modeling concerns the ongoing dynamics of the firm, not acquisition financing. It should be noted that there is a long history of both simulation modeling in general and forecasting simulation in particular, especially since the advent and widespread use of the digital computer.[1] An examination of corporate and financial models as well as articles relating to telecommunication acquisition suggest that the application of simulation technology to telecommunication investment analysis is appropriate and desirable, yet often lacks a comprehensive method of accurately projecting such items as revenues, which are an integral part of acquisition financing.

This chapter begins with a review of various discussions relating to the role and application of forecasting simulation in business. The chapter concludes with a broader discussion of telecommunication acquisition models which provide insight into the decision making process involved in acquisition financing. After reviewing these models it becomes evident that what they lack is a quantitative forecasting component which reflects the ongoing dynamics of various financial elements.

Forecasting Simulation

Makridakis and Wheelwright suggest that the major role of forecasting "is to aid in assessing various future alternatives and the levels of risk and return that are associated with each of them, so that managers can effectively address this dilemma."[2] The authors also stress that forecasting is not just a statistical technique, but an integral part of sociology, politics, economics and psychology.

A simple framework has been proposed to categorize forecasting possibilities to help managers develop guidelines and act as a reference point for planning applications.[3]

Table 2. Forecasting Possibilities

	Implicit	Explicit
Intuitive	Estimating the sales of Product A for the coming month in an intuitive, ad hoc manner.	Using a monthly meeting of senior management to develop forecasts for Product A for the next month.
Formal	Predicting the sales of Product A for the coming month using a statistical forecasting method.	Obtaining monthly forecasts for each major product group on a specified date for use in production planning.

SOURCE: Spyros Makridakis and Steven C. Wheelwright, The Handbook of Forecasting: A Manager's Guide (New York: John Wiley & Sons, 1982), p. 5.

"Intuitive" forecasting consists of internal processes to planners with regard to subjective and judgemental estimating procedures. "Formal" methods, on the other hand, may be slightly more accurate than intuitive procedures. Formal methods can be written down and provide similar results regardless of the user.

The "implicit" column refers to forecasts which are not part of plans or decisions being made. This is true even for formal procedures which would not be part of specific plans or actions. Conversely, "explicit" forecasting methods attempt to clearly define the value of the forecast and use it in the decision making process.[4]

Makridakis and Wheelwright emphasize that forecasting procedures usually begin on the intuitive and implicit level then move toward formal explicit techniques. This systematic approach often leads to "significant improvement in forecasting performance" which allows decision makers to better understand future uncertainties and evaluate the associated levels of risk.[5]

Forecasting Procedures

A discussion of the selection of proper forecasting procedures is provided by Fildes who proposes that forecasting choices are based on a broad range of considerations:

1. Prior Beliefs of the Forecaster--The forecaster is likely to be influenced by past experiences and related research with which the forecaster feels comfortable.

2. How the Forecast is to be Used--The methods employed will be directed toward an expected goal.

3. Complexity and Comprehensiveness--When the model is too complicated it probably won't be used because it won't be understood. However, the model must include all pertinent elements or the forecast will not accomplish required goals.

4. Comprehensive Testing--Several parallel models ought to be

developed and used to test the primary model's performance.[6]

Fildes breaks down the methods of forecasting into three broad classes:

> The judgmental--where individual opinions are processed, perhaps in a complicated fashion.
>
> The extrapolative--where forecasts are made for a particular variable using only that variable's past history. The patterns identified in the past are assumed to hold over to the future.
>
> The causal (or structural)--where an attempt is made to identify relationships between variables that have held in the past, for example, volume of brand sales and that product's relative price. The relationships are then assumed to hold into the future.[7]

Most techniques use more than just one of the above approaches, while most models tend to include parts of all these methods.

More specifically, Hanke and Reitsch list four basic steps in developing a forecasting procedure:

1. Data collection
2. Data reduction or condensation
3. Model building
4. Model extrapolation (the actual forecast)[8]

Although these steps are geared to statistical methods of forecasting, Hanke and Reitsch do not diminish the importance of intuitive methods for predicting the future in an attempt to reduce risk and uncertainty. They propose that quantitative techniques should supplement the "gut" feelings, common sense, and management ability of decision makers.

Forecasting, then, is useful if it reduces uncertainty while resulting in informed decisions that have increased value over and above the cost required to produce the forecast.[9]

Sullivan and Claycombe sum up forecasting as:

> "A blend of science and art that defies precise definition for a successful application. Preparation of a forecast entails more than just using historical data and mathematical formulas to project into the future. The key to realistic forecasting is the inclusion of informed judgement and intuition into the methodological framework being employed in order to minimize uncertainty associated with the future development, or event, in question."[10]

Telecommunication Acquisition Models

Chapman and Associates, a national media brokerage firm, currently uses a computer program for broadcast station investment analysis. The program is lauded by Chapman as a time saving device giving the brokers and investors pertinent financial data along with projections of financial activity.[11]

The program utilizes nine financial variables in the calculations. They are: income, expense, profit or loss, loan principal payment, loan interest payment, leverage factors, the depreciation schedule, covenants not to compete, and the appreciation factor. The program makes financial assumptions about each variable and takes into account the variable's effect on each other. The naive financial assumptions used are based on static percentages. For example, the fixed expenses may be set to increase by six percent over a ten-year pro forma period, while the sales figure automatically increases by nine percent. This shows growth occurring in an exponential manner year to year when, in fact, this growth should be linear. Month to month or quarter to quarter variables, on the other hand, usually change exponentially.

The output from the program includes a pro forma profit and loss statement, a ten-year cash flow analysis, a return on investment analysis which incorporates an analysis of return on down payment, return on total payments, and a return on purchase price. The broker or analyst takes the outputs and evaluates them with the client to determine if the results fall into line with the goals and needs of the investor.

There are several advantages to the Chapman model. The most obvious is the freedom to utilize the buyer's preference for a certain type of investment analysis. For example, the program can accommodate the buyer who wants to consider the purchase in terms of a multiple of cash flow, a "time-gross" formula, or a return on investment analysis.

Like the "TEEM" model to be discussed, the Chapman program relies on the insights and experience of the broker to evaluate the results of the financial analysts. A significant problem with the program is its reliance on a set percentage rate to estimate growth. There is no allowance for seasonal trends or more cyclical variations such as the quadrennial effect associated with the broadcast industry (a jump in revenue every four years due to the national elections and Olympics). The article does not discuss the basis of the financial assumptions. How were they derived? How reliable are they? How are the changes and shifts in the marketplace evaluated? Additional methods, like risk and ratio analysis are also missing from the Chapman program.

Another non-computerized method for valuing a station is used by analyst David Schutz. Schutz emphasizes profitability as the key factor in station valuation.[12] The prices paid for a station, according to Schutz reflect the future earnings that they will likely generate.

The difficulty for the buyer is in the determination of the future earnings.

An extensive market analysis is used to aid in the determination of station value. The variables which are part of the market analysis include the total market advertising revenues, disposable income, total retail sales, and advertising competition. The buyer is advised to ascertain the vitality of the market which should reflect the potential of the station in question.

The most interesting component of the Schutz analysis is the subjective evaluation of the station and a comparison of theoretical versus actual audience share. The variables used in this mathematical evaluation of theoretical (or potential) share are based on such factors as power, frequency, and hours of operation. Schutz uses a hypothetical market to illustrate the method of obtaining the theoretical share (Table 3).

A comparison can then be made between actual and theoretical shares to see if the station is performing "better" or "worse" than technical conditions suggest it "should" (Table 4). Schutz estimates that if a station is within 20 percent of its theoretical share, it is considered normal."[14]

This kind of analysis is beneficial to a potential owner who is then able to look at a station with a poor actual share (compared to the theoretical share) and determine if the problem is indicative of poor management. Likewise a station might be doing better than it should indicating that little can be done in the way of improvement.

This idea of earning potential and sound management is discussed by Schutz in the close of the article.

Table 3. Listing and Ranking of Radio Stations in Hypothetical Market[13]

Station	Frequency (KHz/MHz)	Power (watts)[1] Day	Night	Power[2]	Frequency[3]	Hours of Operation[4]	Total Points	Share[5]
A	620	1,000	-0-	1	1.3	.5	2.8	12%
B	1500	10,000	1,000	3	.8	1.0	4.8	20%
WDES	1230	1,000	250	1	.9	1.0	2.9	12%
C	103.7	12,000	12,000	3	1.0	1.0	5.0	21%
D	94.3	3,000	3,000	2	1.0	1.0	4.0	17%
E	96.7	3,000	3,000	2	1.0	1.0	4.0	17%
						Total Points	23.5	

[1] In the case of FM stations antenna height has not been given separate treatment since it was considered "normal" for stations of the respective classes.

[2] Computed on the basis of $\sqrt{(\text{station power}/1{,}000)}$ and rounded to nearest whole number.

[3] Applied to AM stations only on the basis $\sqrt{(1060/\text{station freq. in KHz})}$. FM stations receive 1.0.

[4] Daytime stations receive .5 while stations with unlimited hours receive 1.0.

[5] Shares do not total 100 percent due to rounding.

SOURCE: David E. Schutz, "Is That Station Really a Bargain," Broadcast Management/Engineering, 14 (July 1978), p. 84.

Table 4. Comparison Between Audience Shares and Theoretical Shares

	Net Weekly Circulation[1]	Audience Share	Theoretical Share[2]
A	31,300	13%	12%
B	60,100	25%	20%
WDES	26,500	11%	12%
D	45,700	19%	21%
E	38,400	16%	17%
F	38,500	16%	17%
Total	240,500	100%	

[1] In place of Net Weekly Circulation, Average Quarter Hour Audience (6:00 a.m.-midnight, Mon.-Sun.) could be used.

[2] From Table 3.

SOURCE: David E. Schutz, "Is That Station Really a Bargain," Broadcast Management/Engineering, 14 (July 1978), p. 84.

> Your success as a station owner will not be determined solely by your ability to acquire a station at a low price. Instead it will be determined by your ability to run your station efficiently and effectively.[15]

The final telecommunication acquisition model considered here was developed by Wagner, Akutagawa, and Cuneo (1969). The Telecommunications Earning Estimation Model (TEEM) was designed for the Security Analysts of Wells Fargo Bank. TEEM is a probabilistic model used to derive an earnings estimate for a company by means of simulation. The model was built to assist an operating analyst in simulating the expected financial behavior of one company at a time, one year at a time.[16]

The operating income statement and the funds flow statement provide the framework over which TEEM operates. The analyst, not the model, is responsible for the accuracy of the financial estimates used in the calculations. The analyst has the option of accepting a system-generated estimate of earnings, or the analyst can replace it with one he or she has generated. In other words, the estimates used in the model are only advisory to the analyst.

The output of the program includes standard financial statements with a built-in probability distribution expressed as "Pessimistic," "Most Likely," and "Optimistic." The range is arbitrarily set at two standard deviations from the "Most Likely" parameter.

TEEM is not applicable to this paper because it cannot be used as a training tool for inexperienced investors. It relies too heavily on the implicit knowledge of a seasoned analyst who makes similar investment decisions as part of everyday business. What TEEM did was to speed-up the process of investment analysis. The program did not give the analyst any new information and was weak in the sense that the analyst had the option of overriding most variable assumptions. These shortcomings were so prevalent, that the authors considered TEEM somewhat of a failure. Although it was introduced to over 100 analysts, no one elected to use it.[17]

To investigate the reasons for its failure, the authors studied the reliability of the model. Their study showed that the model did not outperform the estimates of the analysts, the very people it was designed to help.

CHAPTER II--NOTES

[1] Robert C . Meier, William T. Newell, and Harold L. Pazer, *Simulation in Business and Economics* (Englewood Cliffs, New Jersey: Prentice Hall, Inc., 1969), p. 1.

[2] Spyros Makridakis and Steven C. Wheelwright, *The Handbook of Forecasting: A Manager's Guide* (New York: John Wiley & Sons, 1982), p. 7.

[3] Ibid., p. 5

[4] Ibid.

[5] Ibid.

[6] Robert Fildes, "Forecasting: The Issues," *The Handbook of Forecasting: A Manager's Guide*, ed. Spyros Makridakis and Steven C. Wheelwright (New York: John Wiley & Sons, 1982), pp. 89-90.

[7] Ibid., p. 92.

[8] John E. Hanke and Arthur G. Reitsch, *Business Forecasting* (Boston, MA: Allyn and Bacon, Inc., 1981), p. 4.

[9] William G. Sullivan and W. Wayne Claycombe, *Fundamentals of Forecasting* (Reston, VA: Reston Publishing Company, Inc., 1977), p. 2.

[10] Ibid., pp. 1-2.

11
Chapman & Associates, "Using a Computer for Investment Analysis," Broadcast Financial Journal 7 (January 1978).

12
David E. Schutz, "Is That Station Really a Bargain?," Broadcast Management/Engineering, 14 (July 1978), p. 82.

13
Ibid., p. 87.

14
David E. Schutz, "Is That Station Really a Bargain?, Part II." Broadcast Management/Engineering 14 (August 1978), p. 86.

15
Ibid., p. 38.

16
Albert N. Schrieber, ed., Corporate Simulation Models (Seattle, WA: University of Washington, 1970), pp. 396-399.

17
Ibid., p. 416.

CHAPTER III

FORECASTING METHODOLOGY

Introduction

Successful buying of telecommunication properties, as stated in Chapter I, lies in the preparation of a sound financial plan. The plan will determine possible future benefits of the purchase and secondly, financial forecasts are used in the prospectus required by lending institutions.

This chapter will explore methods of financial forecasting which, when used by potential investors, should provide projections of earning ability. These predictions of future events can be obtained by discovering patterns of events in the past.[1]

Forecasting Defined

Having the ability to make decisions based on information which predicts uncontrollable business events should give management an improved choice of options while attempting to reduce risk. Forecasting is the prediction of future events with the intent of reducing the risk involved in decision making. While usually wrong, the information from the forecasting process is used to improve the decision making process.[2]

There are basically two types of forecasting. The first involves "qualitative" estimations of future events. This subjective method relies on the opinions of experts who use various tools such as marketing tests, customer surveys, sales force estimates and historical data. Decisions are based on "opinions."[3]

The second basic type of forecasting revolves around "quantitative" methods which use procedures that explicitly define how the forecast is determined. The operations are mathematical in nature with the logic clearly stated. Quantitative forecasting examines historical data to determine the underlying process generating the values of each variable and, assuming this process follows some stable pattern, using the information to extrapolate the process into the future.[4]

Although business decisions must be based on both qualitative and quantitative information, this study is the formulation of an analytical tool for potential investors through the use of a computer which relies on quantitative data. Therefore, only statistical forecasting procedures will be explored.

Forecasting Components

Patterns

Operational variables such as revenues and expenses change over time and follow some sort of pattern. All forecasting methods assume that a pattern or relationship exists which can be uncovered, identified and used as the basis for preparing a forecast. An effective forecasting procedure depends on matching a pattern with a particular technique that can handle and project that pattern into the future.[5]

There are four common patterns that are considered the most important. These patterns can be found alone or in combination. The first basic pattern is "horizontal" or "stationary" in nature and does not increase or decrease in any systematic way (Figure 3-1). The average mean value of the data remains constant. On the other hand, a "seasonal" pattern exists where a series of values fluctuate according to some seasonal factor or factors (Figure 3-2). Lawn mower sales is an example of a seasonal series. A "cyclical" pattern is very similar to a seasonal pattern but the length of the cycle is generally longer than one year (Figure 3-3). This particular type of fluctuation is often the most difficult to predict because it doesn't repeat itself at constant invervals of time. Finally, when there is a general increase or decrease in a value over time, the fluctuation follows a "trend" pattern (Figure 3-4).[6]

Time Elements

Forecasting patterns involve the mapping of some variable over time. When used in forecasting, the variable time consists of three separate elements. The first is the basic unit of time for which the forecasts are made called the forecast "period." The period can be a week, month, quarter, year, or whatever length of time makes sense to the problem at hand. The forecasting "horizon" is the length of time (or "lead-time") in the future for which the forecast is made. The forecast could be done for a year broken down by months. In this case, the period is a month and the horizon is a year. Finally,

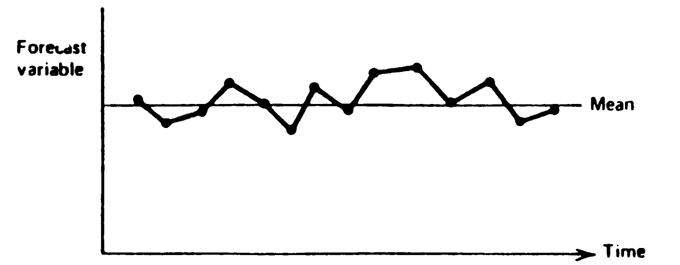

Figure 3-1. Horizontal Data Pattern

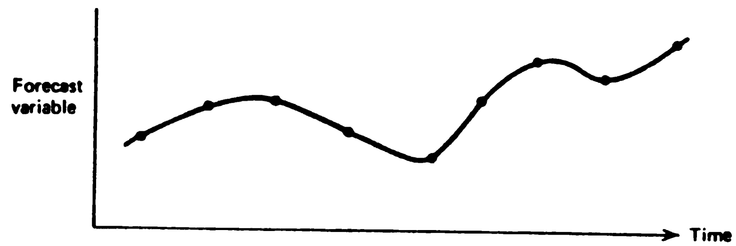

Figure 3-3. Cyclical Data Pattern

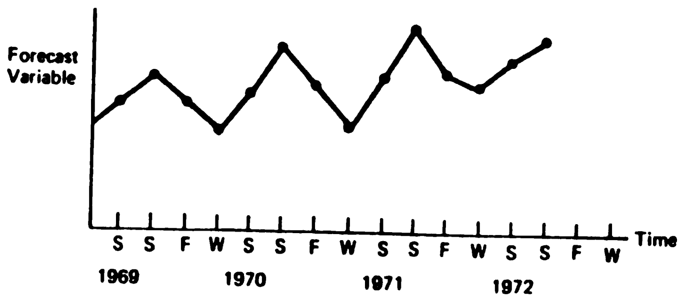

Figure 3-2. Seasonal Data Pattern

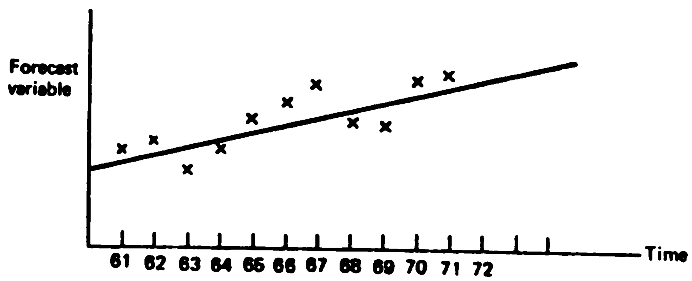

Figure 3-4. Trend Data Pattern

the period over which each new forecast is prepared, is called the forecast "interval." The forecast interval is often the same as the period which means the forecast is revised each period using the most current data point to update the forecast.[7]

When the forecast is revised each period and the horizon or lead-time remains constant, the forecast is operating on a "moving horizon" basis. For example, if the problem involves forecasting monthly sales for the next year on a continual basis, the period and interval would be a month and the moving horizon would be a year. So as each month's data is received, the lead-time is moved ahead by 12 months. The forecast usually becomes less accurate when the forecast lead-time is increased. In other words, the shorter the lead-time, the quicker the forecast model can react to error.[8]

Forecasting Methods

Forecasting systems use both quantitative and qualitative methods of analysis. The statistical methods lend objectivity to the system and quantify historical trends. Forecasts done by statistical methods become another piece of information used by financial managers prior to making decisions.[9]

Montgomery and Johnson list eight factors which contribute to the selection of appropriate forecasting methods:

1. Form of forecast required.
2. Forecast horizon, period, and interval.
3. Data availability.
4. Accuracy required.
5. Behavior of process being forecast (demand pattern).
6. Cost of development, installation, and operation.

7. Ease of operation.[10]
8. Management comprehension and cooperation.

Since this study concentrates on the quantitative methods of forecasting, qualitative considerations will not be discussed. First, a brief description of general forecasting models will be presented followed by a discussion of several common interactive forecasting methods which range from the basic regression methods through the more complex exponential smoothing methods including Winters' Method which takes into account seasonal trends.

Forecasting Models

There are two basic models used in forecasting: "time-series" and "causal" models. Very simply, a time-series is a time ordered sequence of observations of a variable. A time-series analysis uses values of a variable over time in order to develop a model for predicting the future such as revenues over months of a year.[11]

Causal models examine the relationship of the primary variable and other time-series. An example of a causal model would be the correlation of revenues with share of audience. There are two limitations to the use of causal models. First, the independent variable, in this case share of audience, must be known at the time of forecasting revenues. Since the share of audience cannot be explicitly known in advance, the entire projection for revenue is tainted. The second drawback to the use of causal models involves the complex nature of the forecast in terms of the amount of computation and data handling.[12] Therefore, this study will concentrate on the various methods of time-series analysis that have a direct application to broadcasting.

Regression

Simple regression utilizes the "line of best fit" by plotting the dependent variable, say revenues, over the independent variable time and drawing a straight line through the middle of the data points.[13] The object of regression is to arrive at an equation for the line through the data which minimizes the squared differences between the line and the actual data.[14] In this method the key variable (revenue) is directly dependent upon the independent variable (time). Simply put, the variable revenues increases or decreases at the same rate every period.

The equation for simple regression is:[15]

$$Y = A + B * Y \qquad (1)$$

Where: A--is the "Y intercept" which is the value of the line when X = 0.

B--is the regression coefficient and indicates how much the value of Y changes when the value of X changes one unit. B is also called the "slope" of the line.

Y--is the dependent variable for which the equation is being solved.

X--is the independent variable (time).

A and B are the "parameters" of the equation and must be solved for by using the method of least squares in such a way that the sum of squared errors is minimized. In other words, the deviations above the "line" will exactly offset the deviations below the "line."[16]

$$B = \frac{N*\Sigma XY - X*\Sigma Y}{N*\Sigma X^2 - (\Sigma X)^2} \tag{2}$$

$$A = \frac{\Sigma Y}{N} - \frac{B*\Sigma X}{N} \tag{3}$$

Where: N--is the number of data points.

The most obvious disadvantage to the use of regression analysis in forecasting is the fact that not all data points fall on the regression line and the data points may take the form of a cyclical or seasonal pattern which is not accounted for by using linear regression methods.[17] Another disadvantage to the use of regression forecasts is that the forecast cannot be updated when new data points become available. If new estimates for the parmeters are needed, an entire new set of data points must be used.[18]

Simple Moving Averages

In general, moving average techniques attempt to eliminate randomness in a time-series. The goal is to distinguish between the random fluctuations and the basic underlying pattern in the historical data. This objective is achieved by averaging ("smoothing") the historical values in order to eliminate the extreme values in the sequence. The forecast is then based on the smoothed value.[19]

The technique of "simple (or single) moving averages" takes a set of historical values, finding their average and then using that average as the forecast for the upcoming period. The number of data points used in the averaging procedure (N) is determined by the operator and remains constant.[20] Since the key variable to be forecast can change slowly over time, it would make sense that the more recent observations in the historical trend should hold more weight than observations in the distant past. Because of this, only the most current data points might be used allowing the model to react to data shifts. This is where the "moving" concept comes into play. As each new data point becomes available, the oldest is discarded.

The formula for an N-period simple moving average is:[21]

$$S_t = \frac{X_{t-1} + X_{t-2} + \cdots + X_{t-N}}{N} \qquad (4)$$

Where: S_t--is the forecast for period t.

X_t--is the actual value at period t.

N--is the number of values used in the average.

Since the formula averages only the last N values, if N is increased the model is less sensitive to variations and takes longer to adjust to data shifts. Conversely, a small N reacts quickly to change but may force the model to react to random variations which are not part of the underlying data pattern.[22]

Double Moving Averages

For data with a linear or quadratic trend the single moving average procedure would produce misleading forecasts because the projection would "lag" behind the data shifts. To correct for this lag, a "double moving average" is used.[23] The double moving average is simply the average of the single moving average. The double moving average treats the single moving average as a single data point.

The formula for an N-period double moving average is:[24]

$$M_t|2| = \frac{M_t^{|1|} + M_{t-1}^{|1|} + \ldots + M_{t-N+1}^{|1|}}{N} \tag{5}$$

Note: The |2| refers to double moving average, not the squared value. Likewise the |1| is the single moving average.

The forecast equation is then:

$$Y_{t+X} = A_t + B_t * X \text{ (This is the regression equation)} \tag{6}$$

Where:

$$A_t = 2M_t^{|1|} - M_t^{|2|} \tag{7}$$

$$B_t = \left(\frac{2}{N-1}\right) * (M_t^{|1|} - M_t^{|2|}) \tag{8}$$

The primary advantage of moving average techniques over regression is that the forecast can be quickly revised with a smaller number of calculations as each new data point is received. Secondly, this procedure allows the forecaster to place more weight on current data rather than treating all data with equal importance. This also minimizes data storage since only the most recent N values are used in the averaging.[25]

There are, however, disadvantages to moving average forecasting procedures. These have to do with the basic premise of the techniques, which assumes that the trends and patterns will continue into the future. An erratic data point which breaks the norm could be the start of a new shift in the data or it could be a "freak" value that would throw the entire forecast off balance.

Another limitation to moving averages is that the technique gives equal weight to each of the last N observations. No weight is given to the discarded values. While it is preferable to weight the current values more heavily, it may not be advantageous to completely disregard past observations.[26] The next section addresses this problem by describing techniques which focus attention on recent values without ignoring past data points.

Single Exponential Smoothing

Developed within the past 25 years, exponential smoothing techniques have become popular due to their simplicity, computational efficiency, reasonable accurateness, and the fact that they require only a few data points to produce forecasts.[27] Like averaging techniques, smoothing procedures can be used for simple linear trends with more random or seasonal trends.

"Single exponential smoothing" is based on averaging (smoothing) past data points in a decreasing (exponential) manner.[28] The new estimate is obtained by modifying the old estimate by some fraction of the forecast error which results from the previous estimate. In other words, the error between the actual and the forecasted value for the current period is used for correcting the forecast for the upcoming period. The fraction used in the correction is generally denoted by the Greek letter Alpha (α), called the "smoothing constant."

The general formula for single exponential smoothing is:[29]

$$S_{t+1} = \alpha X_t + (1-\alpha)S_t \tag{9}$$

Where: S_t--is the exponentially smoothed value in period t.

α--is the smoothing contant.

X_t--is the actual value at period t.

If the equation for S_t is expanded by substituting the equation for S_t, the equation then becomes:

$$\begin{aligned} S_{t+1} &= \alpha X_t + (1-\alpha)\ (\alpha X_{t-1} + (1-\alpha)\ S_{t-1}) \\ &= \alpha X_t + \alpha(1-\alpha)\ X_{t-1} + (1-\alpha)^2\ S_{t-1} \end{aligned} \tag{10}$$

When the new equation includes the formula for S_{t-1} the above equation becomes:

$$S_{t+1} = \alpha X_t + (1-\alpha)\ X_{t-1} + \alpha(1-\alpha)^2\ X_{t-2} + \alpha(1-\alpha)^3\ X_{t-3} + \ldots$$

and so on ... (11)

The above equation shows that decreasing weights are given to older observations. Another form of the equation is:

$$S_{t+1} = S_t + \alpha(X_t - S_t) \tag{12}$$

This formula is simply the old forecast S_t plus α times the error $(X_t - S_t)$. Montgomery and Johnson refer to this equation in their definition of moving averages which is: "a procedure that adjusts the smoothed statistic by an amount that is proportional to the most recent forecast error."[30]

Double Exponential Smoothing

In the same way that the single moving average technique showed signs of "lag," the single exponential smoothing model also lags behind the true value when forecasting a linear trend.[31] The double exponential smoothing model is completely analogous to double moving averages in that we can add to the single exponential smoothing value the difference between this value and the double exponential smoothing value and then adjust for the trend:[32]

$$\text{A)}\quad S_t^{|1|} = \alpha X_t + (1-\alpha)\, S_{t-1}^{|1|} \tag{13}$$

$$\text{B)}\quad S_t^{|2|} = \alpha S_t^{|1|} + (1-\alpha)\, S_{t-1}^{|2|} \tag{14}$$

Like double moving averages, the forecast for double exponential smoothing is:

$$S_{t+X} = A_t + B_t\, X \tag{15}$$

$$A_t = 2S_t^{|1|} - S_t^{|2|} \tag{16}$$

$$B_t = \frac{\alpha}{1-\alpha}\left(S_t^{|1|} - S_t^{|2|}\right) \tag{17}$$

Note: |2| refers to second order exponential smoothing, not the squared value.

Where: α--is the smoothing constant.

X--is the number of periods ahead to be forecasted.

Double exponential smoothing can handle a trend pattern better than single exponential smoothing because it reacts more quickly to the shift in the data values. The forecast follows the trend more closely and eliminates the problems with lag.

<u>Triple Exponential Smoothing</u>

If the underlying pattern of the data is curved rather than linear, the double exponential smoothing technique becomes inadequate.[33] Exponential smoothing can be expanded to estimate coefficients in polynomials of any degree. Triple exponential smoothing techniques carry the general formulas into the next higher polynomial. The formula for triple exponential smoothing and the resulting forecast are:[34]

$$S_t^{|3|} = \alpha S_t^{|2|} + (1-\alpha)\, S_{t-1}^{|3|} \tag{18}$$

$$Y_{t+X} = A_t + B_t X = C_t X^2 \tag{19}$$

$$A_t = 3S_t^{|1|} - 3S_t^{|2|} + S_t^{|3|} \tag{20}$$

$$B_t = \frac{\alpha}{2(1-\alpha)^2} \left((6-5\alpha)S_t^{|1|} - 2\,(5-4\alpha)S_t^{|2|} + (4-3\alpha)S_t^{|3|}\right) \tag{21}$$

$$C_t = \frac{\alpha^2}{(1-\alpha)^2} \left(S_t^{|1|} - 2S_t^{|2|} + S_t^{|3|}\right) \tag{22}$$

Note: |2| and |3| refer to the second and third order exponential smoothing not squared or cubed values.

As mentioned, the exponential smoothing procedures are often more desirable than moving averages because they only require a few data points to generate a forecast while the moving averages require the storage and handling of N data points. Secondly, the exponential smoothing models do not "discard" older values, they just give less weight to observations in the past.

Before moving to more advanced forecasting models, two concepts should be addressed which are integral parts of exponential smoothing procedures. They are model initialization and the choice of an appropriate smoothing constant.

Model Initialization

Initial values are needed for all types of exponential smoothing. The number and type of initial values depends on the type of smoothing employed. The need for initialization arises only when smoothing is used for the first time. Even then, the problem is more theoretical than real.[35]

The reason for initialization can be seen by examining the smoothing formula:

$$S_{t+1} = \alpha X_t + (1-\alpha)S_t \tag{23}$$

Where: X_t--is the most recent value.

S_t--is the latest forecast.

S_{t+1}--is the forecast for the next period.

When T = 1:

$$S_2 = \alpha X_1 + (1-\alpha)S_1$$

In order to solve for S_2, S_1 must be known. The value of S_1 should have been $S_1 = \alpha X_0 + (1-\alpha)S_0$. It can be seen that X_0 does not exist and S_0 cannot be found. In other words, S_1 must be supplied in order to solve for S_2. The problem arises in that S_1 cannot be found in the data.[36]

Makridakis and Wheelwright suggest three approaches to arrive at initialized values, assuming past data exists. First, the forecaster could separate the data into two parts using the first to estimate the initial values and the second to estimate and check optimal parameter values. A second approach involves the technique of back forecasting. This approach inverts the data and starts the estimating procedure from the most recent value and ending with the oldest value. What this does is provide parameter values and/or forecasts for the beginning of the data. These are then used as the initialized values when the data is forecast in a normal (beginning to end) sequence.

Finally, the least squares method can be used. For instance, in single exponential smoothing, S_1 can be found by averaging the past N observations. For linear forms of exponential smoothing, A_1 and B_1 can be found by using the straight line equation to obtain A_1 (the intercept) and B_1 (the slope) and using these as the starting parameter values.[37]

When there are no past values, the forecaster can either wait for data points or arbitrarily specify the initial values based on common sense. Another arbitrary way of assigning a value to S_1 is to make it equal to X_1 and then start the forecasting.[38]

Choice of a Smoothing Constant

The selection of the appropriate smoothing constant along with the choice of the proper smoothing technique are the two most critical decisions made by the forecaster. These decisions will determine whether the forecasting process is a success or failure. The smoothing constant (α) is critical because it is the control factor in determining the number of past observations that influence the forecast. Small values result in a slow response to data shifts because significant weight is given to many past observations. Conversely, the larger constant gives weight only to the most recent values which causes the system to react more rapidly to shifts in the data.[39]

A rule of thumb is to have the constant fall between 0.01 and 0.30.[40] In general, if the underlying data pattern seems to remain fairly constant, a small α should be used. Likewise, frequent and dramatic shifts in the data ought to be handled by using a larger smoothing constant so the model can react quickly to the changes. This, however, is precisely why the forecaster should proceed with caution in choosing the constant. A too small value for the smoothing constant prevents the model from responding quickly to a shift in the underlying pattern. Yet, a constant that reacts very quickly could respond to a random observation which is not indicative of the basic pattern.[41]

Although there is really no explicit rule for arriving at an appropriate constant, several approaches can aid the forecaster in making an educated choice. One such approach is to arrive at a smoothing constant which will give similar results found in moving averages. The formula is:[42]

$$\alpha = \frac{2}{N+1}$$

Where: N--is the same number of data points used in moving averages.

Another technique would be to go through several iterations using different constants in the exponential smoothing formula and making a measure of effectiveness such as minimum sum of squared errors. Alternatively, if there are 36 data points available, a forecast could be done using a particular constant on the first 24 observations and comparing the results to the actual values in periods 25 through 36.

Winters' Method of Exponential Smoothing

Many data sets, such as beer sales, broadcast revenues, or toy sales can exhibit seasonal influences in addition to linear trends. The previously mentioned exponential smoothing procedures control for randomness and adjust for trends but they do not take into account seasonality. Winters' Method is similar to double or triple exponential smoothing but includes an additional parameter which adjusts for seasonal shifts in the data.[43]

There are four basic equations needed to arrive at a forecast using Winters' Method:[44]

1. Estimate the current intercept:

$$A_t = \alpha\left(\frac{X_t}{F_{t-n}}\right) + (1-\alpha)\ (A_{t-1} + B_{t-1}) \tag{24}$$

2. Estimate the slope:

$$B_t = \beta(A_t - A_{t-1}) + (1-\beta)\ B_{t-1} \tag{25}$$

3. Solve for the updated seasonal factor:

$$F_t = \sigma\left(\frac{X_t}{A_t}\right) + (1-\sigma)\ F_{t-N} \tag{26}$$

4. Forecast for T periods ahead:

$$Y_{t+T} = (A_t + B_t T)\ F \tag{27}$$

Where: X_t--is the observation at period t.

A_t--is the estimate of the intercept of the trend line at t.

B_t--is the estimate of the slope of the trend line at t.

N -- is the number of observations comprising periodicity of the data.

F_t--is the estimate of the multiplicative seasonal factor at period t.

F_{t-N}--is the estimate of the seasonal factor N periods in the past.

F -- is used to denote the best estimate of the seasonal factor in period t+T.

α,β,σ--are the smoothing constants.

The values for the smoothing constants in Winters' Method are arrived at in the same general manner as α was in exponential smoothing. However, with three constants, which can be used in many different combinations, the task of arriving at optimum values is far more difficult. The iterative process of forming different combinations of α, β and σ would be computationally exhausting and near impossible to do without the aid of an optimizing routine in a computer forecasting model. Without such an aid the forecaster is forced to arbitrarily assign values that lie between 0.01 and 0.30 as was done in exponential smoothing.

Box-Jenkins

There are other forecasting models beside the ones previously mentioned which are useful in particular situations. One such method is the Box-Jenkins approach to time-series analysis which is a powerful tool for providing accurate short-range forecasts. The methods and formulas which are part of the Box-Jenkins procedure are far too complicated to be included in this study. More importantly this method, which combines the strengths of autoregressive models with moving average techniques, has several drawbacks.

First, a large amount of data is required to complete the computations. For instance, at least 72 data points are needed to forecast seasonal data in a 12-month horizon. The model works best with many observations over a short period such as daily stock prices. Secondly, there is no easy way to update the model with new data, which is a strength of smoothing methods. The model must be completely refitted with the new data in order to update the forecast. This makes the cost of operating the model prohibitive. Finally, the methodology is more difficult to understand and the results are more difficult to comprehend than in other methods.[45]

Evaluation of Forecasts

Referring back to the basic definition of forecasting, one finds the ideas of uncertainty and randomness prevalent throughout the discussion. Because this uncertainty exists in an uncontrollable situation, randomness will always be present. Forecasting attempts to minimize the uncertainty by minimizing the difference between the forecasted value and the actual value.[46]

This difference, called "forecast error" should not, however, be considered a negative aspect of the forecasting situation. It should be considered a given and used for its advantages. Because of the wide range of forecasting procedures, performance evaluation is essential. Forecast error is used to measure this performance.[47]

The first step in model evaluation is to define error, which is simply the difference between the actual value and the predicted value. This error is then statistically manipulated to provide different measures of reliability. One of the most basic is the measure of error dispersion around the mean, called the "standard deviation" and the squared value called "variance." The formula for standard deviation is:[48]

$$S = \sqrt{\frac{\Sigma(Y-Y_R)^2}{N - 1}} \qquad (28)$$

Where: Y--is the actual value.

Y_R--is the forecasted value.

N--is the number of conservations.

If there are several residuals which differ greatly from the mean (usually two standard deviations), the forecasting procedure can be considered suspect in closely following the trends.[49]

Another measure of error is to take the absolute value of the error value and compute the average (mean) error. This technique is called the "mean absolute deviation" (MAD). A similar alternative is to compute the "mean square error" (MSE). The MSE is obtained by squaring each error and finding the mean of the squared values.

An advantage to using the MSE criterion is its ability to penalize the forecast more for large deviations than small ones. For instance, an error of 2.00 is squared and then counts for four times as much error as an error of 1.00. By attempting to minimize the mean square error in the forecasting routine, it is assumed that several small errors are more desirable than a few large deviations.[50]

When several different forecasting techniques are used simultaneously, the operator must know which procedure handles the data most efficiently. By computing the mean square error for each technique, the operator can then choose forecasts generated by the procedure which produces the smaller MSE. In this way a multiple forecasting technique can be developed which analyzes different types of data sets. The operator then has several techniques ready to use for any data set and does not have to redesign the entire forecasting system to fit particular variables. In this way the MSE is not just used to judge how well a forecasting procedure works, but it also allows evaluation between forecasting techniques.

CHAPTER III--NOTES

[1]Spyros Makridakis and Steven Wheelwright, Interactive Forecasting (San Francisco: Holden-Day, Inc., 1978), p. 13.

[2]Douglas Montgomery and Lynwood Johnson, Forecasting and Time Series Analysis (New York: McGraw-Hill, Inc., 1976), p. 2.

[3]Ibid., p. 7.

[4]Ibid.

[5]Steven C. Wheelwright and Spyros Makridakis, Forecasting Methods for Management (New York: John Wiley & Sons, 1973), p. 19.

[6]Ibid., pp. 19-21.

[7]Montgomery and Johnson, Forecasting and Time Series Analysis, p. 4.

[8]Ibid., p. 5.

[9]Ibid., p. 8.

[10]Ibid., p. 9.

[11]Ibid., p. 7.

[12]Ibid., p. 8.

[13]Makridakis and Wheelwright, Interactive Forecasting, p. 120.

[14]William G. Sullivan and W. Wayne Claycombe, Fundamentals of Forecasting (Reston, VA: Reston Publishing Company, Inc., 1977), p. 60.

[15]Ibid.

[16]Wheelwright and Makridakis, Forecasting Methods for Management, p. 107.

[17]Ibid., p. 137.

[18]Makridakis and Wheelwright, Interactive Forecasting, p. 121.

[19]Wheelwright and Makridakis, Forecasting Methods for Management, p. 55.

[20]Ibid.

[21]Ibid.

[22]Ibid., p. 88.

[23]Sullivan and Claycombe, Fundamentals of Forecasting, p. 88.

[24]Ibid.

[25]Ibid., p. 83.

[26]Wheelwright and Makridakis, Forecasting Methods for Management, p. 62.

[27]Makridakis and Wheelwright, Interactive Forecasting, p. 58.

[28]Ibid.

[29]Wheelwright and Makridakis, Forecasting Methods for Management, p. 62.

[30]Montgomery and Johnson, Forecasting and Time Series Analysis, p. 49.

[31]Ibid., p. 57.

[32]Wheelwright and Makridakis, Forecasting Methods for Management, pp. 71-72.

[33]Sullivan and Claycombe, Fundamentals of Forecasting, p. 95.

[34]Ibid., pp. 95-96.

[35]Wheelwright and Makridakis, Forecasting Methods for Management, p. 80.

[36]Ibid., p. 79.

[37]Ibid.

[38]Ibid.

[39]Spyros Makridakis and Steven C. Wheelwright, The Handbook of Forecasting: A Manager's Guide (New York: John Wiley & Sons, 1982), p. 122.

[40]Montgomery and Johnson, Forecasting and Time Series Analysis, p. 67.

[41]Ibid.

[42]Sullivan and Claycombe, Fundamentals of Forecasting, p. 93.

[43]Wheelwright and Makridakis, Forecasting Methods for Management, p. 73.

[44]Sullivan and Claycombe, Fundamentals of Forecasting, pp. 101-102.

[45]John E. Hanke and Arthur G. Reitsch, Business Forecasting (Boston, MA: Allyn and Bacon, Inc., 1981), pp. 306-307.

[46]Wheelwright and Makridakis, Forecasting Methods for Management, p. 22.

[47]Makridakis and Wheelwright, The Handbook of Forecasting: A Manager's Guide, p. 457.

[48]Hanke and Reitsch, Business Forecasting, p. 7.

[49]Wheelwright and Makridakis, Forecasting Methods for Management, p. 112.

[50]Ibid., p. 23.

CHAPTER IV

THE MULTIPLE FORECASTING PROGRAM

Introduction

This chapter presents a computer program developed to generate multiple forecasts using the following methods of time-series analysis:

1. Simple Regression
2. Single Moving Average
3. Double Moving Average
4. Single Exponential Smoothing
5. Double Exponential Smoothing
6. Triple Exponential Smoothing
7. Winters' Method

In addition, the program provides checks of accuracy using calculations of variance, standard error and the number of residuals exceeding two standard deviations. The program also provides a "method analysis" based on the comparison of mean square error (MSE) generated for each forecasting routine. This method analysis indicates which of the above methods provides the "best" forecast for a particular data set.

A data set and manually generated forecasts will be used to validate the methods employed. A computer program using and evaluating the forecasting methods is then introduced which will expand and expedite the manual calculations. Finally, results obtained by using the computer program with the data set are presented at the end of the chapter.

The Data Set

In order to test the application of time-series techniques to broadcast properties, monthly revenue figures from a Midwest radio station, in a medium-sized market are used. The station is in a market that contains at least five other commercial radio stations which compete for available advertising revenue. Thus, the value of a program such as this, to forecast future revenues is apparent.

Table 5. Monthly Revenues for a Midwest Radio Station.

Month	Period	Revenue	Month	Period	Revenue
January	1	$106,794	July	19	$139,617
February	2	116,734	August	20	153,507
March	3	126,114	September	21	148,409
April	4	113,021	October	22	183,845
May	5	119,626	November	23	171,785
June	6	117,485	December	24	176,756
July	7	119,626	January	25	127,109
August	8	112,130	February	26	130,440
September	9	111,678	March	27	140,694
October	10	139,704	April	28	159,302
November	11	135,321	May	29	162,168
December	12	152,337	June	30	158,753
January	13	86,111	July	31	152,182
February	14	105,933	August	32	168,858
March	15	116,682	September	33	157,313
April	16	129,772	October	34	207,745
May	17	157,178	November	35	194,117
June	18	148,367	December	36	180,291

Forecasting Routines

A sample forecast is manually generated from the data set for each method in order to validate the forecasting equations used in the computer program. Each method uses the variables "X" to denote the period and "Y" for the observation. The number of periods used in moving averages (N) has been set at 6. The exponential smoothing constant (α) has been set at 0.15.

Simple Regression

1. Calculate the slope (B):

$$B = \frac{\Sigma(X*Y) - (\bar{X}*\Sigma Y)}{\Sigma X^2 = (\bar{X}*\Sigma X)}$$

$$= 2,024.99$$

2. Calculate the intercept (A):

$$A = \bar{Y} - (B*\bar{X})$$

$$= 104,976.61$$

3. Generate the forecast for 12 periods ahead (period 48):

$$YEST = A + B * X$$

$$= 104,976.61 + 2,024.99 * 48$$

$$= \$202,175.52$$

Single Moving Average

1. Generate the forecast for the last period (36) and any future period.

$$SMA\ (36) = \frac{\Sigma Y\ (30\ \text{to}\ 35)}{N}$$

$$= \frac{1{,}038{,}968}{6}$$

$$= \$173{,}161.33$$

Double Moving Average

1. Calculate the double moving average using the last N single moving averages (periods 31 to 36):

$$DMA = \frac{\Sigma SMA}{N}$$

2. Calculate the intercept (A) at period 36:

$$A(I) = (SMA(I)*2) = DMA(I)$$

$$A(36) = (173{,}161.33 * 2) - 159{,}125.69$$

$$= 187{,}136.97$$

3. Calculate the slope (B) at period 36:

$$B(I) = \frac{(SMA(I) - DMA(I))*2}{N - 1}$$

$$B(36) = \frac{(173{,}161.33 - 159{,}125.69)*2}{5}$$

$$= 5{,}614.16$$

4. Generate the forecast for 12 periods ahead:

FDMA = A(36) + B(36) * 12

= 187,136.97 + 5,614.26 * 12

= $254,508.09

Single Exponential Smoothing

1. Initialize the model using the first observation:

SES(1) = Y(1)

= 106,794

2. Generate subsequent forecasts using α:

SES(I) = α*(Y(I) - SES(I-1)) + SES(I-1)

SES(2) = .15 * (116,734 - 106,794) + 106,794

= $108,285

Double Exponential Smoothing

1. Initialize the model using the first observation:

DES(1) = Y(1)

= 106,794

2. Generate subsequent forecasts using α:

DES(I) = (α * SES(I)) + ((1 - α) * DES(I-1))

DES(36) = (.15 * 168,949.54) + (.85 * 151,598.34)

= 154,201.02

3. Calculate the intercept at period 36:

A(I) = (2 * SES(I)) = DES(I)

A(36) = (2 * 168,949.54) - 154,201.02

= 183,698.06

4. Calculate the slope at period 36:

$$B(I) = \frac{(SES(I) - DES(I)) * \alpha}{(1 - \alpha)}$$

$$B(36) = \frac{(168,949.54 - 154,202.02) * .15}{.85}$$

= ?,602.68

5. Generate the forecast for 12 periods ahead:

FDES = A(I) + B(I) * X

= 183,698.06 + 2,602,68 * 12

= $214,930.22

Triple Exponential Smoothing

1. Initialize the model using the first observation:

TES(1) = Y(1)

= 106,794

2. Generate subsequent TES values using α:

TES(I) = (α * DES(I)) + ((1 - α) * TES(I-1))

TES(36) = (.15 * 154,201.02) + (.85 * 141,424.62)

= 14,334.08

3. Calculate the intercept (A) at period 36:

$$A(I) = (3 * SES(I)) - (3 * DES(I)) + TES(I-1)$$

$$A(36) = (3 * 168{,}949.54) - (3 * 154{,}201.02) + 141{,}424.62$$

$$= 185{,}670.18$$

4. Calculate the slope (B) at period 36:

$$B(I) = \left(\frac{\alpha}{2 * (1 - \alpha)^2}\right) * \quad ((6 - 5 * \alpha) * SES(I)) -$$

$$((10 - 8 * \alpha) * DES(I)) + ((4 - 3 * \alpha) * TES\ (I))$$

$$B(36) = .1 * (886{,}982.25 - 1{,}356{,}968.98 + 508{,}860.84)$$

$$= 3{,}887.70$$

5. Calculate the third polynomial coefficient at period 36:

$$C(I) = \left(\frac{\alpha}{1 - \alpha}\right)^2 * (SES(I) - (2 * DES(I)) + TES(I))$$

$$C(36) = .03 * (168{,}949.54 - 2 * 154{,}201.02 + 143{,}341.08)$$

$$= 116.66$$

6. Generate the forecast for 12 periods ahead:

$$FTES(I) = A(I) + B(I) * X + \left(\frac{C}{2 * X^2}\right)$$

$$FTES(36) = 185{,}670.18 + (3{,}887.70 * 12) + .40$$

$$= \$232{,}322.98$$

Winters' Method

In this example, the equations needed to solve for each component of the Winters' equation are listed in Chapter III. The basic forecast for 12 periods ahead is:

$$FFP(I) = (A + B * X) * S$$

$$FFP(36) = (169{,}993.58 + 1{,}592.20 * 12) * 1.16$$

$$= \$219{,}355$$

Method Analysis

The above methods of time-series analysis produce unique forecasts for any given data set. A manager must choose the forecast generated by the procedure that handles the data set most efficiently. To measure this "efficiency," the "mean square error" (MSE) is computed for each method:

$$MSE = \frac{1}{N} * \Sigma E^2 \tag{29}$$

Where: N--is the number of residuals.

ΣE^2--is the sum of squared residuals.

The forecasting routine generating the smallest MSE is considered the "best" method for a particular data set. This measure of accuracy lets management use several forecasting methods simultaneously and then decide which method provides the most accurate forecasts of future activity.

The Program

Written in Fortran IV, the program is listed in its entirety in the Appendix. The concept of a multiple forecasting program is derived from two sources. Sullivan and Claycombe designed a system which fundamentally combined various forecasting methods into a single program.[1] Montgomery and Johnson developed a routine to find the optimum smoothing constants for use in Winters' Method of exponential smoothing.[2] Neither program contained extensive checks of accuracy such as variance, standard deviation or number of residuals exceeding two standard deviations. In addition, neither program included a comparative analysis based on each method's mean square error. Thus, this program is an extension of and improvement on other programs commercially available.

Control Cards and Data Deck

Aside from the data set, several control cards must be input by the user. The control card and data deck set-up are listed in Table 6.

Table 6. Control Cards and Data Deck

Card	Variable Name	Format	Description
1	N	I3	Number of data points.
2	X, Y	I2, F8.0	Period and corresponding data.
3	NUM	I3	Number of data points used for moving averages. NUM must be an even multiple of N.

Table 6. (continued)

Card	Variable Name	Format	Description
4	ALPHA	F5.3	Exponential smoothing constant.
5	T	I2	Number of periods ahead that the forecasts will be made.
6	NW, N1, KS, KN, LW, LT	2I3, 2I1, 2I3	These variables are all used in Winters' Method: NW--is the number of data points and must equal N. N1--is the length of the time series used in model calculations. KS--is set at 0 if the smoothing constants are specified; or set at 1 if smoothing constant optimization is desired. KN--is set at 0 if initial values are specified; or set at 1 if the initial values are to be developed from the data. LW--is the length of season. LT--is the forecast lead time.
7	(If KS = 0) WALPHA, WBETA, WGAMMA	3F4.0	Specified smoothing constants.
7	(If KS = 1) AL, AD, AU, BL, BD, BU, GL, GD, DU	9F4.0	Lower limit, step size, and upper limit of smoothing constants for the optimization routine. The upper limit must be set one step size higher than the desired upper limit.
8	(If KN = 0)	F4.0	Specified value of permanent component.
9	(If KN = 0) BO	F4.0	Specified value of the trend component.
10 through (L + 5)	(If KN = 0) S(I)	F4.0	Initial seasonal factors for each of L periods.

NOTE: Cards 8 through (L + 5) are needed only when KN = 0 (initial values specified)

Sample Run

Using the data set listed in Table 5 and the control card specifications listed below in Table 7 (as formatted in Table 6), a sample computer run was made using the facilities of the Michigan State University Computer Center. The results (output) are included on pages 61-73.

Table 7. Control Card Specifications for the Sample Computer Run

Card	Variable	User Specification	Notes
1	N	036	For 36 periods of data.
2-37	X, Y	(See data set listed in Table 5)	
38	NUM	006	6 months of data used for averaging.
39	ALPHA	0.15	
40	T	12	Forecasts will be generated for the next 12 months.
41	NW	36	Length of time series (36 periods).
	N1	24	24 months will be used in model calculations.
	KS	1	Requesting optimization of the smoothing constants.
	KN	1	Initial values will be developed from the data.
	LW	12	Length of 1 season is 12 months.
	LT	1	The lead time is set at 1 period.
42	AL, AD, AU BL, BD, BU GL, GD, GU	0.05, 0.05, 0.35 0.05, 0.05, 0.35 0.05, 0.05, 0.35	The lower limit for smoothing constant optimization is set at 0.05 for each constant, the steps will increase at rate of 0.05 and the upper limit will stop the optimizing routine at 0.30.

MULTIPLE FORECASTING OF A TIME SERIES

SIMPLE REGRESSION

X	Y	FORECAST	ERROR	ERROR-SQ
1	106794.00	107001.60	-207.60	43099.25
2	116734.00	109026.60	7707.40	59404050.47
3	126114.00	111051.59	15062.41	226876141.89
4	113021.00	113076.59	-55.59	3089.79
5	119926.00	115101.58	4824.42	23275029.08
6	117485.00	117126.57	358.43	128469.20
7	119626.00	119151.57	474.43	225085.64
8	112130.00	121176.56	-9046.56	81840285.95
9	111678.00	123201.56	-11523.56	132792348.46
10	139704.00	125226.55	14477.45	209596549.19
11	135321.00	127251.54	8069.46	65116113.66
12	152337.00	129276.54	23060.46	531784885.45
13	86111.00	131301.53	-45190.53	2042184233.16
14	105933.00	133326.53	-27393.53	750405301.83
15	116682.00	135351.52	-18669.52	348551003.94
16	129772.00	137376.51	-7604.51	57828645.35
17	157178.00	139401.51	17776.49	316003636.53
18	148367.00	141426.50	6940.50	48170499.16
19	139617.00	143451.50	-3834.50	14703367.55
20	153507.00	145476.49	8030.51	64489072.88
21	148409.00	147501.49	907.51	823583.11
22	183845.00	149526.48	34318.52	1177760864.46
23	171785.00	151551.47	20233.53	409395600.33
24	176756.00	153576.47	23179.53	537290729.75
25	127109.00	155601.46	-28492.46	811820363.39
26	130440.00	157626.46	-27186.46	739103368.01
27	140694.00	159651.45	-18957.45	359384898.30
28	159302.00	161676.44	-2374.44	5637983.16
29	162168.00	163701.44	-1533.44	2351431.60
30	158753.00	165726.43	-6973.43	48628752.71
31	152182.00	167751.43	-15569.43	242407025.89
32	168858.00	169776.42	-918.42	843495.44
33	157313.00	171801.41	-14488.41	209914144.79
34	207745.00	173826.41	33918.59	1150470867.20
35	194117.00	175851.40	18265.60	333632058.73
36	180291.00	177876.40	2414.60	5830310.56

SUM OF FORECASTS= 5127804.00 SUM OF ERRORS= .00

SUM OF ERROR SQUARED= 11008716386.86

AVERAGE X= 18.50 AVERAGE Y= 142439.00

A OF SIMPLE REGRESSION= 104976.61 B OF SIMPLE REGRESSION= 2024.99

VARIANCE= 305797677.41 STANDARD DEVIATION= 17487.07

NUMBER OF RESIDUALS EXCEEDING TWO STANDARD DEVIATIONS= 1

SIMPLE REGRESSION FORECASTS

PERIOD	FORECAST
37	179901.39
38	181926.38
39	183951.38
40	185976.37
41	188001.37
42	190026.36
43	192051.35
44	194076.35
45	196101.34
46	198126.34
47	200151.33
48	202176.33

MOVING AVERAGES

SIMPLE MOVING AVERAGE

PERIOD	ACTUAL	FORECAST	RESIDUAL	RESIDUAL SQ
1	106794.00	-I	-I	-I
2	116734.00	-I	-I	-I
3	126114.00	-I	-I	-I
4	113021.00	-I	-I	-I
5	119926.00	-I	-I	-I
6	117485.00	-I	-I	-I
7	119626.00	116679.00	2947.00	8684809.00
8	112130.00	118817.67	-6687.67	44724885.44
9	111678.00	118050.33	-6372.33	40606632.11
10	139704.00	115644.33	24059.67	578867560.11
11	135321.00	120091.50	15229.50	231937670.25
12	152337.00	122657.33	29579.67	880882613.44
13	86111.00	128466.00	-42355.00	1793946025.00
14	105933.00	122880.17	-16947.17	287206458.03
15	116682.00	121847.33	-5165.33	26680668.44
16	129772.00	122681.33	7090.67	50277553.78
17	157178.00	121026.00	36152.00	1306967104.00
18	148367.00	124668.83	23698.17	561603103.36
19	139617.00	124007.17	15609.83	243666896.69
20	153507.00	132924.83	20582.17	423625564.69
21	148409.00	140853.83	7555.17	57080543.36
22	183845.00	146141.67	37703.33	1421541344.44
23	171785.00	155153.83	16631.17	276595704.69
24	176756.00	157588.33	19167.67	367399445.44
25	127109.00	162319.83	-35210.83	1239802784.03
26	130440.00	160235.17	-29795.17	887751956.69
27	140694.00	156390.67	-15696.67	246385344.44
28	159302.00	155104.83	4197.17	17616205.03
29	162168.00	151014.33	11153.67	124404280.11
30	158753.00	149411.50	9341.50	87263622.25
31	152182.00	146411.00	5771.00	33304441.00
32	168858.00	150589.83	18268.17	333725913.36
33	157313.00	156992.83	320.17	102506.69
34	207745.00	159762.67	47982.33	2302304312.11
35	194117.00	167836.50	26280.50	690664680.25
36	180291.00	173161.33	7129.67	50832146.78

SUM OF FORECASTS= 4199410.00 SUM OF RESIDUALS= 228320.00

SUM OF RESIDUAL SQUARED= 14616452798.06

VARIANCE= 472395047.55 STANDARD DEVIATION= 21734.65

NUMBER OF RESIDUALS EXCEEDING TWO STANDARD DEVIATIONS= 1

FORECAST FOR ANY PERIOD AHEAD IS 173161.33

DOUBLE MOVING AVERAGE

PERIOD	ACTUAL	M(2)	FORECAST	RESIDUAL	RESIDUAL-SQ
1	106794.00	-I	-I	-I	-I
2	116734.00	-I	-I	-I	-I
3	126114.00	-I	-I	-I	-I
4	113021.00	-I	-I	-I	-I
5	119926.00	-I	-I	-I	-I
6	117485.00	-I	-I	-I	-I
7	119625.00	-I	-I	-I	-I
8	112130.00	-I	-I	-I	-I
9	111678.00	-I	-I	-I	-I
10	139704.00	-I	-I	-I	-I
11	135321.00	-I	-I	-I	-I
12	152337.00	118656.69	-I	-I	-I
13	86111.00	120621.19	128258.23	-42147.23	1776388809.35
14	105933.00	121298.28	139448.73	-33515.73	1123304008.47
15	116682.00	121931.11	125094.81	-8412.81	70775390.79
16	129772.00	123103.94	121730.04	8041.96	64673049.16
17	157178.00	123259.69	122089.68	35088.32	1231190356.37
18	148367.00	123594.94	117898.83	30468.17	928309518.56
19	139617.00	122851.81	126172.28	13444.72	180760555.63
20	153507.00	124525.92	125624.67	27882.33	777424202.31
21	148409.00	127693.67	144683.32	3725.68	13880716.30
22	183845.00	131603.72	159278.07	24566.93	603534213.40
23	171785.00	137291.69	166494.79	5290.21	27986333.60
24	176756.00	142778.28	180160.83	-3404.83	11592852.22
25	127109.00	149163.72	178322.41	-51213.41	2622813477.64
26	130440.00	153715.44	180738.39	-50298.39	2529927924.82
27	140694.00	156304.92	169362.78	-28668.78	821898819.27
28	159302.00	157798.78	156510.72	2791.28	7791262.65
29	162168.00	157108.86	151333.31	10834.69	117390483.32
30	158753.00	155746.06	142481.99	16271.01	264745621.79
31	152182.00	153094.58	140543.12	11638.88	135463475.93
32	168858.00	151487.03	137053.98	31804.02	1011495476.13
33	157313.00	151587.39	149333.76	7979.24	63668253.25
34	207745.00	152363.69	164560.46	43184.54	1864904878.87
35	194117.00	155167.39	170121.23	23995.77	575797084.54
36	180291.00	159125.69	185573.26	-5282.26	27902223.75

SUM OF FORECASTS= 3582869.67 SUM OF RESIDUALS= 74064.33

SUM OF RESIDUAL SQUARED= 16853618988.10

VARIANCE= 790679855.17 STANDARD DEVIATION= 28119.03

NUMBER OF RESIDUALS EXCEEDING TWO STANDARD DEVIATIONS= 0

DOUBLE MOVING AVERAGE FORECASTS

PERIODS AHEAD	FORECAST
1	192811.23
2	198425.48
3	204039.74
4	209653.99
5	215268.25
6	220882.51
7	226496.76
8	232111.02
9	237725.27
10	243339.53
11	248953.78
12	254568.04

EXPONENTIAL SMOOTHING

SINGLE EXPONENTIAL SMOOTHING

PERIOD	ACTUAL	SES	FORECAST	RESIDUAL	RESIDUAL-SQ
0	0.00	106794.00	-I	-I	-I
1	106794.00	106794.00	-I	-I	-I
2	116734.00	108285.00	106794.00	9940.00	98803600.00
3	126114.00	110959.35	108285.00	17829.00	317873241.00
4	113021.00	111268.60	110959.35	2061.65	4250400.72
5	119926.00	112567.21	111268.60	8657.40	74950618.05
6	117485.00	113304.98	112567.21	4917.79	24184679.38
7	119626.00	114253.05	113304.98	6321.12	39956599.85
8	112130.00	113934.59	114253.05	-2123.05	4507320.88
9	111678.00	113596.10	113934.59	-2256.59	5092191.26
10	139704.00	117512.29	113596.10	26107.90	681622434.60
11	135321.00	120183.59	117512.29	17808.71	317150325.42
12	152337.00	125006.60	120183.59	32153.41	1033841622.99
13	86111.00	119172.26	125006.60	-38895.60	1512867971.97
14	105933.00	117186.37	119172.26	-13239.26	175278084.22
15	116682.00	117110.72	117186.37	-504.37	254392.65
16	129772.00	119009.91	117110.72	12661.28	160308074.49
17	157178.00	124735.12	119009.91	38168.09	1456803103.65
18	148367.00	128279.90	124735.12	23631.88	558465591.86
19	139617.00	129980.47	128279.90	11337.10	128529725.62
20	153507.00	133509.45	129980.47	23526.53	553497653.69
21	148409.00	135744.38	133509.45	14899.55	221996626.55
22	183845.00	142959.47	135744.38	48100.62	2313669503.63
23	171785.00	147283.30	142959.47	28825.53	830910935.13
24	176756.00	151704.21	147283.30	29472.70	868639862.14
25	127109.00	148014.93	151704.21	-24595.21	604924238.91
26	130440.00	145378.69	148014.93	-17574.93	308878041.30
27	140694.00	144675.98	145378.69	-4684.69	21946297.17
28	159302.00	146869.89	144675.98	14626.02	213920332.55
29	162168.00	149164.60	146869.89	15298.11	234032269.51
30	158753.00	150602.86	149164.60	9588.40	91937343.15
31	152182.00	150839.73	150602.86	1579.14	2493673.14
32	168858.00	153542.47	150839.73	18018.27	324657920.81
33	157313.00	154108.05	153542.47	3770.53	14216869.06
34	207745.00	162153.59	154108.05	53636.95	2876922127.33
35	194117.00	166948.11	162153.59	31963.41	1021659278.21
36	180291.00	168949.54	166948.11	13342.89	178032833.71

SUM OF FORECASTS= 4606639.74 SUM OF RESIDUALS= 414370.26

SUM OF RESIDUAL SQUARED= 17277075784.62

VARIANCE= 377311349.25 STANDARD DEVIATION= 19424.50

NUMBER OF RESIDUALS EXCEEDING TWO STANDARD DEVIATIONS= 3

FORECAST FOR ANY PERIOD AHEAD IS 168949.54

DOUBLE EXPONENTIAL SMOOTHING

PERIOD	ACTUAL	DES	EA	EB	FORECAST	RESIDUAL	RESIDUAL-SQ
0	0.00	106794.00	-I	-I	-I	-I	-I
1	106794.00	106794.00	105794.00	.00	-I	-I	-I
2	116734.00	107017.65	109552.35	223.65	106794.00	9940.00	98803600.00
3	126114.00	107608.91	114309.80	591.26	109776.00	16338.00	266930244.00
4	113021.00	108157.86	114379.34	548.95	114901.05	-1880.05	3534588.00
5	119926.00	108619.26	116315.15	651.40	114928.29	4997.71	24977105.24
6	117485.00	109492.10	117117.65	672.84	116976.56	508.44	258514.41
7	119626.00	110206.24	118299.85	714.14	117790.49	1835.51	3369089.02
8	112130.00	110765.50	117103.68	559.25	119013.99	-6883.99	47389274.73
9	111678.00	111190.09	116002.11	424.59	117662.93	-5984.93	35619411.41
10	139704.00	112138.42	122886.15	948.33	116426.70	23277.30	541832510.74
11	135321.00	113345.19	127021.99	1236.78	123834.48	11486.52	131940064.82
12	152337.00	115094.40	134918.80	1749.21	128228.77	24108.23	581206846.50
13	86111.00	115706.08	122638.44	611.68	136658.01	-50547.01	2555011665.70
14	105933.00	115928.13	118444.62	222.04	123250.12	-17317.12	299682693.02
15	116682.00	116105.52	118115.92	177.39	118666.66	-1984.66	3938890.12
16	129772.00	116541.17	121478.65	435.66	118293.31	11478.69	131760366.81
17	157178.00	117770.27	131699.98	1229.09	121914.30	35263.70	1243528234.86
18	148367.00	119346.71	137213.10	1576.45	132929.07	15437.93	238329615.74
19	139617.00	120941.78	139019.16	1595.06	138789.54	827.46	684685.36
20	153507.00	122826.93	144191.97	1985.15	140614.23	12892.77	166223629.78
21	148409.00	124764.55	146724.22	1937.62	146077.12	2331.88	5437657.57
22	183845.00	127493.78	158425.16	2729.24	148661.84	35183.16	1237855034.91
23	171785.00	130462.21	164104.39	2968.43	161154.40	10630.60	113009585.99
24	176756.00	133648.51	169759.90	3186.30	167072.82	9683.18	93763942.44
25	127109.00	135803.47	160226.38	2154.96	172946.20	-45837.20	2101049175.12
26	130440.00	137239.76	153517.62	1436.28	162381.34	-31941.34	1020249258.46
27	140694.00	138355.19	150996.78	1115.43	154953.90	-14259.90	203344781.93
28	159302.00	139632.39	154107.38	1277.20	152112.21	7189.79	51693038.79
29	162168.00	141062.23	157266.98	1429.83	155384.58	6783.42	46014742.24
30	158753.00	142493.32	158712.40	1431.10	158696.81	56.19	3157.00
31	152182.00	143745.28	157934.18	1251.96	160143.50	-7961.50	63385487.20
32	168858.00	145214.86	161870.09	1469.58	159186.15	9671.85	93544753.87
33	157313.00	146548.84	161667.26	1333.98	163339.66	-6026.66	36320677.37
34	207745.00	148889.55	175417.64	2340.71	163001.24	44743.76	2002003768.82
35	194117.00	151598.34	182297.87	2738.78	177758.35	16358.65	267605466.89
36	180291.00	154201.02	183698.06	2602.68	185006.66	-4715.66	22237424.07

SUM OF FORECASTS= 4905335.31 SUM OF RESIDUALS= 115674.69

SUM OF RESIDUAL SQUARED= 13733939022.93

VARIANCE= 416514540.02 STANDARD DEVIATION= 20408.69

NUMBER OF RESIDUALS EXCEEDING TWO STANDARD DEVIATIONS= 3

DOUBLE EXPONENTIAL SMOOTHING FORECASTS

PERIODS AHEAD	FORECAST
1	186300.74
2	188903.42
3	191506.10
4	194108.78
5	196711.46
6	199314.15
7	201916.83
8	204519.51
9	207122.19
10	209724.87
11	212327.55
12	214930.23

TRIPLE EXPONENTIAL SMOOTHING

PERIOD	ACTUAL	TES	TA	TB	TC	FORECAST	RESIDUAL	RESIDUAL-SQ
0	0.00	106794.00	-I	-I	-I	-I	-I	-I
1	106794.00	106794.00	106794.00	.00	.00	-I	-I	-I
2	116734.00	106827.55	110596.05	620.63	33.55	106794.00	9940.00	98803600.00
3	126114.00	106944.75	116878.88	1581.19	83.66	111233.45	14880.55	221430693.90
4	113021.00	107126.72	116276.97	1315.31	64.76	118501.90	-5480.90	30040225.07
5	119926.00	107380.60	118370.56	1512.40	71.92	117624.66	2301.34	5296171.15
6	117485.00	107697.32	118818.92	1416.50	62.84	119918.92	-2433.92	5923949.70
7	119626.00	108073.66	119837.73	1419.55	59.61	120266.84	-640.84	410673.33
8	112130.00	108477.44	117580.94	683.92	27.44	121287.09	-9157.09	83852219.97
9	111678.00	108884.34	115695.48	461.54	3.12	118478.58	-6800.58	46247853.47
10	139704.00	109372.45	125005.94	1909.37	81.21	116158.58	23545.42	554386959.85
11	135321.00	109968.36	129887.65	2482.41	107.80	126955.92	8365.08	69974561.88
12	152337.00	110737.27	139704.96	3796.32	172.99	132423.95	19913.05	396529546.25
13	86111.00	111482.59	121135.80	332.60	-23.58	143587.77	-57476.77	3303579319.36
14	105933.00	112149.42	115257.33	-706.78	-78.49	121456.61	-15523.61	240982521.99
15	116682.00	112742.83	115165.03	-691.37	-73.42	114511.31	2170.69	4711913.27
16	129772.00	113312.58	120149.04	155.64	-23.66	114436.95	15335.05	235163879.35
17	157178.00	113981.24	134207.15	2399.42	98.90	120292.85	36885.15	1360514185.02
18	148367.00	114786.06	140780.81	3187.78	136.17	136656.03	11710.97	137146871.21
19	139617.00	115709.42	141902.14	2997.74	118.54	144036.68	-4419.68	19533548.26
20	153507.00	116777.04	147756.98	3592.33	144.27	144959.15	8547.85	73065754.94
21	148409.00	117975.17	149716.55	3481.85	130.50	151421.45	-3012.45	9074854.27
22	183845.00	119402.96	164372.24	5446.97	229.57	153263.65	30581.35	935218714.77
23	171785.00	121061.85	169866.23	5703.06	231.10	169934.04	1850.96	3426062.15
24	176756.00	122949.85	175228.94	5897.45	229.11	175684.84	1071.16	1147392.15
25	127109.00	124877.89	159584.21	2629.82	40.04	181240.95	-54131.95	2930257691.97
26	130440.00	126732.17	149294.69	563.40	-73.76	162233.05	-31793.05	1010797969.30
27	140694.00	128475.62	145694.55	-195.02	-110.83	149821.21	-9127.21	83305948.22
28	159302.00	130149.14	150188.10	449.61	-69.94	145443.12	13858.88	192068433.09
29	162168.00	131786.10	154456.27	997.29	-36.55	150602.75	11565.25	133755112.34
30	158753.00	133392.19	156114.73	1065.68	-30.88	155435.29	3317.71	11007209.98
31	152182.00	134945.15	154675.54	623.40	-53.12	157164.97	-4982.97	24829973.71
32	168858.00	136485.61	159927.99	1321.57	-12.51	155272.37	13585.63	184569225.25
33	157313.00	137995.09	159163.24	967.48	-30.97	161243.30	-3930.30	15447253.89
34	207745.00	139629.26	177787.22	3816.14	124.68	160115.24	47629.76	2268594311.02
35	194117.00	141424.62	185678.57	4616.22	161.19	181665.70	12451.30	155034866.28
36	180291.00	143341.08	185670.19	4035.67	121.10	190375.39	-10084.39	101694845.69

SUM OF FORECASTS= 4950498.52 SUM OF RESIDUALS= 70511.48

SUM OF RESIDUAL SQUARED= 14947834352.04

VARIANCE= 462411614.91 STANDARD DEVIATION= 21503.76

NUMBER OF RESIDUALS EXCEEDING TWO STANDARD DEVIATIONS= 3

TRIPLE EXPONENTIAL SMOOTHING FORECASTS

PERIODS AHEAD	FORECAST
1	189766.41
2	193983.73
3	198322.15
4	202781.66
5	207362.27
6	212063.99
7	216885.79
8	221830.70
9	226895.70
10	232081.81
11	237389.01
12	242817.30

WINTERS METHOD

INITIAL VALUES OF THE PERMANENT, TREND AND SEASONAL COMPONENTS TO BE ESTIMATED FROM THE DATA

THE FIRST 24 PERIODS OF DATA WHICH CORRESPOND TO 2 SEASONS WILL BE USED

INITIAL PERMANENT COMPONENT= 112277.00

INITIAL TREND COMPONENT= 1715.92

INITIAL SEASONAL FACTOR FOR PERIOD 1 =	.7967
INITIAL SEASONAL FACTOR FOR PERIOD 2 =	.9024
INITIAL SEASONAL FACTOR FOR PERIOD 3 =	.9697
INITIAL SEASONAL FACTOR FOR PERIOD 4 =	.9483
INITIAL SEASONAL FACTOR FOR PERIOD 5 =	1.0624
INITIAL SEASONAL FACTOR FOR PERIOD 6 =	1.0074
INITIAL SEASONAL FACTOR FOR PERIOD 7 =	.9727
INITIAL SEASONAL FACTOR FOR PERIOD 8 =	.9763
INITIAL SEASONAL FACTOR FOR PERIOD 9 =	.9467
INITIAL SEASONAL FACTOR FOR PERIOD 10 =	1.1635
INITIAL SEASONAL FACTOR FOR PERIOD 11 =	1.0923
INITIAL SEASONAL FACTOR FOR PERIOD 12 =	1.1601

SMOOTHING CONSTANT OPTIMIZATION ROUTINE

ALPHA	BETA	GAMMA	RESIDUAL SUM OF SQUARES
.05	.05	.05	.26E+10
.05	.05	.10	.28E+10
.05	.05	.15	.29E+10
.05	.05	.20	.31E+10
.05	.05	.25	.33E+10
.05	.05	.30	.35E+10
.05	.10	.05	.28E+10
.05	.10	.10	.30E+10
.05	.10	.15	.32E+10
.05	.10	.20	.33E+10
.05	.10	.25	.35E+10
.05	.10	.30	.37E+10
.05	.15	.05	.30E+10
.05	.15	.10	.32E+10
.05	.15	.15	.34E+10
.05	.15	.20	.36E+10
.05	.15	.25	.38E+10
.05	.15	.30	.40E+10
.05	.20	.05	.33E+10
.05	.20	.10	.35E+10
.05	.20	.15	.37E+10
.05	.20	.20	.39E+10
.05	.20	.25	.41E+10
.05	.20	.30	.43E+10
.05	.25	.05	.35E+10
.05	.25	.10	.37E+10
.05	.25	.15	.39E+10
.05	.25	.20	.41E+10
.05	.25	.25	.44E+10
.05	.25	.30	.46E+10
.05	.30	.05	.38E+10
.05	.30	.10	.40E+10
.05	.30	.15	.42E+10
.05	.30	.20	.44E+10
.05	.30	.25	.47E+10
.05	.30	.30	.49E+10
.10	.05	.05	.27E+10
.10	.05	.10	.28E+10
.10	.05	.15	.30E+10
.10	.05	.20	.31E+10
.10	.05	.25	.33E+10
.10	.05	.30	.35E+10
.10	.10	.05	.30E+10
.10	.10	.10	.32E+10
.10	.10	.15	.33E+10
.10	.10	.20	.35E+10
.10	.10	.25	.36E+10
.10	.10	.30	.38E+10
.10	.15	.05	.33E+10
.10	.15	.10	.35E+10
.10	.15	.15	.37E+10
.10	.15	.20	.38E+10
.10	.15	.25	.40E+10
.10	.15	.30	.42E+10
.10	.20	.05	.37E+10
.10	.20	.10	.38E+10
.10	.20	.15	.40E+10
.10	.20	.20	.42E+10
.10	.20	.25	.44E+10
.10	.20	.30	.45E+10
.10	.25	.05	.40E+10
.10	.25	.10	.41E+10
.10	.25	.15	.43E+10
.10	.25	.20	.45E+10
.10	.25	.25	.47E+10
.10	.25	.30	.49E+10
.10	.30	.05	.42E+10
.10	.30	.10	.44E+10
.10	.30	.15	.46E+10
.10	.30	.20	.48E+10
.10	.30	.25	.50E+10
.10	.30	.30	.52E+10
.15	.05	.05	.26E+10
.15	.05	.10	.27E+10
.15	.05	.15	.28E+10
[illegible]	[illegible]	[illegible]	[illegible]

.15	.05	.25	.31E+10
.15	.05	.30	.33E+10
.15	.10	.05	.29E+10
.15	.10	.10	.31E+10
.15	.10	.15	.32E+10
.15	.10	.20	.33E+10
.15	.10	.25	.35E+10
.15	.10	.30	.36E+10
.15	.15	.05	.32E+10
.15	.15	.10	.33E+10
.15	.15	.15	.35E+10
.15	.15	.20	.36E+10
.15	.15	.25	.38E+10
.15	.15	.30	.39E+10
.15	.20	.05	.35E+10
.15	.20	.10	.36E+10
.15	.20	.15	.38E+10
.15	.20	.20	.39E+10
.15	.20	.25	.41E+10
.15	.20	.30	.42E+10
.15	.25	.05	.37E+10
.15	.25	.10	.38E+10
.15	.25	.15	.40E+10
.15	.25	.20	.41E+10
.15	.25	.25	.43E+10
.15	.25	.30	.45E+10
.15	.30	.05	.39E+10
.15	.30	.10	.40E+10
.15	.30	.15	.42E+10
.15	.30	.20	.44E+10
.15	.30	.25	.45E+10
.15	.30	.30	.47E+10
.20	.05	.05	.25E+10
.20	.05	.10	.26E+10
.20	.05	.15	.27E+10
.20	.05	.20	.28E+10
.20	.05	.25	.29E+10
.20	.05	.30	.30E+10
.20	.10	.05	.27E+10
.20	.10	.10	.28E+10
.20	.10	.15	.30E+10
.20	.10	.20	.31E+10
.20	.10	.25	.32E+10
.20	.10	.30	.33E+10
.20	.15	.05	.30E+10
.20	.15	.10	.31E+10
.20	.15	.15	.32E+10
.20	.15	.20	.33E+10
.20	.15	.25	.35E+10
.20	.15	.30	.36E+10
.20	.20	.05	.32E+10
.20	.20	.10	.33E+10
.20	.20	.15	.34E+10
.20	.20	.20	.36E+10
.20	.20	.25	.37E+10
.20	.20	.30	.39E+10
.20	.25	.05	.33E+10
.20	.25	.10	.35E+10
.20	.25	.15	.36E+10
.20	.25	.20	.38E+10
.20	.25	.25	.39E+10
.20	.25	.30	.41E+10
.20	.30	.05	.35E+10
.20	.30	.10	.37E+10
.20	.30	.15	.38E+10
.20	.30	.20	.40E+10
.20	.30	.25	.42E+10
.20	.30	.30	.44E+10
.25	.05	.05	.23E+10
.25	.05	.10	.24E+10
.25	.05	.15	.25E+10
.25	.05	.20	.26E+10
.25	.05	.25	.27E+10
.25	.05	.30	.28E+10
.25	.10	.05	.25E+10
.25	.10	.10	.26E+10
.25	.10	.15	.27E+10
.25	.10	.20	.28E+10
.25	.10	.25	.29E+10
.25	.10	.30	.31E+10
.25	.15	.05	.27E+10

.25	.15	.10	.28E+10
.25	.15	.15	.29E+10
.25	.15	.20	.31E+10
.25	.15	.25	.32E+10
.25	.15	.30	.33E+10
.25	.20	.05	.29E+10
.25	.20	.10	.30E+10
.25	.20	.15	.31E+10
.25	.20	.20	.33E+10
.25	.20	.25	.34E+10
.25	.20	.30	.35E+10
.25	.25	.05	.31E+10
.25	.25	.10	.32E+10
.25	.25	.15	.33E+10
.25	.25	.20	.35E+10
.25	.25	.25	.36E+10
.25	.25	.30	.38E+10
.25	.30	.05	.32E+10
.25	.30	.10	.34E+10
.25	.30	.15	.35E+10
.25	.30	.20	.37E+10
.25	.30	.25	.38E+10
.25	.30	.30	.40E+10
.30	.05	.05	.22E+10
.30	.05	.10	.23E+10
.30	.05	.15	.23E+10
.30	.05	.20	.24E+10
.30	.05	.25	.25E+10
.30	.05	.30	.26E+10
.30	.10	.05	.24E+10
.30	.10	.10	.25E+10
.30	.10	.15	.25E+10
.30	.10	.20	.26E+10
.30	.10	.25	.27E+10
.30	.10	.30	.28E+10
.30	.15	.05	.25E+10
.30	.15	.10	.26E+10
.30	.15	.15	.27E+10
.30	.15	.20	.28E+10
.30	.15	.25	.29E+10
.30	.15	.30	.30E+10
.30	.20	.05	.27E+10
.30	.20	.10	.28E+10
.30	.20	.15	.29E+10
.30	.20	.20	.30E+10
.30	.20	.25	.31E+10
.30	.20	.30	.33E+10
.30	.25	.05	.28E+10
.30	.25	.10	.30E+10
.30	.25	.15	.31E+10
.30	.25	.20	.32E+10
.30	.25	.25	.33E+10
.30	.25	.30	.34E+10
.30	.30	.05	.30E+10
.30	.30	.10	.31E+10
.30	.30	.15	.32E+10
.30	.30	.20	.33E+10
.30	.30	.25	.35E+10
.30	.30	.30	.36E+10

THE OPTIMUM SMOOTHING CONSTANTS ARE:

ALPHA= .30 BETA= .05 GAMMA= .05

OUTPUT OF THE INITIALIZATION PHASE

PERIOD	OBSERVATION	PERMANENT COMPONENT	TREND	SEASONAL FACTOR	FITTED MODEL	RESIDUAL
1	106794.00	120009.17	2016.73	.80	0.00	0.00
2	116734.00	124227.15	2126.79	.90	110112.84	6621.16
3	126114.00	127466.15	2182.40	.97	122519.16	3594.84
4	113021.00	126510.45	2025.50	.95	122940.08	-9919.08
5	119926.00	123841.25	1793.76	1.05	136550.76	-16624.75
6	117485.00	122929.20	1655.62	1.00	126561.02	-9076.02
7	119626.00	124100.30	1631.70	.97	121177.43	-1551.43
8	112130.00	122411.51	1465.37	.97	122974.60	-10844.60
9	111678.00	122105.06	1376.78	.95	117269.03	-5591.03
10	139704.00	122458.81	1325.63	1.16	143671.69	-3967.69
11	135321.00	123814.55	1327.13	1.09	135211.33	109.67
12	152337.00	126992.17	1419.66	1.16	145180.99	7156.01
13	86111.00	122125.51	1105.34	.80	102902.79	-16791.79
14	105933.00	121407.10	1014.15	.90	111430.04	-5497.04
15	116682.00	121758.39	981.01	.97	118826.67	-2144.67
16	129772.00	127092.72	1198.68	.95	116051.61	13720.39
17	157178.00	134386.90	1503.45	1.06	135688.19	21489.81
18	148367.00	139420.25	1679.95	1.01	136544.05	11822.95
19	139617.00	141852.39	1717.56	.97	137179.38	2437.62
20	153507.00	147735.67	1925.84	.98	139969.47	13537.53
21	148409.00	151874.27	2036.48	.95	141438.41	6970.59
22	183845.00	155186.68	2100.28	1.16	178901.33	4943.57
23	171785.00	157279.70	2099.91	1.09	171811.44	-26.44
24	176756.00	157195.68	1990.72	1.15	185215.86	-8459.86

SUM OF RESIDUALS= 1909.82 AVERAGE RESIDUAL= 79.58

VARIANCE= 94453063.90 STANDARD DEVIATION= 9718.70

MEAN ABSOLUTE DEVIATION= 7620.78

NUMBER OF RESIDUALS EXCEEDING TWO STANDARD DEVIATIONS= 1

OUTPUT OF FORECASTING PHASE

LENGTH OF THE SEASON IS = 12 PERIODS   FORECAST LEAD TIME IS 1 PERIODS

PERIOD	OBSERVATION	PERMANENT COMPONENT	TREND	SEASONAL FACTOR
25	127109.00	159303.56	1996.58	.80
26	130440.00	156262.28	1744.68	.90
27	140694.00	154117.54	1550.21	.97
28	159302.00	159310.90	1732.37	.95
29	162168.00	158485.47	1674.53	1.06
30	158753.00	159322.00	1566.08	1.01
31	152182.00	159552.11	1499.28	.97
32	168858.00	164526.07	1673.02	.98
33	157313.00	166192.33	1672.68	.95
34	207745.00	171071.71	1833.01	1.17
35	194117.00	174345.65	1905.06	1.09
36	180291.00	169993.58	1592.20	1.16

PERIOD	FORECAST	ERROR	TRACKING SIGNALS CUM. ERROR	SMOOTHED ERROR
25	126797.92	311.08	.04	.00
26	145598.12	-15158.12	-1.66	-.17
27	153270.09	-12576.09	-2.94	-.28
28	147773.95	11528.05	-1.67	-.12
29	171229.75	-9061.75	-2.63	-.21
30	161336.28	-2583.28	-3.13	-.23
31	156514.17	-4332.17	-3.82	-.27
32	157529.04	11328.96	-2.38	-.10
33	157334.32	-21.32	-2.64	-.10
34	195308.52	12436.48	-.99	.06
35	168870.39	5246.61	-.36	.12
36	204489.87	-24198.87	-2.83	-.16

SUM OF FORECAST ERRORS= -27080.41   AVERAGE FORECAST ERROR= -2256.70

VARIANCE= 133044298.81   STANDARD DEVIATION= 11534.48

FORECASTS USING WINTERS METHOD

PERIODS AHEAD	FORECAST
1	136686.22
2	155731.74
3	169031.62
4	167865.95
5	188854.63
6	180841.51
7	176042.40
8	179175.07
9	174491.06
10	216763.16
11	205019.39
12	218455.74

METHOD ANALYSIS

METHOD	MEAN SQUARE ERROR
SIMPLE REGRESSION	305797677.41
SIMPLE MOVING AVERAGE	487215093.27
DOUBLE MOVING AVERAGE	702234124.50
SINGLE EXPONENTIAL SMOOTHING	493630736.70
DOUBLE EXPONENTIAL SMOOTHING	392398257.80
TRIPLE EXPONENTIAL SMOOTHING	427080981.49
WINTERS METHOD	127049974.27

USING GIVEN PARAMETERS, THE BEST FORECASTING METHOD IS:

** WINTERS METHOD **

CHAPTER IV--NOTES

[1]William G. Sullivan and W. Wayne Calycombe, Fundamentals of Forecasting (Reston, VA: Reston Publishing Company, Inc., 1977), pp. 113-120.

[2]Douglas Montgomery and Lynwood Johnson, Forecasting and Time Series Analysis (New York: John Wiley & Sons, 1973), pp. 278-282.

CHAPTER V

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

Introduction

This paper attempted to create a multiple forecasting tool that has the ability to handle various data sets associated with telecommunication properties. The multiple forecasting system is intended for use by both professionals and students, especially those interested in acquisition finance. The forecasts generated might be used as part of the financial analysis required by both investors and lenders in their determination of property's potential. The forecasts can also be used as part of management's ongoing financial analysis for an established property.

The chapter begins with a summary of results and a discussion of the model's limitations followed by conclusions and recommendations for further study.

Summary of Results

The data set used in this study consisted of monthly radio station revenues over a three-year period. The radio station, located in the Midwest, is in the top 100 markets and has more than five other stations competing for advertising revenues in the market. Using established forecasting theories, discussed in Chapter III, projections of future revenues were generated. Initial calculations were validated manually. Then, using a computerized multiple forecasting routine, developed in Chapter IV, monthly revenue forecasts were generated for the next year.

Seven common methods of time-series analysis were used to generate multiple forecasts. These methods were used because each has strengths and weaknesses in handling various data sets common to broadcasting. In addition, the mean square error for each method was calculated as part of the "Method Analysis."

This method analysis, on page 73, shows Winters' Method as having the lowest mean square error and therefore providing the best forecasts for the given data set. This is evident earlier in the results which showed an average forecast error for Winters' Method of only -2,256.40. Compared to the average observation of 142,439.00, the average forecast error is fairly insignificant.

Other checks of forecast accuracy included a standard deviation of 9,718.7, a variance of 94,453,063 and calculation showing that there was only one residual which exceeded two standard deviations. The variance measure provides the operator with a mathematical index of the degree to which the individual observations (revenues) deviate from the mean. The standard deviation represents the given distance of the observations from the mean, and is useful in the examination of residuals. The fact that only one residual exceeds two standard deviations in the Winters' example indicates this particular method does a reasonable job in tracking the observations.

Since Winters' Method appears to be the best time-series analysis for this particular data set, one would conclude that the monthly revenue observations follow a seasonal trend. The strength of Winters' Method lies in its ability to track seasonal variations and formulate projections which also follow similar seasonal trends.

Like other exponential smoothing methods, Winters' Method averages historical observations in a decreasing (exponential) manner. However, Winters' Method adds a third smoothing constant to the forecasting equation to account for seasonality.

A second look at the method analysis shows simple regression with the next lowest mean square error. While the data set follows seasonal fluctuations, as indicated by Winters' Method, these changes do not appear extreme and the data seems to be increasing in somewhat of a linear manner. Linear data is best handled by regression methods of forecasting.

Limitations

Results indicated that, for this particular data set and using given parameters, Winters' Method provided the best forecasts. This is important, not because of the particular forecasts generated, but because it demonstrates the program's ability to project data using various forecasting methods. There are, however, several limitations to the program which need to be discussed.

First, the user must supply several parameters such as the number of periods used in moving averages or the exponential smoothing constants. Changes in these parameters will effect forecast accuracy. Likewise, the user supplied boundries for Winters' optimizing routine can be changed so the resulting smoothing constants alter the forecasts. Therefore, some level of expertise is required to operate the program.

The second major limitation involves the data set used in this paper. This data consisted of monthly revenue figures from a single Midwest radio station. Not all data sets have monthly observations, some consist of quarterly or yearly observations which would change the results. Monthly data tend to exhibit a seasonal pattern and yearly data will most likely be linear. Similarly, only one station in one market was tested. Different market sizes, conditions, and characteristics might also alter the results. Since time-series analysis is based on the continuation of previous market and station patterns, changes in program strategy, not an underlying trend, could cause severe fluctuations in this historical pattern. Likewise, changes in the market, such as new competition being introduced or stations going off-the-air, will affect the outcome.

Finally, only "revenues" from a radio station were used to test the program. Other financial variables such as cash flow and expenses may have their own unique forecasting needs and limitations. Likewise, forecasts of non-financial variables such as ratings and shares, should be tested to see if the program can accommodate these data over time. Other media also need to be tested in the model. Observations from television or cable properties may contain characteristics not explored in this paper.

Conclusions

Despite its limitations, the program developed in this paper is a powerful and unique forecasting tool. Unlike standard forecasting routines, this program combines several methods of time-series analysis in order to handle various types of data sets without having the operator develop a forecasting system for each type of data that needs to be analyzed.

This multiple forecasting system also provides the operator with various methods for analyzing each individual routine. In addition to the mean square error calculations used to identify the best routine, each method is evaluated using measures of variance, standard error and the number of residuals exceeding two standard deviations. A key advantage of this forecasting program is the ability to analyze the accuracy of each routine. This self-analysis adds strength to the multiple forecasting program, and increases the comprehensiveness of the program without sacrificing the ease of operation which is another of its strengths.

The computerized multiple forecasting routine developed in this paper, serves as an adequate base upon which management can develop a budget which accommodates previous performance and future expectations.

Recommendations

The limitations discussed in previous sections highlight the need for further testing of the model. Likewise, the limitations might be reduced as the model is expanded and refined.

First, the model needs testing using numerous data sets from a wide range of media, markets, and properties. This must be done to insure the model's comprehensiveness and utility. As unique data sets are introduced, the model should react accordingly and generate unique forecasts which must also be as accurate as possible.

This accuracy can be further enhanced by proper selection of model parameters. Iterations using various smoothing constants and moving average numbers need to be done in an attempt to find the optimum parameters. However, this process could be tedious and diminish the usefulness of the model.

To alleviate this problem, it might be possible to expand the model to include optimizing routines to generate smoothing constants in a similar way the Winters' optimizing routine provides the Alpha, Beta and Gamma. Further optimizing routines would help the model react to many different data sets. They would also strengthen the individual forecasting methods contained in the model. Currently, the optimizing procedure in Winters' Method gives this forecasting routine an advantage over the other methods in the system which suffer without the optimizing.

The time-series techniques used in this program are essentially "short term" in nature. They provide optimum forecasts for periods of one year or less. Therefore, they should be updated on a monthly or quarterly basis. This ongoing process should be part of a station's budgeting procedure. The information provided will let management examine previous performance, continually update the forecasts and modify them in light of new information.

To further enhance the program's usefulness, the language needs to be converted from Fortran IV to Basic so it is compatible with smaller computer systems. This would make the program more attractive to owners of smaller broadcast stations.

There are other options that may be included in the program to make it more appealing to these smaller station owners. One addition would be a scattergram option. The data in question would be plotted so managers can graphically see existing trends. This visual plot of data over time may be helpful in the identification and selection of the proper number of periods to employ in a moving average, or what constants to employ in exponential smoothing. Intuitive decisions can then be made regarding which forecasting method generates projections that seem to fit the data set in question. The program might also be rewritten to make it part of an interactive operation thus eliminating the need for computer cards

BIBLIOGRAPHY

BIBLIOGRAPHY

Chapman & Associates. "Using a Computer for Investment Analysis." Broadcast Financial Journal, 7 (January 1978): 24-35.

Dickstein, Barry J. "'True' Station Value is Key Ingredient in Broadcast Financing." Broadcast Financial Journal 10 (March 1981): 16-20.

Fildes, Robert. "Forecasting: The Issues." In The Handbook of Forecasting: A Manager's Guide, pp. 89-95. Edited by Spyros Makridakis and Steven C. Wheelwright. New York: John Wiley & Sons, 1982.

Granof, Michael H. Financial Accounting. Englewood Cliffs, New Jersey: Prentice-Hall, Inc., 1980.

Hague, Lee. "Acquisition Financing: An Overview Update." Broadcast Financial Journal, 8 (March 1979): 19-23.

Hanke, John E. and Arthur G. Reitsch. Business Forecasting. Boston: Allyn and Bacon, Inc., 1981.

Ingle, Kay D. "Radio Entrepreneurs Fill the Airways." Venture, (1979): 62-64.

Makridakis, Spyros and Steven C. Wheelwright. The Handbook of Forecasting: A Manager's Guide. New York: John Wiley & Sons, 1982.

__________. Interactive Forecasting. San Francisco: Holden-Day, Inc., 1978.

Meier, Robert C., William T. Newell and Harold Pazer. Simulation in Business and Economics. Englewood Cliffs, New Jersey: Prentice-Hall, Inc., 1969.

Montgomery, Douglas and Lynwood Johnson. Forecasting and Time Series Analysis. New York: McGraw-Hill, Inc., 1976.

National Association of Broadcasters. Purchasing A Broadcast Station: A Buyer's Guide. Washington: National Association of Broadcasters, 1978.

Nielsen Station Index. "Buffalo, New York." Viewers in Profile. Northbrook, Illinois: A.C. Nielsen Company, May 1983.

PK Services Corp. The Primer on Radio Station Investment. Carmel, California: PK Services Corp., 1979.

Poole, Harold. "What's Your Station Worth?" Broadcast Financial Journal, 8 (March 1979): 10-12.

Quaal, Ward L. and James A. Brown. Broadcast Management. New York: Hastings House Publishers, 1976.

Sansweet, Steven J. "How to Buy Your Own Radio Station." The Green Pages. (1978): 54-55.

Schall, Lawrence D. and Charles W. Haley. Introduction to Financial Management. New York: McGraw-Hill Book Company, 1980.

Schrieber, Albert N., ed. Corporate Simulation Models. Seattle: University of Washington, 1970.

Spiro, Herbert T. Finance for the Nonfinancial Manager. New York: John Wiley & Sons, 1977.

Schutz, David E. "Is That Station Really A Bargain?, Part II." Broadcast Management/Engineering. 14 (August 1978): 86-88.

Still, Richard R., Edward W. Cundiff and Norman A.P. Govoni. Sales Management: Decisions, Policies and Cases. Englewood Cliffs, New Jersey: Prentice-Hall, Inc., 1076.

Sullivan, William G. and Wayne W. Claycombe. Fundamentals of Forecasting. Reston, Virginia: Reston Publishing Company, Inc., 1977.

Ungruhe, C. David. "A Comparative Analysis of the Communications Media." Valvation Reporter (First Quarter 1979).

Wheelwright, Steven C. and Spyros Makridakis. Forecasting Methods for Management. New York: John Wiley & Sons, 1973.

Weston, J. Fred and Eugene F. Brigham. Essentials of Managerial Finance. Hinsdale, Illinois: The Dreyden Press, 1979.

Yadon, Robert E. "Application of Forecasting Techniques to the Telecommunication Industry." East Lansing, Michigan: Department of Telecommunication, College of Communication Arts and Sciences, Michigan State University, 1980.

Zwass, Vladimir. Programming in Fortran. New York: Barnes & Nobel Books, 1981.

APPENDIX

```
PROGRAM DELUX       74/175   CPT=1   PMDMF

      PROGRAM DELUX (INPUT,OUTPUT,TAPE 5=INPUT,TAPE 6=OUTPUT)
      INTEGER X,T,SM1,SM2,DM1,DM2,BX,BY,Z,T1
      REAL MA,MB,MSER,MSESMA,MSEDMA,MSESES,MSEDES,MSETES,MSEW,ONEMAA,ONE
     *MBB,ONEMGG
      DIMENSION X(61),Y(61),DX(61),DY(61),DXSQ(61),DYSQ(61),E(61),ESQ(61
     *),SMA(62),DES(62),YESTSG(61),YEST(61),DMA(62),MA(62),MB(62),FDMA(6
     *2),SES(62),EA(62),EB(62),FDES(62),ESMA(62),ESMASQ(62),EDMA(62),EDM
     *ASQ(62),ESES(62),ESESSQ(62),EDES(62),EDESSQ(62),SMASQ(62),FDMASQ(6
     *2),SESSQ(62),FDESSQ(62),EFWSQ(61),TFS(62),TA(62),TB(62),TC(62),FTE
     *S(62),ETES(62),FTESSQ(62),ETESSQ(62),FSES(62),REGFOR(61),Z(61),T1(
     *61),FORDMA(61),DESFOR(61),TESFOR(61),WA(500),WB(500),S(500),V(10),
     *FF(10,24),R(500),FFP(500),SAVE(24),SS(500),F(500),WDATA(500)
      SUMY=0.
      SUMDY=0.
      SUMX=0.
      SDYSQ=0.
      SDXSQ=0.
      SUMXY=0.
      SUMXSQ=0.
      S1=0.
      S2=0.
      S3=0.
      S4=0.
      S5=0.
      S6=0.
      S7=0.
      S8=0.
      S9=0.
      S10=0.
      S11=0.
      S12=0.
      S13=0.
      S14=0.
      S15=0.
      S16=0.
      SS1=0.
      SS2=0.
      SS3=0.
      SS4=0.
      SS5=0.
      SS6=0.
      SS7=0.
      SS8=0.
      SS9=0.
      SS10=0.
      SS11=0.
      SS12=0.0
      SS13=0.0
      BX=0
      BY=0
C
C
C
C     READ IN NUMBER OF DATA POINTS
C
      READ(5,7)N
7     FORMAT(I2)
C
C     READ IN PERIOD AND CORRESPONDING DATA
C
      J=N+1
      X(1)=0
      Y(1)=0.0
      READ(5,10)(X(I),Y(I),I=2,J)
10    FORMAT(I2,1X,F6.0)
      DO 21 I=1,N
      WDATA(I)=Y(I+1)
21    CONTINUE
C
C     INPUT NUMBER FOR MOVING AVERAGE
C
      READ(5,470)NUM
470   FORMAT(I3)
```

```
o       FORMAT(F5.3)
C
C       READ IN THE NUMBER OF PERIODS AHEAD
C       THAT THE FORECAST SHOULD BE MADE
C
        READ(5,19)T
19      FORMAT(I2)
C
C       NW= LENGTH OF TIME SERIES
C       N1= LENGTH OF TIME SERIES IN MODEL CALCULATIONS
C       KS= '0' IF SMOOTHING CONSTANTS ARE SPECIFIED
C       KS= '1' IF SMOOTHING CONSTANTS ARE OPTIMIZED
C       KN= '0' IF INITIAL VALUES ARE SPECIFIED
C       KN= '1' IF THE INITIAL VALUES ARE DEVELOPED FROM THE DATA
C       LW= LENGTH OF SEASON
C       LT= LEAD TIME
C
        READ(5,43)NW,N1,KS,KN,LW,LT
43      FORMAT(2I3,2I1,2I3)
        XLT=LT
        IF(KS.EQ.0)READ(5,80)WALPHA,WBETA,WGAMMA
80      FORMAT(9F4.0)
        IF(KS.EQ.1)READ(5,80)AL,AD,AU,BL,BD,BU,GL,GD,GU
        IF(KN.EQ.1)GO TO 138
        READ(5,80)A0
        READ(5,80)B0
        READ(5,80)S(I)
138     CONTINUE
C
C       ***************************************************************
C       SIMPLE REGRESSION
C       ***************************************************************
C
        DO 2 I=2,J
        SUMY=SUMY+Y(I)
2       SUMX=SUMX+X(I)
        AVGY=SUMY/N
        AVGX=SUMX/N
        DO 3 I=2,J
        DY(I)=Y(I)-AVGY
        SUMDY=SUMDY+DY(I)
        DX(I)=X(I)-AVGX
        DYSQ(I)=DY(I)**2
        SDYSQ=SDYSQ+DYSQ(I)
        DXSQ(I)=DX(I)**2
        SDXSQ=SDXSQ+DXSQ(I)
        SUMXY=SUMXY+(X(I)*Y(I))
3       SUMXSQ=SUMXSQ+X(I)**2
C
C       COEFFICIENTS OF SIMPLE REGRESSION
C       SIMPLE LINEAR REGRESSION LINE IS "Y(I)=A + BX(I)"
        B=(SUMXY-(AVGX*SUMY))/(SUMXSQ-(AVGX*SUMX))
        A=AVGY-(B*AVGX)
C
C       ESTIMATED VALUES AND RESIDUALS
C       YEST(I)=ESTIMATED Y VALUE AT TIME I
C       E(I)=DIFFERENCE BETWEEN ESTIMATED Y VALUE AND ACTUAL VALUE
C       AT TIME I
C
        DO 4 I=2,J
        YEST(I)=A+B*X(I)
        YESTSQ(I)=YEST(I)**2
        E(I)=Y(I)-YEST(I)
        ESQ(I)=E(I)**2
4       CONTINUE
        WRITE(6,999)
999     FORMAT(1H1,53X,"MULTIPLE FORECASTING OF A TIME SERIES",////)
        WRITE(6,12)
12      FORMAT(//,56X,"***SIMPLE REGRESSION***")
        WRITE(6,15)
15      FORMAT(//,43X,"X",7X,"Y",9X,"FORECAST",7X,"ERROR",8X,"ERROR-SQ",/)
        DO 5 I=2,J
        WRITE(6,16)X(I),Y(I),YEST(I),E(I),ESQ(I)
16      FORMAT(42X,I2,2X,F10.2,3X,F10.2,2X,F10.2,2X,F14.2)
5       CONTINUE
C       SS1=SUM OF SQUARES OF RESIDUALS IN SIMPLE REGRESSION
C
```

```
      DO 6 I=2,J
      S1=S1+YEST(I)
      S2=S2+YESTSQ(I)
      S15=S15+E(I)
      SS1=SS1+ESQ(I)
    6 CONTINUE
      AVE=S15/J
      VAR=(SS1-J*AVE**2)/(J-1.0)
      STD=SQRT(VAR)
      MSER=(1.0/N)*SS1
      WRITE(6,17)S1,S15
   17 FORMAT(/,39X,"SUM OF FORECASTS= ",2X,F14.2,5X,"SUM OF ERRORS= "
     +,2X,F10.2)
      WRITE(6,35)SS1
   35 FORMAT(/,39X,"SUM OF ERROR SQUARED= ",2X,F14.2)
      WRITE(6,18)AVGX,AVGY
   18  FORMAT(/,39X,"AVERAGE X= ",F8.2,5X,"AVERAGE Y= ",F14.2)
      WRITE(6,36)A,B
   36 FORMAT(/,39X,"A OF SIMPLE REGRESSION= ",F12.2,5X,"B OF SIMPLE REGR
     +ESSION= ",F10.2)
      WRITE(6,303)VAR,STD
  303 FORMAT(/,39X,"VARIANCE= "F14.2,4X,"STANDARD DEVIATION= ",F10.2)
      KTR=0.0
      STDM=STD*(-2.0)
      STD=2.0*STD
      DO 330 I=2,J
      IF(E(I).GT.STD.OR.E(I).LT.STDM)KTR=KTR+1
  330 CONTINUE
      WRITE(6,304)KTR
  304 FORMAT(/,39X,"NUMBER OF RESIDUALS EXCEEDING TWO STANDARD DEVIATION
     +S= ",I3)
      WRITE(6,510)
  510 FORMAT(///,55X,"SIMPLE REGRESSION FORECASTS")
      BX=T+N
      BY=N+1
      DO 520 I=BY,BX
      Z(I)=I
  520 REGFOR(I)=A+B*Z(I)
      WRITE(6,556)
  556 FORMAT(//,58X,"PERIOD",10X,"FORECAST",/)
      DO 540 I=BY,BX
      Z(I)=I
      WRITE(6,550)Z(I),REGFOR(I)
  550 FORMAT(60X,I2,8X,F12.2)
  540 CONTINUE
C
C
C
C     **************************************************************
C     MOVING AVERAGES AND EXPONENTIAL SMOOTHING
C     **************************************************************
C
C     SMA=SIMPLE MOVING AVERAGES
C     DMA=DOUBLE MOVING AVERAGES
C     FDMA=FORECAST WITH DOBLE MOVING AVERAGES
C
      NP1=N+2
      NUM1=NUM
      NUM=NUM1+2
      SM1=1
      SM2=NUM1
      DO 8 I=NUM,NP1
      SM=0.0
      DO 450 M=SM1,SM2
      SM=SM+Y(M+1)
  450 CONTINUE
      SM1=SM1+1
      SM2=SM2+1
      SMA(I)=SM/NUM1
      FORSMA=SMA(J)
      SMASQ(I)=SMA(I)**2
    8 CONTINUE
      NUM=NUM1*2+1
      DM1=1
      DM2=NUM1
      DO 45 I=NUM,NP1
      DM=0.0
```

PROGRAM DELUX 74/175 OPT=1 PMDMP FTN 4.8+564

```
      DO 460 M=DM1,DM2
      DM=DM+SMA(M+1+NUM1)
460   CONTINUE
      DM1=DM1+1
      DM2=DM2+1
      DMA(I)=DM/NUM1
      MA(I)=SMA(I)*2.-DMA(I)
      MB(I)=(SMA(I)-DMA(I))*2/(NUM1-1)
      FDMA(I+1)=MA(I)+MB(I)
      FDMASQ(I+1)=FDMA(I+1)**2
45    CONTINUE
C
C
C     SES=SMOOTHED STATISTIC FOR SINGLE EXPONENTIAL SMOOTHING
C     DES=SMOOTHED STATISTIC FOR DOUBLE EXPONENTIAL SMOOTHING
C     TES=SMOOTHED STATISTIC FOR TRIPLE EXPONENTIAL SMOOTHING
C     EA,EB ARE THE COEFFICIENTS IN THE FORECASTING EQUATION FOR DOUBLE
C     EXPONENTIAL SMOOTHING
C     TA,TB,TC ARE THE COEFFICIENTS IN THE FORECASTING EQUATION FOR
C     TRIPLE EXPONENTIAL SMOOTHING
C     FDES=FORECAST WITH DOUBLE EXPONENTIAL SMOOTHING
C     FTES=FORECAST WITH TRIPLE EXPONENTIAL SMOOTHING
C
C
      SES(1)=Y(2)
      DO 46 I=2,J
      SES(I)=ALPHA*(Y(I)-SES(I-1))+SES(I-1)
46    CONTINUE
      DO 410 I=3,J
      FSES(I)=SES(I-1)
      SESSQ(I)=FSES(I)**2
410   CONTINUE
      SESFOR=SES(J)
      DES(1)=Y(2)
      DO 55 I=2,J
      DES(I)=ALPHA*SES(I)+(1.-ALPHA)*DES(I-1)
      EA(I)=2.*SES(I)-DES(I)
      EB(I)=(SES(I)-DES(I))*ALPHA/(1.-ALPHA)
55    CONTINUE
      DO 420 I=3,J
      FDES(I)=EA(I-1)+EB(I-1)
      FDESSQ(I)=FDES(I)**2
420   CONTINUE
      TES(1)=Y(2)
      DO 51 I=2,J
      TES(I)=ALPHA*DES(I)+(1.-ALPHA)*TES(I-1)
      TA(I)=3.*SES(I)-3.*DES(I)+TES(I-1)
      TB(I)=(ALPHA/(2.*(1.-ALPHA)**2))*((6.-5.*ALPHA)*SES(I)-(10.-8.*ALP
     *HA)*DES(I)+(4.-3.*ALPHA)*TES(I))
      TC(I)=(ALPHA/(1.-ALPHA))**2*(SES(I)-2.0*DES(I)+TES(I))
51    CONTINUE
      DO 430 I=3,J
      FTES(I)=TA(I-1)+TB(I-1)+TC(I-1)/2
      FTESSQ(I)=FTES(I)**2
430   CONTINUE
C
C     ESMA,EDMA,ESES,EDES=DIFFERENCE BETWEEN ESTIMATED AND ACTUAL VALUE
C     IN SIMPLE, DOUBLE MOVING AVERAGES AND SINGLE DOUBLE EXPONENTIAL
C     SMOOTHING
C     ETES=DIFFERENCE BETWEEN ESTIMATED AND ACTUAL VALUE IN TRIPLE
C     EXPONENTIAL SMOOTHING
C
      NUM=NUM1+2
      DO 11 I=NUM,J
      ESMA(I)=Y(I)-SMA(I)
      ESMASQ(I)=ESMA(I)**2
11    CONTINUE
      NUM=NUM1*2+2
      DO 47 I=NUM,J
      EDMA(I)=Y(I)-FDMA(I)
      EDMASQ(I)=EDMA(I)**2
47    CONTINUE
      DO 48 I=3,J
      ESES(I)=Y(I)-FSES(I)
      ESESSQ(I)=ESES(I)**2
      EDES(I)=Y(I)-FDES(I)
      EDESSQ(I)=EDES(I)**2
```

```
          ETES(I)=Y(I)-FTES(I)
            ETESSQ(I)=ETES(I)**2
   48     CONTINUE
          WRITE(6,20)
   20     FORMAT(1H1,58X,"***MOVING AVERAGES***",/////)
          WRITE(6,22)
   22     FORMAT(59X,"SIMPLE MOVING AVERAGE",///)
          WRITE(6,23)
   23     FORMAT(39X,"PERIOD",4X,"ACTUAL"9X,"FORECAST",6X,"RESIDUAL",4X,"RES
         *IDUAL SQ",/)
          DO 98 I=2,J
          WRITE(6,24)X(I),Y(I),SMA(I),ESMA(I),ESMASQ(I)
   24     FORMAT(41X,I2,3X,F10.2,2X,F12.2,2X,F12.2,2X,F14.2)
   98     CONTINUE
          NUM=NUM1+2
          DO 13 I=NUM,J
          S3=S3+SMA(I)
          S16=S16+ESMA(I)
          S14=S14+ESMA(I)
          SS2=SS2+ESMASQ(I)
   13     SS3=SS3+SMASQ(I)
          AVE=S14/((J-NUM)-1)
          WRITE(6,25)S3,S16
          WRITE(6,34)SS2
          VAR=(SS2-((J-NUM)-1)*AVE**2)/(((J-NUM)-1)-1.0)
          STD=SQRT(VAR)
          MSESMA=(1.0/(J-(NUM-1)))*(SS2)
          WRITE(6,303)VAR,STD
          KTR=0.0
          STDM=STD*(-2.0)
          STD=2.0*STD
          DO 301 I =NUM,J
          IF(ESMA(I).GT.STD.OR.ESMA(I).LT.STDM)KTR=KTR+1
  301     CONTINUE
          NUM=NUM1*2+2
          DO 49 I=NUM,J
          S4=S4+FDMA(I)
          S13=S13+EDMA(I)
          SS4=SS4+EDMASQ(I)
   49     SS5=SS5+FDMASQ(I)
          WRITE(6,304)KTR
          WRITE(6,59)FORSMA
          WRITE(6,39)
   39     FORMAT(1H1,56X,"DOUBLE MOVING AVERAGE",///)
          WRITE(6,30)
   30     FORMAT(32X,"PERIOD",5X,"ACTUAL",10X,"M(2)",6X,"FORECAST",6X,"RESID
         *UAL",5X,"RESIDUAL-SQ",/)
          DO 79 I=2,J
          WRITE(6,40)X(I),Y(I),DMA(I),FDMA(I),EDMA(I),EDMASQ(I)
   40     FORMAT(34X,I2,3X,F10.2,2X,F12.2,2X,F12.2,2XF12.2,2X,F14.2)
   79     CONTINUE
          WRITE(6,25)S4,S13
          WRITE(6,34)SS4
   34     FORMAT(/,39X,"SUM OF RESIDUAL SQUARED= ",2X,F14.2)
          AVE=S13/((J-NUM)-1)
          VAR=(SS4-((J-NUM-1)*AVE**2))/(((J-NUM)-1)-1.0)
          STD=SQRT(VAR)
          MSEDMA=(1.0/(J-(NUM-1)))*(SS4)
          WRITE(6,303)VAR,STD
          KTR=0.0
          STDM=STD*(-2.0)
          STD=STD*2.0
          DO 309 I=NUM,J
          IF(ESMA(I).GT.STD.OR.ESMA(I).LT.STDM)KTR=KTR+1
  309     CONTINUE
          WRITE(6,304)KTR
   25     FORMAT(//,39X,"SUM OF FORECASTS= ",2X,F10.2,5X,"SUM OF RESIDUALS=
         *",2X,F10.2)
   59     FORMAT(/,39X,"FORECAST FOR ANY PERIOD AHEAD IS ",1X,F10.2)
          WRITE(6,560)
  560     FORMAT(///,54X,"DOUBLE MOVING AVERAGE FORECASTS")
          WRITE(6,531)
  531     FORMAT(//,55X,"PERIODS AHEAD",6X,"FORECAST",/)
          DO 570 I=1,T
          T1(I)=I
          FORDMA(I)=MA(J)+MB(J)*T1(I)
          WRITE(6,550)T1(I),FORDMA(I)
```

```
 570  CONTINUE
      WRITE(6,26)
 26   FORMAT(1H1,54X,"***EXPONENTIAL SMOOTHING***"///)
      WRITE(6,27)
 27   FORMAT(//,55X,"SINGLE EXPONENTIAL SMOOTHING"//)
      WRITE(6,28)
 28   FORMAT(38X,"PERIOD",3X,"ACTUAL",5X,"SES",9X,"FORECAST",6X,"RESIDUA
     *L",5X,"RESIDUAL-SQ",/)
      DO 14 I=1,J
      WRITE(6,29)X(I),Y(I),SES(I),FSES(I),ESES(I),ESESSQ(I)
 29   FORMAT(39X,I2,3X,F10.2,2X,F12.2,2X,F12.2,2X,F12.2,2X,F14.2)
 14   CONTINUE
      DO 38 I=3,J
      S5=S5+FSES(I)
      S6=S6+FDES(I)
      S8=S8+FTES(I)
      S9=S9+ESES(I)
      S10=S10+EDES(I)
      S11=S11+ETES(I)
      SS6=SS6+ESESSQ(I)
      SS7=SS7+SESSQ(I)
      SS8=SS8+EDESSQ(I)
      SS12=ETESSQ(I)+SS12
      SS13=SS13+FTESSQ(I)
 38   SS9=SS9+FDESSQ(I)
      WRITE(6,390)S5,S9
      WRITE(6,391)SS6
 391  FORMAT(/,39X,"SUM OF RESIDUAL SQUARED= ",F14.2)
      AVE=S9/((J-3)-1)
      VAR=(SS6-((J-3)-1)*AVE**2)/(((J-3)-1)-1.0)
      STD=SQRT(VAR)
      WRITE(6,303)VAR,STD
      KTR=0.
      STDM=STD*(-2.0)
      STD=2.0*STD
      MSESES=(1.0/(J-2))*(SS6)
      DO 880 I=3,J
      IF(EDES(I).GT.STD.OR.EDES(I).LT.STDM)KTR=KTR+1
 880  CONTINUE
      WRITE(6,304)KTR
      WRITE(6,59)SESFOR
      WRITE(6,74)
 74   FORMAT(1H1,54X,"DOUBLE EXPONENTIAL SMOOTHING"//)
      WRITE(6,76)
 76   FORMAT(18X,"PERIOD",4X,"ACTUAL",7X,"DES",13X,"EA",12X,"EB",11X,"FOR
     *RECAST",7X,"RESIDUAL",5X,"RESIDUAL-SQ",/)
      DO 77 I=1,J
      WRITE(6,78)X(I),Y(I),DES(I),EA(I),EB(I),FDES(I),EDES(I),EDESSQ(I)
 78   FORMAT(19X,I2,3X,F10.2,1X,F12.2,3X,F12.2,2X,F12.2,4X,F12.2,3X,F12.
     *2,2X,F14.2)
 77   CONTINUE
      WRITE(6,390)S6,S10
 390  FORMAT(/,39X,"SUM OF FORECASTS= ",F12.2,5X,"SUM OF RESIDUALS= ",F1
     *2.2)
      WRITE(6,391)SS8
      AVE=S10/((J-3)-1)
      VAR=(SS8-((J-3)-1)*AVE**2)/(((J-3)-1)-1.0)
      STD=SQRT(VAR)
      WRITE(6,303)VAR,STD
      KTR=0.
      STDM=STD*(-2.0)
      STD=2.0*STD
      MSEDES=(1.0/(J-2))*(SS8)
      DO 887 I=3,J
      IF(EDES(I).GT.STD.OR.EDES(I).LT.STDM)KTR=KTR+1
 887  CONTINUE
      WRITE(6,304)KTR
      WRITE(6,552)
 552  FORMAT(///,50X,"DOUBLE EXPONENTIAL SMOOTHING FORECASTS")
      WRITE(6,531)
      DO 532 I=1,T
      T1(I)=I
      DESFOR(I)=EA(J)+T1(I)*EB(J)
 532  WRITE(6,550)T1(I),DESFOR(I)
      WRITE(6,31)
 31   FORMAT(1H1,54X,"TRIPLE EXPONENTIAL SMOOTHING"/)
      WRITE(6,32)
```

```
32    FORMAT(13X,"PERIOD",4X,"ACTUAL",9X,"TES",10X,"TA",11X,"TB",11X,"TC
     *",9X,"FORECAST",6X,"RESIDUAL",5X,"RESIDUAL-SQ",/)
      DO 97 I=1,J
      WRITE(6,33)X(I),Y(I),TES(I),TA(I),TB(I),TC(I),FTES(I),ETES(I),ETES
     *SQ(I)
33    FORMAT(14X,I2,3X,F10.2,2X,F12.2,1X,F12.2,1X,F12.2,1X,F12.2,3X,F12.
     *2,2X,F12.2,2X,F14.2)
97    CONTINUE
      WRITE(6,390)SE,S11
      WRITE(6,391)SS12
      AVE=S11/((J-3)-1)
      VAR=(SS12-((J-3)-1)*AVE**2)/(((J-3)-1)-1.0)
      STD=SQRT(VAR)
      WRITE(6,303)VAR,STD
      KTR=0.
      STDM=STD*(-2.0)
      STD=2.0*STD
      MSETES=(1.0/(J-2))*(SS12)
      DO 900 I=3,J
      IF(ETES(I).GT.STD.OR.ETES(I).LT.STDM)KTR=KTR+1
900   CONTINUE
      WRITE(6,304)KTR
      WRITE(6,553)
553   FORMAT(///,50X,"TRIPLE EXPONENTIAL SMOOTHING FORECASTS")
      WRITE(6,531)
      DO 533 I=1,T
      T1(I)=I
      TESFOR(I)=TA(J)+TB(J)*T1(I)+TC(J)/2.0*T1(I)**2
533   WRITE(6,550)T1(I),TESFOR(I)
C
C     ****************************************************************
C     WINTERS METHOD
C     ****************************************************************
C
C
C
C     F(I) IS THE FORECAST MADE IN PERIOD I
C     FFP(I) IS THE FORECAST MADE FOR PERIOD I
C     R(I) IS Y(I)-FFP(I)
C
      DO 99 I=1,N
      Y(I)=WDATA(I)
99    CONTINUE
      WRITE(6,345)
345   FORMAT(1H1,54X,"***WINTERS METHOD***",////)
      IF(KN.EQ.1)GO TO 81
      WRITE(6,350)
350   FORMAT(14X,"INITIAL VALUES OF THE PERMANENT, TREND AND SEASONAL CO
     *MPONENTS SPECIFIED",//)
      DO 82 I=1,LW
82    SAVE(I)=S(I)
      WRITE(6,83)A0
83    FORMAT(1H0,20X,"INITIAL PERMANENT COMPONENT= ",F12.2,/)
      WRITE(6,84)B0
84    FORMAT(1H0,20X,"INITIAL TREND COMPONENT= ",F12.2,/)
      DO 85 I=1,LW
85    WRITE(6,86)I,S(I)
86    FORMAT(1H0,20X,"INITIAL SEASONAL FACTOR FOR PERIOD ",I3,1X,"= ",F1
     *0.4,/)
      GO TO 96
81    WRITE(6,87)
87      FORMAT(14X,"INITIAL VALUES OF THE PERMANENT, TREND AND SEASONAL
     *COMPONENTS TO BE ESTIMATED FROM THE DATA",//)
      KK=N1/LW
      WRITE(6,88)N1,KK
88    FORMAT(14X,"THE FIRST ",I3,1X,"PERIODS OF DATA WHICH CORRESPOND TO
     * ",I3,1X,"SEASONS WILL BE USED",/)
      RL=LW
      J1=1
      J2=LW
      DO 89 I=1,KK
      V(I)=0.0
      DO 90 J=J1,J2
90    V(I)=V(I)+Y(J)
      V(I)=V(I)/RL
      J1=J2+1
      J2=J1+LW-1
89    CONTINUE
```

```
                  RR=N1-LW
                  BO=(V(KK)-V(1))/RR
                  AO=V(1)-PL/2.*BO
                  J1=0
                  DO 92 I=1,KK
                  DO 93 J=1,LW
                  JT=J+J1*LW
                  RJ=J
        93        FF(I,J)=Y(JT)/(V(I)-(((RL+1.0)/2.0)-RJ)*BO)
                  J1=J1+1
        92        CONTINUE
                  SUMS=0.0
                  RKK=KK
                  DO 140 J=1,LW
                  SUM=0.0
                  DO 94 I=1,KK
        94        SUM=SUM+FF(I,J)
                  S(J)=SUM/RKK
        140       SUMS=SUMS+S(J)
                  WRITE(6,83)AO
                  WRITE(6,84)BO
                  DO 95 J=1,LW
                  S(J)=S(J)*(RL/SUMS)
                  SAVE(J)=S(J)
        95        WRITE(6,66)J,S(J)
        96        IF(KS.EQ.0)GO TO 100
                  WRITE(6,101)
        101       FORMAT(1H1,45X,"SMOOTHING CONSTANT OPTIMIZATION ROUTINE",//)
                  WRITE(6,102)
        102       FORMAT(32X,"ALPHA",10X,"BETA",10X,"GAMMA",10X,"RESIDUAL SUM OF SQU
                 *ARES",/)
        C
        C         SEARCH FORM OPTIMUM VALUES
        C
                  KA=(AU-AL)/AD+1.0
                  KB=(BU-BL)/BD+1.0
                  KG=(GU-GL)/GD+1.0
                  AAW=AL
                  ABEST=0.0
                  BBEST=0.0
                  GBEST=0.0
                  EBEST=1.0E+38
                  DO 103 II=1,KA
                  ONEMAA=1.0-AAW
                  BBW=BL
                  DO 104 IJ=1,KB
                  ONEMBB=1.0-BBW
                  GG=GL
                  DO 105 IK=1,KG
                  DO 106 IL=1,LW
        106       S(IL)=SAVE(IL)
                  ONEMGG=1.0-GG
                  WA(1)=AAW*(Y(1)/S(1))+ONEMAA*(AO+BO)
                  WB(1)=BBW*(WA(1)-AO)+ONEMBB*BO
                  S(1)=GG*(Y(1)/WA(1))+ONEMGG*S(1)
                  XHAT=(WA(1)+XLT*WB(1))*S(1+LT)
                  EW=(Y(1+LT)-XHAT)**2
                  DO 107 I=2,N1
                  IL=MOD(I,LW)
                  IF(IL.EQ.0)IL=LW
        108       WA(I)=AAW*(Y(I)/S(IL))+ONEMAA*(WA(I-1)+WB(I-1))
                  WB(I)=BBW*(WA(I)-WA(I-1))+ONEMBB*WB(I-1)
                  S(IL)=GG*(Y(I)/WA(I))+ONEMGG*S(IL)
                  ILLT=IL+LT
                  IF(ILLT.GT.LW)ILLT=ILLT-LW
                  XHAT=(WA(I)+XLT*WB(I))*S(ILLT)
        107       EW=EW+(Y(I+LT)-XHAT)**2
                  WRITE(6,110)AAW,BBW,GG,EW
        110       FORMAT(22X,F12.2,5X,F12.2,2X,F12.2,6X,E15.2)
                  IF(EW.GE.EBEST)GO TO 105
                  WALPHA=AAW
                  WBETA=BBW
                  WGAMMA=GG
                  EBEST=EW
        105       GG=GG+GD
        104       BBW=BBW+BD
        103       AAW=AAW+AD
```

```
        WRITE(6,111)
  111   FORMAT(//,32X,"THE OPTIMUM SMOOTHING CONSTANTS ARE:",/)
  100   IF(KS.EQ.0)WRITE(6,112)
  112   FORMAT(//,14X,"THE SMOOTHING CONSTANTS ARE SPECIFIED AS:",/)
        WRITE(6,113)WALFHA,WBETA,WGAMMA
  113   FORMAT(32X,"ALFHA= ",F12.2,5X,"BETA= ",F12.2,5X,"GAMMA= ",F12.2)
        IF(N1.EQ.0)N1=LW
C
C       FORECAST WITH OPTIMUM SMOOTHING CONSTANTS
C
        DO 115 IL=1,LW
  115   S(IL)=SAVE(IL)
        ONEMAA=1.0-WALFHA
        ONEMBB=1.0-WBETA
        ONEMGG=1.0-WGAMMA
        WA(1)=WALPHA*(Y(1)/S(1))+ONEMAA*(A0+B0)
        WB(1)=WBETA*(WA(1)-A0)+ONEMBB*B0
        S(1)=WGAMMA*(Y(1)/WA(1))+ONEMGG*S(1)
        F(1)=(WA(1)+XLT*WB(1))*S(LT+1)
        SS(1)=S(1)
        FFP(1+LT)=F(1)
        R(1)=0.
        R(1+LT)=Y(1+LT)-F(1)
      * SUM=R(1)
        WSUMSQ=R(1)**2
        XMAD=ABS(R(1))
        DO 116 I=2,N1
        IL=MOD(I,LW)
        IF(IL.EQ.0)IL=LW
  117   WA(I)=WALPHA*(Y(I)/S(IL))+ONEMAA*(WA(I-1)+WB(I-1))
        WB(I)=WBETA*(WA(I)-WA(I-1))+ONEMBB*WB(I-1)
        S(IL)=WGAMMA*(Y(I)/WA(I))+ONEMGG*S(IL)
        SS(I)=S(IL)
        ILLT=IL+LT
        IF(ILLT.GT.LW)ILLT=ILLT-LW
        F(I)=(WA(I)+XLT*WB(I))*S(ILLT)
        FFP(I+LT)=F(I)
        R(I+LT)=Y(I+LT)-F(I)
        SUM=SUM+R(I)
        XMAD=XMAD+ABS(R(I))
  116   WSUMSQ=WSUMSQ+R(I)**2
        DO 118 I=1,LT
        R(I)=0.
  118   FFP(I)=0.
        J=N1+1
        SUME=0.0
        SUME2=0.0
C
C       START THE FORECASTING PHASE
C
        DO 120 I=J,NW
        IL=MOD(I,LW)
        IF(IL.LE.0)IL=LW
  121   FFP(I)=(WA(I-LT)+XLT*WB(I-LT))*S(IL)
        WA(I)=WALPHA*(Y(I)/S(IL))+ONEMAA*(WA(I-1)+WB(I-1))
        WB(I)=WBETA*(WA(I)-WA(I-1))+ONEMBB*WB(I-1)
        S(IL)=WGAMMA*(Y(I)/WA(I))+ONEMGG*S(IL)
        SS(I)=S(IL)
        R(I)=Y(I)-FFP(I)
        SUME=SUME+R(I)
  120   SUME2=SUME2+R(I)**2
        WRITE(6,122)
  122   FORMAT(1H1,50X,"OUTPUT OF THE INITIALIZATION PHASE",//)
        WRITE(6,123)
  123   FORMAT(1H0,14X,"PERIOD",5X,"OBSERVATION",9X,"PERMANENT COMPONENT",
      *6X,"TREND",7X,"SEASONAL FACTOR",4X,"FITTED MODEL",9X,"RESIDUAL",/)
        DO 124 I=1,N1
  124   WRITE(6,125)I,Y(I),WA(I),WB(I),SS(I),FFP(I),R(I)
  125   FORMAT(16X,I3,6X,F12.2,11X,F12.2,4X,F12.2,7X,F12.2,7X,F12.2,5X,F12
      *.2)
        WT=N1
        WAVE=SUM/WT
        WVAR=(WSUMSQ-WT*WAVE**2)/(WT-1.0)
        WSTD=SQRT(WVAR)
        XMAD=XMAD/WT
        WRITE(6,126)SUM,WAVE
  126   FORMAT(//,39X,"SUM OF RESIDUALS= ",F12.2,6X,"AVERAGE RESIDUAL= ",F
```

```
     *12.2)
      WRITE(6,303)WVAR,WSTD
      WRITE(6,127)XMAD
127   FORMAT(/,39X,"MEAN ABSOLUTE DEVIATION= ",F12.2,/)
      KTR=0
      WSTDM=WSTD*(-2.0)
      WSTD=2.0*WSTD
      DO 128 I= 1,N1
      IF(R(I).GT.WSTD.OR.R(I).LT.WSTDM)KTR=KTR+1
128   CONTINUE
      WRITE(6,304)KTR
      WRITE(6,130)
130   FORMAT(1H1,50X,"OUTPUT OF FORECASTING PHASE",///)
      WRITE(6,131)LW,LT
131   FORMAT(16X,"LENGTH OF THE SEASON IS =",I3,1X,"PERIODS",5X,"FORECAS
     *T LEAD TIME IS ",I3,1X,"PERIODS",//)
      WRITE(6,132)
132   FORMAT(15X,"PERIOD",5X,"OBSERVATION",9X,"PERMANENT COMPONENT",6X,"
     *TREND",9X,"SEASONAL FACTOR",/)
      WY=0.0
      WZ=0.0
      DO 134 I=J,NW
135   WY=WY+R(I)
      WZ=0.1*R(I)+0.9*WZ
      XMAD=0.1*ABS(R(I))+0.9*XMAD
      WTC=WY/XMAD
      WTS=WZ/XMAD
134   WRITE(6,136)I,Y(I),WA(I),WB(I),SS(I)
136   FORMAT(16X,I3,6X,F12.2,11X,F12.2,5X,F12.2,7X,F12.2)
      WRITE(6,154)
154   FORMAT(//,15X,"PERIOD",8X,"FORECAST",18X,"ERROR",17X,"TRACKING SIG
     *NALS")
      WRITE(6,133)
133   FORMAT(70X,"CUM. ERROR",8X,"SMOOTHED ERROR",/)
      WY=0.0
      WZ=0.0
      DO 152 I=J,NW
      WY=WY+R(I)
      WZ=0.1*R(I)+0.9*WZ
      XMAD=0.1*ABS(R(I))+0.9*XMAD
      WTC=WY/XMAD
      WTS=WZ/XMAD
152   WRITE(6,153)I,FFP(I),R(I),WTC,WTS
153   FORMAT(16X,I3,6X,F12.2,11X,F12.2,5X,F12.2,7X,F12.2)
      XN=NW-N1
      WAVG=SUME/XN
      WVAR=(SUME2-XN*WAVG**2)/(XN-1.0)
      WSTD=SQRT(WVAR)
      WRITE(6,137)SUME,WAVG
137   FORMAT(//,39X,"SUM OF FORECAST ERRORS= ",F12.2,5X,"AVERAGE FORECAS
     *T ERROR= ",F12.2)
      WRITE(6,303)WVAR,WSTD
      LW=LW+1
      LP1=1+LW
      LT2=2*LW-1
      LP3=1+LT2
      LT3=3*LW-2
      LP5=1+LP3
      DO 150 I=J,NW
      R(I)=Y(I)-FFP(I)
      S12=S12+FFP(I)
      EFWSQ(I)=R(I)**2
150   CONTINUE
      DO 151 I=J,NW
      SS10=SS10+EFWSQ(I)
151   CONTINUE
      MSEW=(1.0/(NW-N1))*(SS10)
      WRITE(6,554)
554   FORMAT(///,55X,"FORECASTS USING WINTERS METHOD")
      WRITE(6,531)
      FFP(I)=0.0
      S(NW+I-T)=0.0
      DO 555 I=1,T
      T1(I)=I
      FFP(I)=(WA(NW)+T1(I)*WB(NW))*SS(NW+I-T)
555   WRITE(6,550)T1(I),FFP(I)
      WRITE(6,949)
```

```
  949 FORMAT(1H1,61X,"METHOD ANALYSIS")
      WRITE(6,950)
  950 FORMAT(///,54X,"METHOD",10X,"MEAN SQUARE ERROR")
      WRITE(6,951)MSER
  951 FORMAT(//,44X,"SIMPLE REGRESSION",15X,F14.2)
      WRITE(6,952)MSESMA
  952 FORMAT(/,44X,"SIMPLE MOVING AVERAGE",11X,F14.2)
      WRITE(6,953)MSEDMA
  953 FORMAT(/,44X,"DOUBLE MOVING AVERAGE",11X,F14.2)
      WRITE(6,954)MSESES
  954 FORMAT(/,44X,"SINGLE EXPONENTIAL SMOOTHING",4X,F14.2)
      WRITE(6,955)MSEDES
  955 FORMAT(/,44X,"DOUBLE EXPONENTIAL SMOOTHING",4X,F14.2)
      WRITE(6,956)MSETES
  956 FORMAT(/,44X,"TRIPLE EXPONENTIAL SMOOTHING",4X,F14.2)
      WRITE(6,957)MSEW
  957 FORMAT(/,44X,"WINTERS METHOD",18X,F14.2)
      WRITE(6,650)
  650 FORMAT(//,43X,"USING GIVEN PARAMETERS, THE BEST FORECASTING METHOD
     + IS:")
      IF(MSER.LT.MSESMA)GO TO 620
      IF(MSESMA.LT.MSEDMA)GO TO 605
      IF(MSEDMA.LT.MSESES)GO TO 610
      IF(MSESES.LT.MSEDES)GO TO 613
      IF(MSEDES.LT.MSETES)GO TO 615
      IF(MSETES.LT.MSEW)GO TO 601
  620 IF(MSER.LT.MSEDMA)GO TO 601
      IF(MSEDMA.LT.MSESES)GO TO 610
      IF(MSESES.LT.MSEDES)GO TO 613
      IF(MSEDES.LT.MSETES)GO TO 615
      IF(MSETES.LT.MSEW)GO TO 600
  601 IF(MSER.LT.MSESES)GO TO 602
      IF(MSESES.LT.MSEDES)GO TO 613
      IF(MSEDES.LT.MSETES)GO TO 615
      IF(MSETES.LT.MSEW)GO TO 600
  602 IF(MSER.LT.MSEDES)GO TO 603
      IF(MSEDES.LT.MSETES)GO TO 615
      IF(MSETES.LT.MSEW)GO TO 600
  603 IF(MSER.LT.MSETES)GO TO 604
      IF(MSETES.LT.MSEW)GO TO 600
  604 IF(MSER.LT.MSEW)GO TO 625
  605 IF(MSESMA.LT.MSESES)GO TO 606
      IF(MSESES.LT.MSEDES)GO TO 613
      IF(MSEDES.LT.MSETES)GO TO 615
      IF(MSETES.LT.MSEW)GO TO 600
  606 IF(MSESMA.LT.MSEDES)GO TO 607
      IF(MSEDES.LT.MSETES)GO TO 615
      IF(MSETES.LT.MSEW)GO TO 600
  607 IF(MSESMA.LT.MSETES)GO TO 608
      IF(MSETES.LT.MSEW)GO TO 600
  608 IF(MSESMA.LT.MSEW)GO TO 626
  610 IF(MSEDMA.LT.MSEDES)GO TO 611
      IF(MSEDES.LT.MSETES)GO TO 615
      IF(MSETES.LT.MSEW)GO TO 600
  611 IF(MSEDMA.LT.MSETES)GO TO 612
      IF(MSETES.LT.MSEW)GO TO 600
  612 IF(MSEDMA.LT.MSEW)GO TO 627
  613 IF(MSESES.LT.MSETES)GO TO 614
      IF(MSETES.LT.MSEW)GO TO 600
  614 IF(MSESES.LT.MSEW)GO TO 628
  615 IF(MSEDES.LT.MSEW)GO TO 629
      IF(MSETES.LT.MSEW)GO TO 600
      WRITE(6,651)
  651 FORMAT(/,60X,"** WINTERS METHOD **")
      GO TO 658
  600 WRITE(6,657)
  657 FORMAT(/,53X,"** TRIPLE EXPONENTIAL SMOOTHING **")
      GO TO 658
  625 WRITE(6,652)
  652 FORMAT(/,58X,"** SIMPLE REGRESSION **")
      GO TO 658
  626 WRITE(6,653)
  653 FORMAT(/,56X,"** SIMPLE MOVING AVERAGES **")
      GO TO 658
  627 WRITE(6,654)
  654 FORMAT(/,56X,"** DOUBLE MOVING AVERAGES **")
      GO TO 658

  628 WRITE(6,655)
  655 FORMAT(/,53X,"** SINGLE EXPONENTIAL SMOOTHING **")
      GO TO 658
  629 WRITE(6,656)
  656 FORMAT(/,53X,"** DOUBLE EXPONENTIAL SMOOTHING **")
      GO TO 658
  658 WRITE(6,994)
  994 FORMAT(1H1,4X,"THIS IS THE LAST PAGE SO THROW IT AWAY")
      STOP
      END
```