Judgemental Forecasting

Chair: Spyros Makridakis, INSEAD, France

AIDED VERSUS UNAIDED JUDGEMENT WHEN FORECASTING MARKET SHARE AND SALES EXPERIMENTAL RESULTS

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Armstrong, Brodie and MacIntyre (1987 p 370) in their review of forecasting methods in marketing concluded that while considerable research effort had been directed at the methods for modelling the factors affecting market share and sales, far less attention had been given to the predictive validity of these methods and models. An area of particular importance where little empirical evidence was available was the evaluation of methods which used aided versus unaided judgement. This paper describes a sequence of experiments which were designed to compare the use of aided versus unaided judgement to forecast market share and sales. The experiments were conducted using panels of experts and non-experts. The results were surprising because the use of aided judgement did not improve the forecasting accuracy of the panel of experts. In contrast, the use of aided judgement with the panel of non-experts considerably improved their forecasting accuracy. The paper concludes by examining why these results have occurred.

THE EFFECT OF INFORMATION CONTENTS ON HUMAN PREDICTIONS: DIFFERENCES BETWEEN EXPERT VS. NOVICE DECISION MAKERS

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One major concern of information providers and researchers interested in how decision makers use information is assessing the marginal value of information. In this study I conduct an experiment to determine the marginal value of three types of data available to users of financial information. The three types of data are: most recent, historical, and forecast. The experiment tests the effect of variations in the types of data on the decision effectiveness of experienced as well as novice decision makers.

STRUCTURING SUBJECTIVE FORECASTS: A COMPARISON

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One of the problems concerning subjective forecasts is their lack of consistency. The individual may generate the forecast employing any subjective method or he/she may use a quantitative forecast method and then subjectively modify the forecast in an attempt to improve it. The general opinion is that the subjective adjustment to the forecast will not make it more accurate. There have been some exceptions to this. In a recent one, the forecast is subjectively modified using Saaty's AHP (Analytical Hierarchical Planning) methodology. In this example, an experiment was carried out taking ARIMA forecasts and adjusting them using AHP with a reasonable degree of success. The process used is rather involved and demands from the user the pairwise comparison of many factors especially subjective perception of percentage values to modify the forecast. Also, the process is done for different levels of the decision process. Recently, another method was developed by T. Solymosi and J. Dombi. This method, dubbed the Centroid method, reduces the complexity of the analysis considerably. In this research, a comparison is made on a real data set generated by financial and non-financial experts predicting earnings per share. An ARIMA forecast is made. The decision making process of AHP is utilized to calculate the forecast adjustments for the forecasts. The same process is done using the Centroid method. The results of the experiment illustrate the use of the Centroid technique and show that the values have the same precision. Since the process is simpler, the Centroid idea is suggested as an improvement over the AHP to structure subjective modifications to forecasts.

THE INFLUENCE OF PRESENTATION, SERIES LENGTH AND PATTERN ON JUDGMENTAL FORECASTS.

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ARMA time series were generated differing in their model (invertible and non-invertible), length of series, and size of variance. These were graphed at three different presentation scales and judgementally forecasted with and without advice being given to the subject. For each of the quarterly series, forecasts over the next four horizons were estimated. These forecasts were robust in that they were not significantly influenced by presentation scale, series length or level of advice. However they were influenced by the shape of the last few data points of the series. The results are discussed from

the viewpoint of a number of proposed judgmental anchoring and adjustment strategies. The results help to understand both the strengths and weaknesses of judgmental forecasts.

CONDITIONS FAVORING THE DECOMPOSITION OF JUDGMENT

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Decomposition is a strategy used in many approaches for aiding forecasting and estimation. In principle, decomposition improves estimation performance by breaking a complex problem down into smaller, more tractable components about which an estimator has better knowledge. Estimates of problem components are then combined, either algorithmically or subjectively, to arrive at a global estimate. Previous research on decomposition as a technique for aiding numerical estimation has shown that under some conditions, dramatic improvements in estimation accuracy can be achieved when compared with non-decomposition approaches. However, the effect is not always salutary. A serious question for the practitioner is: what guidelines should be used for structuring estimation problems "on the fly"? Under what conditions should decomposition be used, and under what conditions should it be avoided? This paper presents a reanalysis of results from studies on decomposition of judgmental estimates in which decomposition produced a substantial improvement in accuracy for large numerical values, but modest or no improvements for small values. Additional studies were conducted to corroborate previous results and to identify other problem characteristics that relate to the efficacy of decomposition as a numerical estimation aid.

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Using Experts in Forecasting

RULE-BASED FORECASTING: AN EMPIRICAL VALIDATION

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Rule-based forecasting is the application of a set of empirically validated and fully-disclosed conditional actions to make forecasts. This paper discusses the development of a rule-based forecasting system. It then presents tests of the validity of rule-based forecasting by using it to produce extrapolation forecasts for a variety of types of annual data. Rule-based forecasting produced substantially more accurate forecasts than could be obtained by prior approaches. For the typical series, the error was reduced to two-thirds that from combined forecasts.

BELIEF NETWORKS FOR FORECASTING THE OIL MARKET

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ARCO1, currently under development at ARCO and USC, incorporates state-of-the-art artificial intelligence (AI) and decision analysis (DA) belief networks into ARCO's forecasting procedure. ARCO1's underlying belief networks is an AI knowledge base; it models the entire market, rather than a specific problem. DA elicitation techniques collect information about the market's variables, their value ranges, and their interrelationships. A pictorial market model—developed on a MAC II—facilitates consensus among the members of the forecasting team. The system forecasts crude oil prices by running a variant of Monte Carlo on the network. Work on belief networks, decisions based upon them, and their applicability to financial forecasting, is in its infancy. It is already clear, however, that this line of research raises many interesting issues, and offers directions in which the technologies of DA and AI may help lead to powerful forecasting aids and systems.

RELIABILITY AND VALIDITY IN EXPERT JUDGMENT

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The performance of expert systems and statistical models depends critically on the quality of the expert judgment upon which they are based. It therefore would appear of prime importance to be able to assess the reliability and validity of the judgments of any expert providing input to decision support. Alternatively, if expert judgment is to be improved by remedial techniques or decision support, it seems necessary to establish accurately where expertise is lacking, and whether any intervention has resulted in increased performance. In view of these practical considerations we critically review the methods which have been used to assess the standard of expert judgment. Various measurement problems are identified, and the contribution of these problems to the conclusions which have been drawn regarding the quality of expertise are assessed. We concluded that, although there are serious difficulties associated with the accurate measurement of expert judgment in the real world, these difficulties don't in themselves overly influence the findings of expertise research. Rather expert performance seems to be influenced most by aspects of the judgmental task and, to a lesser degree, psychological characteristics of the judge him/herself. We propose a task-analytic framework which can be applied so as to permit the identification of judgmental situations where specific problems with the reliability and validity of performance are likely to occur. We argue that this framework may represent a practical solution to the problem of expertise assessment in the field, given the various difficulties we have seen in the accurate measurement of judgmental reliability and validity.

Demographic Forecasting

Chair: J. Scott Armstrong, The Wharton School, USA

ADVANCES IN POPULATION FORECASTING OVER THE PAST DECADE

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This paper surveys the status of population forecasting in 1980 and the developments that have occurred in the past decade. The paper will focus on the U.S. experience but will draw also on European experience where possible. Changes in official forecasting using the cohort-component method will be covered as well as recent forecasting approaches that use structural economic-demographic models and time series methodology. Advances in forecasting the components of population (fertility, mortality, and migration) will also be discussed. The paper will also discuss recent work on confidence intervals for population forecasts and conclude with a discussion of likely directions for research in the next decade.

A DEMOGRAPHIC MODEL FOR FORECASTING HOUSEHOLD ELECTRICITY CONSUMPTION IN NEW ZEALAND

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The changing demographic structure, in particular the "aging" of the population, is expected to have a significant effect on electricity consumption. This paper describes a model which uses variations in age structure in different localities to estimate the consumption patterns of different age groups. Principal Component Analysis is used to extract the most significant characteristics of the age structure. The model indicates that the historical changes in age structure explain changes in consumption much more realistically than economic factors, such as incomes. This model has been used to estimate household electricity consumption in New Zealand over a period of 30 years which takes into account the expected changes in age structure and internal migration patterns. The results show a steady growth in consumption until the turn of the century, followed by a slight decline.

POPULATION, LABOUR FORCE AND UNEMPLOYMENT IN ANDALUCIA: PROSPECTS FOR 1993

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At 28%, Andalusia is the Spanish region with the highest unemployment rate. This represents around 670 thousand people without employment. This paper is concerned with forecasting population, labour force and unemployment by sex in Andalusia to 1993. A recursive demographic-economic model is presented. The demographic model is based on the component-cohort method of forecasting population by age, sex and geographic areas. The economic model combines regressions and time series analysis to forecast labour force and unemployment, taking into account the effect of short run economic fluctuations on male and female participation rates. The model allows for discouraged/added worker effects of changes in the demand for labour. Regional employment perspectives are based on a top-down approach, taking as exogenous national forecasts given by a national econometric model.

Combining Forecasts

Chair: Robert L. Winkler, Duke University, USA

THEORETICAL AND EMPIRICAL COMPARISONS OF OLS, ERLS, AND IRLS COMBINATION FORECASTS

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Theoretically, the efficiency of OLS combinations of forecasts can be improved by using exact non-sample prior information in the form of linear equality or inequality restrictions on the combination parameters. We provide a comparative review of the in-sample and ex-ante squared error loss risk functions for OLS, ERLS (Equality Restricted LS), IRLS (Inequality Restricted LS), and simple average combination forecasts. There is little empirical evidence on the relative performance of OLS vs. ERLS combination forecasts. Furthermore, there is no empirical evidence on the performance of IRLS combinations. In this study, we provide empirical results on the relative efficiency of simple average, OLS, ERLS, and IRLS in-sample and ex-ante combined forecasts. The theoretical risk functions for these combination methods are numerically evaluated and compared to their empirically observed risks. Data sets used in the analysis include three macroeconomic series (GNP, money supply, and 90-day treasury bill rates) and quarterly earnings for 37 firms from three different industries. The individual forecasts for each series are obtained using Winter's three-parameter exponential smoothing, AUTOPRO, and univariate and bivariate state space procedures from SSI; ARMA and state space procedures from SAS; univariate and bivariate ARMA procedures from AFS; and two "premier" models for the earnings series. The combined forecasts and in-sample and ex-ante are obtained using the software COMFOR. Finally, the sensitivity of the relative theoretical risks of these combination methods to the number of observations in the regression design matrix is numerically evaluated for each time series.

THEORIES ON WHY COMBINING FORECASTS INCREASES FORECASTING ACCURACY

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This paper looks at the reasons why combining forecasts improves accuracy. The first part of the paper looks at the reduction in error variance that can be expected from combining. A simulation is presented that relates improvement in accuracy as a function of correlation. An empirical example is given that conforms to the expectations obtained from the simulation. The rest of the paper focuses on processes other than reduced variances that improve the accuracy of combining forecasts. The topics covered are (1) structural changes, (2) econometric variables and time series combinations, (3) partitioning time series and recombining the forecast to improve accuracy, and (4) forecaster errors in combining that improves accuracy.

THE AGGREGATION OF TIME SERIES DATA AND ITS IMPLICATIONS FOR MODEL IDENTIFICATION AND FORECASTING PERFORMANCE

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The paper focuses on two interrelated topics. Firstly, it examines the ACF patterns that arise in combining two time series of prespecified structure. Simulated time series are combined and used to generate ACFs for model identification analysis. ACF pattern "distortions" are especially evident in those cases in which each of the combined series have different underlying structures. In such situations, correct model identification is difficult, but can be effectively guided by an awareness of expected ACF patterns for aggregated data series. The simulated run results are then generalized; that is, theoretical ACF patterns are derived and the results of Granger and Morris, and Anderson are extended. Secondly, aggregate model forecasts are compared with those based upon combining forecasts for the individual component models. Some generalizations as to the forecasting performance of the two approaches are offered.

Applications

Chair: Benito Flores, Texas A&M University, USA

THE APPLICATION OF THE TRANSFER FUNCTIONS IN THE STUDY OF THE SPACE LEVELS OF ONE MULTISECTORIAL FLIGHT

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When we associate the space level with the fare structure of an airline and we forecast when it will be more profitable to accept a booking for a certain space level, then the problem arises of its relation to other equivalent flights. For this reason we utilize the transfer functions associated with the filling profile of each one of the space levels corresponding to the last section of its booking horizon. This study is carried out with one of the transatlantic routes of Iberia Airlines.

A PROCEDURE FOR SCALING ATTITUDINAL DATA OVER TIME

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Forecasts of consumer durables' sales are often based on surveys which measure consumer expectations. A method is presented for constructing from repeated surveys of such expectations a scale which is based on a psychometrically sound response model and distribution theory. A recursive formulation incorporating a Kalman filter allows prior information about the values of some scale parameters to be incorporated efficiently in the estimation of their current values. The measurement properties of such a scale are superior to ad hoc indices and their use should improve forecasting accuracy. In this paper we describe the method and illustrate it with both simulated and actual data from repeated surveys.

FORECASTING NEW PRODUCT SALES WITH DIFFERENT MARKETING MIXES AND VERY FEW OBSERVATIONS: A METHOD FOR DETERMINING AND COMPARING THE SHAPE OF FUTURE SALES CURVES

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In new product marketing we often have a situation where a wholesaler or a retailer accepts or drops the product/the brand after some weeks of marketing. Very often the marketing mix for one and the same product varies in one way or another, e.g. with respect to different types of shops, different advertising or promotion programs etc. The sales data are observed frequently, e.g. on a weekly basis. To analyze the data, analysis of variance approaches are not appropriate because the data are autocorrelated. Related methods such as dummy variable regression analysis or repeated measures analysis of variance are inappropriate for the same reason. The most powerful methods, the Box-Jenkins approaches, typically require more data than are provided by relatively short-term test marketing. Here we present a method, based on transforming the data into polynomial form by the aid of orthonormal contrast matrices, which allows us to compare the influence of different marketing mixes, and enables the determine of the degree of the sales curves and to estimate them. It also provides a basis for statistical testing and further investigation of the curves obtained. The method slightly resembles procedures applied in regression analysis with orthogonal polynomials as independent variables, but it is, however, significically different.

Improving Forecasts

Chair: Allan Murphy, Oregon State University, USA

AN ERROR MEASURE FOR GENERALIZING ABOUT FORECASTING METHODS: THE RAE SCORE

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Relative absolute errors (RAE scores), which show the accuracy of a given method in comparison with the change over the forecast horizon, provide the most effective criteria for generalizing about the accuracy of forecasting methods. An analysis of annual series showed that the accuracy rankings of 12 forecasting methods based on the RAE scores were more stable than those from other measures. In addition, RAE scores did well with respect to construct validity, sensitivity, cost, and understandability.

A SIMULTANEOUS INFERENCE APPROACH FOR MONITORING A FORECASTING SYSTEM

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This study brings together recent work concerning simultaneous confidence regions (e.g., Lieberman, 1961; Miller, 1981, and Carlstein, 1986) with work concerning tracking signals to monitor the performance of a forecasting system (e.g. CUSUM, smoothed-error tracking signals, and autocorrelation tracking signals). One way to view tracking signals in a regression context is as an important use of recursive residuals (see Riddell, 1975). Other tests using recursive residuals have been proposed and found to be powerful alternatives to tests using standard residuals. For example, Harvey (1976) suggests a test for structural change using recursive residuals. A recent article by Grubaugh, Stollar, and Thompson (1990) suggests a test for structural change using the same approach as that of Harvey (1976) but rather than using the recursive residuals simultaneous predictions for a range of values are used. This approach allows the cumulation of information from a number of forecasts while at the same time keeping the advantages of the recursive residuals (linear unbiased with a scalar variance matrix). This paper takes the same approach as Grubaugh, Stollar, and Thompson (1990) but applies the concept of simultaneous forecasts to the problem of monitoring a forecasting System. Several tracking signals using the simultaneous prediction approach are developed that

parallel previous tracking signals that use the recursive residual approach.

IS IT TIME TO DITCH THE RATIO-TYPE TRACKING SIGNAL?

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One technique designed to detect changes in time series parameters is a tracking signal (TS) based upon the ratio of two functions of observed forecast errors. R.G. Brown (1963) developed the first of these and "improved" versions were formulated by Trigg (1964), Batty (1969), and others. It can be shown that the theoretical distribution of run lengths (RL) for the ratio-type TS is the geometric distribution. This theory has been confirmed through simulation studies. This paper describes the basis for this theory and a description of the simulation studies that confirm it. It goes on to demonstrate the somewhat improved performance of a new Shewhart control chart type TS model developed by the authors and raises the question as to whether any TS model that produces RL's that have a geometric distribution in the limit can be useful to practitioners. General thoughts on possible new methods are then provided.

VALIDATION THROUGH DECOMPOSITION

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The science of selecting the proper model or representation in time-series forecasting has progressed from "how well does the model fit the historic data?" to "how well does it forecast?" The next logical step in this progression is selection based on "is the representation a valid one?" If a trend is estimated from history and then blindly used to forecast, the trend often continues into the future, but it often does not. However, when there is a known reason for the occurrence of the trend and it is expected that that reason will continue to have the same affect into the future, this estimated trend is more likely to continue. There is more to forecasting than model fitting and fit extrapolation. Time-series forecasting assumes that patterns which have occurred in the immediate past will continue into the immediate future. However, before the estimates of these patterns are used to forecast, their existence should be validated. This paper presents and illustrates using decomposition a framework for forecasting which selects the proper model based on the validity of its representation.

Macroeconomic Forecasting

Chair: Stephen K. McNees, Federal Reserve Bank of Boston, USA

BLUE CHIP RATIONALITY TESTS

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This paper develops tests for the rationality of the forecasts
made by institutions which contributed to the Blue Chip Economic
Indicators consensus forecasting service, and seeks to establish
why some forecasters appear more rational than others. Several
features of the Blue Chip database mean that we can conduct more
powerful tests of rationality than have proved possible with the
well-known Livingston and ASA-NBER surveys of forecasters.
Important components of each forecasters information set are
known, and we have conducted a survey among the Blue Chip
forecasters to determine what forecasting methods they use.
Other features of the Blue Chip data cause problems for
econometric analysis. Forecasts are repeatedly made for fixed
target dates, so that forecast errors are serially correlated and
heteroscedastic. Our rationality tests are based on statistics
obtained from a specially tailored generalized method of moments
estimator. Such problems have rarely been addressed in earlier
studies of forecaster rationality. Three strong results emerge
from the tests. First, some forecasters are more rational than
others. Second, some variables (notably real GNP and interest
rates) are more rationally forecast than others (notably
inflation). Third, an economic forecast is likely to be
technically rational if (a) it is based on a mainstream economic
theory, and (b) it does not rely primarily on an econometric
model, but incorporates a substantial element of forecaster
judgement.

A VAR MODEL INCORPORATING LEADING INDICATOR AND JUDGMENTAL ELEMENTS FOR FORECASTING MACROECONOMIC VARIABLES IN NEW ZEALAND

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A Bayesian VAR model is enhanced by the addition of a synthetic
variable, enabling elements of judgmental and leading indicator
methods to be included. The model includes typical VAR variables
(GDP, Prices, etc) together with a synthetic variable derived
from over 40 series redated to synchronize peaks and troughs.

This variable leads the economy as a whole and enables turning points to be included in two ways, firstly the usual leading indicator effect, and secondly, the imposition of judgmental forecasts of the individual components. Depending on the coefficients of this variable, the effect of the judgment/leading indicator contribution is strong or weak relative to the auto-regressive elements making up most of the model.

A COMPARISON OF THE ACCURACY OF CANADIAN AND AMERICAN AGGREGATE ECONOMIC FORECASTS: UPDATE AND EXTENSIONS

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Not since Daub (1974) has the question of the relative accuracy of Canada and American aggregate economic forecasts been revisited. This is puzzling, especially in light of two oil shocks, an important recession, and a negotiated Free Trade Agreement (FTA). The present paper addresses this absence. It first updates the evidence on nominal GNP forecasts for the 1970's and 80's originally considered by Daub (1974). It then extends the comparison to real GNP and the deflator forecasts, the distinction being important during the periods in question. Among other conclusions suggested by the comparison, and any differences in accuracy pre and post some of the significant events such as the oil shocks, the results also provide a baseline against which researchers in the future can judge the impact of the FTA on the Canadian forecasting industry, and the relative difficulties of forecasting the Canadian economy.

NEW LEADING INFLATION INDEXES FOR MAJOR INDUSTRIAL COUNTRIES

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It has been recognized for some years that inflation rates are cyclical in many market-oriented economies. In 1983, Geoffrey Moore and Stanley Kaish developed a leading index of inflation cycles for the U.S., based on measures of tightness in the labor market, growth in total credit, and changes in industrial materials prices. In 1986 Klein developed similar leading inflation indexes for Canada, the United Kingdom, West Germany, France, Italy, and Japan. Because this work proved promising, we have broadened the leading inflation index for the U.S. and developed a signal system to forecast major swings in inflation as well as in interest rates. In this paper we propose to broaden and bring up to date similar leading indexes for the United Kingdom, West Germany and Japan. We shall also test their ability to forecast major swings in inflation and interest rates in those countries.

Financial Applications in Forecasting

Chair: Kamal El-Sheshai, Georgia State University, USA

FINANCIAL MARKET FORECASTS AND RATES OF RETURN BASED ON LEADING INDEX SIGNALS

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This report describes and analyzes a practical system which will
assist financial analysts and portfolio managers to maximize the
annual rate of return in their asset-allocation program as
between stocks, stock-term bills, and long-term bonds. The level
and stability of the total rates of return (from capital gain or
loss and dividends or interest) are compared for various
investment strategies. Our objective is achieved by developing,
with the aid of new long-leading indexes, a method of forecasting
the beginning and end of major bull markets in stock prices.
During bear-market periods the choice between the short-term
bills and long-term bonds is governed by signals from a leading
index of inflation. The paper, which carries further the results
presented at the 1988 and 1989 ISF meetings, reports the findings
for Australia, Canada, Japan, United Kingdom and United States.

COMPREHENSIVE FINANCIAL STATEMENT FORECASTING: A PRACTICAL ALTERNATIVE TO BANKRUPTCY PREDICTION MODELS

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The landmark work on bankruptcy prediction by Professor Beaver
(1966) was the catalyst for numerous articles. Predicting
financial difficulty has gained importance with the issuance of
two recent statements on Auditing Standards (NOS. 56 and 59) by
the American Institute of Certified Public Accountants. No. 56
discusses the use of analytical procedures in performing an audit
while No. 59 requires the auditor to consider the ability of an
entity to continue as a going concern. The purpose of this paper
is to present a thorough argument that preparation of forecasted
financial statements is preferable to the use of bankruptcy
prediction models based on historical cost financial ratios.

FORECASTING FOR PORTFOLIO SELECTION

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This paper addresses the problem of modelling returns on
financial instruments with the emphasis on portfolio selection.
There is much effort devoted to modelling univariate return
series, the motivation for this is to provide input for option
pricing models. The multivariate behavior of the returns on a
group of shares is generally ignored. There is also considerable
research effort expended in portfolio selection methods. Most
methods are driven by data based estimates of risk and return,
however little consideration is given to their derivation. A
number of models of multivariate share returns will be compared
in terms of their ability to forecast both the return on a
portfolio and the associated risk. The models considered range
from a straightforward mean variance estimation to multivariate
derivatives of the ARCH models. The relationship between model
sophistication and forecasting accuracy will be discussed.

Accuracy in Forecasting

Chair: Essam Mahmoud, American Graduate School of
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FORECASTING ACCURACY AND BIAS IN LOCAL GOVERNMENT REVENUE FORECASTING

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American local government accounts for over 402 billion dollars of economic activity. Usually, financially strapped and under staffed, those organizations usually have few resources to devote to forecasting revenues as part of a rational financial management strategy. This paper attempts to quantify the extent to which improved forecasting can return financial benefits to local governments. A sample of 68 county and 74 local governments in Pennsylvania over a two year period are used to quantify the extent of forecasting errors present and attempt to explain the sources of these errors. The final section of the paper proposes some guidelines for these local governments to improve forecast performance.

COMPARATIVE EVALUATION OF FORECASTS

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It is frequently necessary to compare the performance of two or more forecasting techniques or forecasters. This paper addresses conceptual and methodological aspects of the comparative evaluation of forecasts. First, some basic issues are discussed, including the motivation for undertaking comparative evaluation, the nature and types of comparisons of interest, and statistical relations of potential importance in this context (e.g., sufficiency, extraneousness). Then frameworks for comparative evaluation are described. These frameworks are based on the joint distributions of the relevant forecasts and observations, and on factorizations of the joint distributions into conditional and marginal distributions. Consideration of the joint, conditional, and marginal distributions leads to the identification of fundamental properties (desirable and

undesirable) of the forecasts and to the development of a coherent and diagnostic body of evaluation methodology. The dimensionality of forecast evaluation problems is found to be a basic characteristic of such problems, and the dangers inherent in drawing conclusions regarding relative forecasting performance from comparative analyses of reduced dimensionality are discussed. These conceptual and methodological developments will be illustrated by means of comparative evaluation of objective and subjective weather forecasts.

FORECAST EVALUATION TECHNIQUES

H.O. Stekler
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This paper examines some of the forecast evaluation techniques which have been developed over the past 25 years. The presentation will show that the technique that is used is associated with the question that is asked. (A list of 8 typical questions that have been asked is attached). In several cases, multiple techniques may be used to analyze a particular question

DIRECTIONAL ACCURACY VERSUS MAGNITUDE OF ACCURACY IN TOURISM FORECASTING

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Previous work by the authors in the context of international tourism demand has shown that the naive "no change" extrapolation model generates forecasts with lower average percentage errors over a one-year time horizon than six other quantitative forecasting methods. This study examines whether any of the other models outperform the "no change" model when forecasting performance is measured in terms of directional accuracy. The forecasting methods are used to generate out-of-sample forecasts for tourist flows across 24 original-destination pairs, and the empirical results show that the model performance ranking varies considerably between the two types of accuracy measure. Econometric models yield the most accurate results according to the direction of change criterion, followed by exponential smoothing models. These, therefore, provide useful planning indicators for the international tourism industry, in that it is possible to forecast with some confidence whether there is likely to be an increase or decrease in demand.

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REPORTING-DELAY ADJUSTMENTS FOR ESTIMATING THE SIZE OF THE HIV INFECTED POPULATION AND FOR FORECASTING THE COURSE OF THE AIDS EPIDEMIC.

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   CA 92717, U.S.A.

Since the AIDS epidemic is in a crucial phase of its growth curve, it is important for short-term forecasting purposes to have good information regarding the actual number of AIDS cases diagnosed each month. However, late-reporting characterizes official data. The adjustment to the diagnosed AIDS time series to account for reporting-delay is shown to be a function satisfying certain multivariable multiplicative functional equations. Solutions to these equations are characterized for both stationary and nonstationary cases. Estimation of initial conditions is discussed in the context of the Canadian and U.S. AIDS epidemic. A discussion is given of smoothing and short-term extrapolation of the adjusted series. Following a review of the incubation time distribution for the HIV infection, an integral equation is given which relates the rates for new diagnosed AIDS cases to new HIV infections by means of the incubation time distribution. Solutions of this equations yield estimates of the size of the HIV infected population that are smaller than those previously reported. The most significant feature of the HIV infection estimates is the rapid increase in the rate of infection prior to 1985/86 and the equally precipitous decline after 1985/86; this phenomenon appears to be robust against substantial changes in incubation time distribution and estimates of the size of the diagnosed AIDS population. A discussion is given of implications for the longer term forecasts of the disease.

ON THE CUMULATED MULTI-STEP-AHEAD PREDICTIONS OF VECTOR TIME SERIES PROCESSES

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When a time series model is used for the purpose of making multi-step-ahead predictions then it is often meaningful to evaluate its prediction performance on the basis of cumulated multi-step-ahead prediction errors. In this paper we consider the theoretical properties of cumulated multi-step-ahead predictors and cumulated multi-step-ahead prediction errors for general linear vector time series processes. Two general expressions for the optimal cumulated multi-step-ahead predictor are derived for processes which can be described by a multivariate state-space model. The first one makes use of predictions which follow from the Kalman filter algorithm while the second is based on the fixed lag-smoother. To diagnose the memory type of cumulated multi-step-ahead predictions two information measures are introduced. For the case of a univariate ARMA (p,q) process with $p \leq 2$ and $q \leq 2$ these measures are evaluated analytically as well as numerically. It is shown that the information content of cumulated multi-step-ahead predictions strongly depends on the prediction horizon and the location of the roots of the AR and MA polynomials.

A COMPARISON AMONG IDENTIFICATION PROCEDURES FOR AUTOREGRESSIVE MOVING AVERAGE MODELS

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In this article we contrast the performance of three types of identification methods for univariate ARMA Models: determinantal arrays, correlation methods, and order determination criteria. Simulation results of different model structures with varying number of observations are used to evaluate the approaches.

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MODELLING TIME SERIES VIA STRUCTURAL MODELS: BAYESIAN AND CLASSICAL APPROACHES

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The idea of assuming that a time series is formed by its unobserved components is not new. Indeed, as mentioned by Nerlove et al (1979), this basic idea has already been used and accepted as true by economists and statisticians of the 19th century. In the pioneer studies attempts were made to detect the prominent features of a series, based on ad hoc methodologies without any solid supporting theory. It was assumed in all of them that the series is composed of: a long term trend, a cyclical movement, a seasonal pattern and a random disturbance term. This method of analysis was then named "decomposition method" and has been used as the basis for many approaches which appeared in the specialized literature ever since its creation. Modern approaches which adopt this decomposition method try to establish a kind of structural dependence among the components and a sequential estimation procedure to provide update estimates of these components. The state space modelling is the most important approach where these two aspects are well looked after. In this paper we describe the two newly developed Harrison & Stevens Bayesian and Harvey's Classical approaches which adopt the same state space modelling as the underlying mathematical model. Besides the theoretical similarities and dissimilarities between the two approaches, we also present the relevant points concerning the corresponding softwares BATS (Bayesian) and STAMP (Classical) which have just been released. The Brazilian monthly inflation rate series is used to illustrate the modelling facilities of the softwares.

Theory and Practice in Forecasting

Chair: Robert Fildes, Manchaster Business School, USA

MULTICLIENT FORECASTS AS A SOURCE OF CORPORATE STRATEGIC INFORMATION

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The results of an earlier survey indicated that multiclient forecasts serve the subscriber companies in three ways: 1) as tools for constructing, evaluating and implementing strategic plans and decisions, 2) as tools for increasing the company's preparedness in organizational decision-making, and 3) as useful social symbols. These roles seemed to be interrelated. In this paper the varying roles of multiclient forecasts are further examined. The discussion is based on an in-depth study among forecast users in eight Scandinavian companies. The paper presents descriptive models for the ways in which multiclient forecasts are integrated into companies' strategic information. The potential effects of multiclient forecasts on companies' strategy formation, as well as the critical aspects of the forecasts and the underlying forecasting processes, are also discussed.

THE ORGANIZATION OF FORECASTING

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Quantitative forecasting techniques are not much used in business. Instead organizations rely on the judgement of managers working close to the product market. Increasingly however, developments in the production planning area require more accurate forecasting. This presentation describes how companies produce their market forecasts, and the perceptions of managers as to the inadequacies in the procedures. It concludes with a discussion of the reasons why organizations mismanage their forecasting activity and how these activities might be improved.

BUSINESS PLANNING UNDER UNCERTAINTY: WILL WE ATTAIN OUR GOALS?

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In business, planning often starts with an annual financial goal
from which annual targets and plans for financial measurements
and sales of individual products are generated. Business
planners then take each annual target number and further
apportion it into monthly targets. There are two basic problems
in such a planning process. One is as the year progresses, how
to assess whether the annual target is being attained or if
action needs to be taken to achieve it. The other is how to
generate reasonable annual and monthly targets, in the first
place. In this talk we will summarize our statistical aids for
making these business assessments and generating monthly planning
targets, given the uncertainty present. These aids are three
planning charts called WINEGLASS, SHIPWRECK and OUTLOOK, and a PC
program called WINEGLASS.

THE DIFFUSION OF FORECASTING THOUGHT: INTERNATIONAL PERSPECTIVES

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During the past three decades the forecasting discipline has
undergone extensive and sustained development in new techniques,
new methodologies, and new approaches to prediction. Despite the
creation of this new information, barriers still exist between
the supply and demand of forecasting thought. This paper
discusses the problems of diffusing forecast theory. It reports
on a 1989 survey of approximately 1000 individuals involved in
forecasting activities including IIF members and nonmembers from
over twenty countries. Particular attention is given to the
diffusion of Box-Jenkins techniques, scenarios, and expert
systems. Also examined is the perceptions of forecast
practitioners, academics, and users in considering different
education methodologies for diffusing forecasting knowledge.

Software for Forecasting

Chair: Hans Levenbach, Levenbach Associates, USA

EVALUATING PC SOFTWARE SYSTEMS FOR TIME SERIES MODELING AND FORECASTING

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The use of statistical/forecasting software is an essential ingredient in the modeling of time series. Without useful software, the forecasting process cannot be carried out economically. In addition, educated interpretation of statistical information such as correlograms of ordinary and partial correlation coefficients can be time consuming for forecasters having large numbers of time series to forecast. In this study, the use of several commercially available forecasting systems are examined to determine their usefulness based on a set of criteria for choosing among the varying and increasing supply of such software. These criteria include discussion of the interface language, ability to handle a wide variety of input, breadth of forecasting procedures available, ability to move programs from one environment to another, readable and usable output report features, documentation, and cost to end (single and multiple) users.

AUTOMATIC FORECASTING SOFTWARE: A SURVEY AND EVALUATION

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Forecasting software, through the incorporation of automatic features for model selection and estimation, has made heretofore "complex" methods more accessible to the practitioner, giving rise concommitantly to claims that software now relieves the practitioner of the burden of technical knowledge. Academics, however, have questioned the wisdom of forecasting without foretraining. This paper presents a survey and evaluation of automatic forecasting, based on the features of 10 forecasting packages which perform single-equation modeling of time series data. Our goals are (1) to clarify for the practitioner the virtues and limitations of automatic forecasting, (2) to assess whether the software encourages if not nurtures good forecasting practice in the identification, evaluation and presentation of a forecasting model. Our principal conclusions: Forecasting software can provide substantial and reliable assistance to the practitioner in the selection of appropriate specifications for

29

extrapolative models. With regard to important tasks involving the evaluation and presentation of forecasts, as well as for the determination of whether the introduction of causal variables is worthwhile, the practitioner is left largely to his/her own devices, expertise, and judgment. The serious danger to the untrained practitioner is the "closed-world" problem of knowing what you don't know.

Technological Forecasting

Chair: Keith Ord, The Pennsylvania State University, USA

FORECASTING METHODS FOR NON-LINEAR PROCESSES, WITH APPLICATIONS TO TECHNOLOGICAL FORECASTING

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Many variables of interest to forecasters, such as market shares or levels of technological innovation are intrinsically non-linear. However, almost all available forecasting methods rely, at least implicitly, upon linear structures. A suitable class of transformations is introduced that allows us to induce linearity and thereby take advantage of existing procedures. Transformation and model selection procedures are discussed and evaluated using both simulated and real data sets.

ESTIMATING TECHNOLOGICAL PROGRESS AT THE INTERNATIONAL LEVEL

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This paper examines technological progress by firm, country and industry for a selected number of companies. Technological progress for the purposes of this paper is determined to be the quantity elasticity of substitution. The countries of the United States, Australia, Britain, Canada, Finland, France, India, Italy, Japan, the Netherlands, South Korea, Sweden, Switzerland and West Germany are among those included in the study. The purpose of the paper is to compare domestic and international operations in an effort to gain additional insight on new directions to pursue regarding world competition in our ongoing effort to optimize the allocation of scarce resources and maximize world output.

TRENDS IN OPTIMISM AND PESSIMISM IN LONG-TERM FORECASTS OF NEW TECHNOLOGIES

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Technological forecasts made in recent decades -- especially in the heady days of the 1960s -- proved grossly optimistic when reviewed against the backdrop of the 1980s. Is that outcome unique? Will events conspire to make today's forecasts too pessimistic? Or, will those forecasts also turn out to be overly optimistic? What about pre-WWII forecasts? How did they turn out? This study reviews technological forecasts made during this century. Four hypotheses are examined: (1) a pro-change view of the future has replaced a tradition-based view -- hence a trend from errors of pessimism to errors of optimism, (2) forecasts made in times of economic and technological growth turn out to be overly optimistic, while undue pessimism dominates periods of slow growth, (3) the level of growth experienced after the forecast was made dictates the outcome, and (4) finally, technological forecasts have been, and will likely always be, overly optimistic.

TIME SERIES MODELS FOR TECHNOLOGICAL FORECASTING: CRITERIA FOR SELECTION

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Different approaches to modeling technological growth curves are reviewed and categorized based upon absolute levels and rates of change. Criteria for assessment include such factors as knowledge of upper limit, functional form, availability of linear regression form, existence of prediction intervals and form of error structure. The experimental design entails the usage of both simulated and actual time series data to ascertain the effectiveness of the criteria. The analysis gives rise to a new approach for selecting appropriate growth curve models which combines trend specification with ARMR error structures.